The Pyrenean species of *Chelidura* (Dermoptera, Forficulidae)

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**Abstract**

The Pyrenees are inhabited by scattered populations of earwigs of the genus *Chelidura* Latreille, 1825. There is some controversy about the specific assignment of these populations: while most authors assign them to *C. pyrenaica* (Gené, 1832), other consider that *C. aptera* (Mégerlé, 1825) is also present in the Pyrenees. The main objective of this work was to revise the identity and synonyms of Pyrenean *Chelidura*. Specimens from recent fieldwork and collections (MNCN-CSIC) were used for morphological and molecular studies (cytochrome oxidase 1). All Pyrenean specimens shared similar *cox1* sequences, very divergent from those of Alpine *C. aptera*. As a consequence, the variability observed in male cerci morphology from the Pyrenees, ranging from long and slightly curved to short and very curved, corresponded to *C. pyrenaica*, and the presence of *C. aptera* in the Pyrenees can be rejected. As previously suggested by Maccagno (1933) and Fontana et al. (2021), the revision of the synonymic list uncovered the misplacement of the name *F. simplex* Germar, 1825 under the synonymy of *C. aptera*, while it rather represents a synonym of *C. pyrenaica* (**syn. nov.**). *Forficula simplex* has nomenclatural priority over *C. pyrenaica*, however both names meet the requirements of the article 23.9.1 of the International Code of Zoological Nomenclature to retain the prevailing usage of *C. pyrenaica* (**nomen protectum**) over *F. simplex* (**nomen oblitum**). Additionally, we discuss the taxonomic status of *Chelidura arverna* David & Van Herrewege, 1973 **stat. nov.** from the French Massif Central.

**Key Words**

*Chelidura aptera*, *Chelidura arverna*, *Chelidura pyrenaica*, Cytochrome oxidase 1, earwigs, geographic distribution, intraspecific variation, morphology, taxonomy

**Introduction**

One of the most characteristic genera of Dermaptera in the high elevations of the European Mountains is *Chelidura* Latreille, 1825, represented by robust large-sized species often found in the upper limit of the coniferous forests. After the recent revision by Kirstová et al. (2020) who reconsidered the status of *Mesochelidura* Verhoeff, 1902 and *Chelidurella* Verhoeff, 1902, previously synonymized with *Chelidura* by Steinmann (1993), the genus *Chelidura* includes 13 species confined to mountains of the Palaearctic region (Kočárek 2004; Kirstová et al. 2020). However, the genus is still in need of a rigorous taxonomic revision to determine the status of the Asian species (Kirstová et al. 2020).

The species of *Chelidura* are characterized by absence of wings, a broad and large body with rudimentary tegmina, abdomen strongly dilated towards the posterior end, and flat, rounded and not protruding pygidium (Albouy and Caussanel 1990; Kočárek 2004; Kirstová et al. 2020; Fontana et al. 2021). The Pyrenean Mountain Chain is inhabited by scattered populations of *Chelidura*, distributed over the Spanish, Andorran and French sides of the chain (Lapeira and Pascual 1980; Albouy and Caussanel 1990; Herrera-Mesa 1999; Fontana et al. 2021). The specific ascription of these Pyrenean populations is subject
to discussion. Some authors only mentioned the presence of *C. pyrenaica* (Gené, 1832) in the Pyrenees (Marquet 1877; Finot 1890; de Bormans and Krauss 1900; Houlbert 1900; Xambeu 1903; Kirby 1904; Burr 1904; Xambeu 1907; Hamon 1956; Popham 1968; Vancassel and Foraste 1980; Dauphin 1987; Fontana 1999; Dussoulieux 2004; Fontana et al. 2021), while some others considered that *C. pyrenaica* and also *C. aptera* (Megerle, 1825), are both present in the Pyrenees (Serville 1839; Fieber 1853; Bolivar 1878; Cazurro Ruiz 1888; Chopard 1922; Chopard 1951; Boeseman 1954; Amiet 1961; Sakai 1973; Harz and Kaltenbach 1976; Lapeire and Pascual 1980; Caussanel and Albouy 1987; Albouy and Caussanel 1990; Herrera-Mesa 1999).

*Chelidura pyrenaica* and *C. aptera* are two European species with ecological similarities. Both species are found in mountains at relatively high elevations, between 1000 and 2500 m of altitude (Albouy and Caussanel 1990). Most reports and descriptions indicate that *C. aptera* and *C. pyrenaica* are easily differentiated morphologically by the shape of male cerci (see Finot 1890; Azam 1901; Chopard 1922; Albouy and Caussanel 1990). According to those authors, males of *C. aptera* have long, relatively thin and slightly curved cerci, while males of *C. pyrenaica* have short, broad and very curved cerci. In both species, cerci of females are short, thin and practically straight, with a slight curvature at the apex. However, Dohrn (1867), followed by Brunner von Wattenwyl (1882), Maccagno (1933) and Fontana et al. (2021) considered that long, thin and slightly curved cerci together with short, broad and very curved cerci were part of the intraspecific variability of each taxon, and questioned the presence of *C. aptera* in the Pyrenees (or the presence of *C. pyrenaica* in the Alps). To complicate matters, as already noted by Maccagno (1933), the earliest descriptions of Pyrenean specimens of *Chelidura* as a differentiated taxon correspond to *Forficula simplex* Germar, 1825, which was described based on long cerci Pyrenean specimens (Germar 1825). *Forficula simplex* was subsequently included in the synonymy of *C. aptera* by Dohrn (1867), followed by Bolivar (1876), Brunner von Wattenwyl (1882), Finot (1890), Kirby (1904), Burr (1904), Sakai (1973), Harz and Kaltenbach (1976), and Herrera-Mesa (1999) among others, or treated as a variety of *C. aptera* (Dubrony 1878).

The known distribution range of *Chelidura* in the Pyrenees is quite limited, with very few records in Andorra and the Spanish (Lapeira and Pascual 1980) and French slopes (Albouy and Caussanel 1990) (see “Species accounts” section). During field surveys aimed to document the persistence of the species in some of the classical localities, we were surprised to find consistently specimens with long cerci (referred to as *C. aptera* in the literature; e.g. Lapeira and Pascual 1980; Albouy and Caussanel 1990), and short cerci (referred to as *C. pyrenaica*; op. cit.) coexisting at the same localities. These observations, together with the lack of consensus on the presence of *C. aptera* in the Pyrenees (see references above), prompted us to carry out a study to determine the correct identification of long and short cerci specimens of Pyrenean *Chelidura*. For this purpose, we obtained cytochrome oxidase 1 (cox1) partial sequences of a few Pyrenean specimens, a representative of each cerci morphology, and we also raised under controlled conditions, a series of nymphs collected from the same clutch till they metamorphosed. The results of these analyses revealed that both long and short cerci males corresponded to a single taxonomic entity.

With this main aim, the specific objectives of this work are: (i) to confirm the taxonomic identification of *Chelidura* specimens with long and short cerci present in the Pyrenees, (ii) discuss the taxonomic entity of the subspecies *C. pyrenaica arverna* from the French Massif Central, and (iii) provide a species account including all known localities and synonymies of Pyrenean *Chelidura*.

### Material and methods

**Studied material, morphological study and distribution data**

Sampling was conducted in different localities of the Catalonian Pyrenees (Girona, Lleida, Andorra and Italy (Valle d’Aosta). A total of 104 specimens, 95 specimens of *C. pyrenaica* and 9 specimens of *C. aptera* (see below) were collected. All specimens were collected by hand, photographed in the field (when possible) and geo-referenced prior to being preserved in absolute ethanol, and then stored at −20 °C at the Museo Nacional de Ciencias Naturales (MNCN-CSIC) (Madrid, Spain). A set of 124 additional specimens of *C. aptera* and *C. pyrenaica* from the MNCN-CSIC collection were used for the morphological study. A series of last instar nymphs from Tossa d’Alp were maintained under controlled conditions until metamorphosis, previous to preservation (11 males were obtained from nymphs). The 228 specimens studied are from:

*Chelidura pyrenaica* (Gené, 1832): **ANDORRA**: Sant Julià de Lòria: Bixessari: Coll de la Gallina, 1933 m, 42°27′33.6″N, 1°27′03.7″E: 20-VI-2013, 2 females with eggs, M. García-Paris, G. García-Martín (MNCN_Ent 296001, 296015); La Rabassa, 1963 m, 42°26′21.7″N, 1°31′26.4″E: 20-VI-2013, 3 nymphs IV, 1 nymph V, 2 males, 5 females with eggs, M. García-Paris, G. García-Martín (MNCN_Ent 296016–296017, 296444, 296003–296010).

– **FRANCE**: **Ariège**: L’Hospitalet-près-l’Andorre: 2 nymphs, 1 female, Dr. Martin (MNCN_Ent 283428–283430). **Hautes-Pyrénées**: Bagnères-de-Bigorre: 20-IX-1886, 1 male, 1 female, Collection A. Finot (MNCN_Ent 7849); Coll d’Ares, 1508m, 42°26′21.7″N, 1°31′26.4″E: 20-VI-2013, 3 nymphs IV, 1 nymph V, 2 males, 5 females with eggs, M. García-Paris, G. García-Martín (MNCN_Ent 296016–296017, 296444, 296003–296010).

**Pyrénées-Orientales**: Canigou: 1 female, Col. Marquet (MNCN_Ent 283425); 1 male, Masferrer (sub C. aptera) (MNCN_Ent 7849); Coll d’Ares, 1508m, 42°21′58.7″N, 2°27′31.5″E: 17-VI-2013, 1 female, M. García-Paris, G. García-Martín (MNCN_Ent 295998); Mont-Louis: 1 male, 1 female, E. Simon leg., I. Bolivar det. (MNCN_Ent 283426–283427). – **SPAIN**: **Catalunya**: **Bar-
celona: Berga: Rasos de Peguera: 23-V-1991, 1 female, C. Martín (MNCN_Ent 122647); Montseny: 1 nymph, 3 males, 2 females, Masferrer (MNCN_Ent 122705, 122720–122721, 122723–122725); Girona: Camprodón, 950 m: 15-IX–40, 5 males, J. Mat [J. Mateu] (MNCN_Ent 122699, 122736–122739), 25-IX–40, 2 male, 2 females, J. Mat [J. Mateu] (MNCN_Ent 122697–122698, 122700–122701); La Molina: Tossa d’Alp, 2343 – 2484 m, 42°19’30.07”N, 1°54’10.89”E / 42°19’12.78”N, 1°53’45.57”E: 5-VII-2011, 22 nymphs, 8 females, 10 males, P. Pavón-Gozalo, M. García-Paris, V. Salvador de Jesús (MNCN_Ent 269465–269466, 269468–269471, 269474, 269443, 269480–269485, 296013–296014, 295972–295995); Puigcerdà: 2 males, Zariquiey (MNCN_Ent 122637, 122729); Puigmal, 2909 m: 1 male, Cazurro (MNCN_Ent 122729); Setcases: Vallter, 1736 m, 42°24’11.50”N, 2°17’12.82”E: 4-VII-2011, 8 nymphs, P. Pavón-Gozalo, M. García-Paris, V. Salvador de Jesús (MNCN_Ent 269460–269461, 269467, 269487, 295968–295971); 2174 m, 42°35’40.53”N, 2°15’58.56”E: 4-VII-2011, 23 nymphs, 2 males, 4 females, P. Pavón-Gozalo, M. García-Paris, V. Salvador de Jesús (MNCN_Ent 269462–269464, 269472–269473, 269442, 269475, 269477–269479, 269486, 269489–269491, 295953–295966, 13276); 2175 m, 42°35’36.7”N, 2°15’41.0”E: 17-VI-2013, 1 nymph IV, 1 nymph V, M. García-Paris, G. García Martín (MNCN_Ent 295999–296000); Toses: 26-IX-1932, 1 male, 1 female, A. Vilarrubia (MNCN_Ent 122726–122727); Lleida: Bellver: 10-903 [X-1903], 1 male (MNCN_Ent 122728); Caldes de Boí: VIII-1945, 3 males, Montada, (MNCN_Ent 122730–122732); Llès de la Cerdanya, 1935 m, 42°35’39.39”N, 1°39’51.73”E: 5-VII-2011, 4 nymphs, P. Pavón-Gozalo, M. García-Paris, V. Salvador de Jesús (MNCN_Ent 269476, 269488, 295996–295997); Pto. Payás [Pallars]: Virgen de Arés [Alt Aneu]: 32 females, 29 males (MNCN_Ent 122638–122644, 122646, 122648–122659, 122661–122677, 122679–122689, 122703, 122707–122718), 1923, 1 male, 2 females, M. Escalera (MNCN_Ent 122690, 122694–122695), VIII-1928, 4 females, 5 males, M. Escalera (MNCN_Ent 122660, 122678, 122702, 122704, 122706, 122691–122693, 122696); Sallardu, 1.260 m: VIII-48, 1 nymph, E. Morales (MNCN_Ent 122645); Valle de Arán: Llanes: 1 nymph, 2 females (MNCN_Ent 122733–122735); Pirineos (without further indication): 1 male, Martorell (MNCN_Ent 122719); 1 female, 3 males, Col. Marquet (MNCN_Ent 283423–283424, 283439–283440) (specimens referenced from Pyrenees by Dubrony 1878 and Azam 1901) (Fig. 1).

Chelidura aptera (Megerle, 1825): France: Savoie: Mont-Cenis: 1 female, H. Martin (MNCN_Ent 283431); Saint-Bernard [Col du Petit Saint Bernard]: 1 male, Brunner (MNCN_Ent 283438). – Italy: 3 females, 1 male, Durieu (MNCN_Ent 283434–283437). Gressoney la T. [Trinité] (Piemonte, M. Rosa): VIII-935 [1935], 1 male, 1 female (C. Alzona) (MNCN_Ent 283432–283433); Vallée d’Aosta: Val Veny: Pré de Pascal, 1856 m, 45°48’20.2”N,
DNA extraction and amplification

Total DNA was obtained from six specimens (Table 1). DNA was extracted from one leg, using the DNeasy Blood and Tissue Isolation Kit (Qiagen, Hilden, Germany), following the manufacturer’s instructions, and then stored at 4 °C until further processed. The polymerase chain reaction (PCR) consisted of, with occasional minor variations, 18.8 μL of distilled water, 2.5 μL of 10 × PCR buffer, 1 μL of dNTP mix (10 mM), 0.5 μL of MgCl₂ (50 mM), 0.5 μL of each primer (10 μM), 0.2 μL of DNA polymerase (5u/μL) and 1 μL of DNA template, consisting of a final reaction volume of 25 μL. The universal pair of primers LCO1490 and HCO2198 (Folmer et al. 1994) were used to amplify a fragment of cox1 with the following PCR cycling profile: initial denaturation at 96 °C for 5 min, followed by 40 cycles at 94 °C for 30 s, 42 °C for 45 s and 72 °C for 1 min, and a final extension step at 72 °C for 5 min. After the amplification, 4 μL of the reaction was analyzed by electrophoresis on a 1% agarose gel. Samples with single bands were sent to the company Macrogen Inc. (Macrogen Europe, Madrid, Spain) for sequencing in both directions.

Phylogenetic analyses and species concept

The cox1 data set included four Pyrenean specimens (with diverse cerci morphology), two specimens from the Italian Alps, one specimen of C. p. arvernana from Kirstová et al. (2020), and six additional specimens of C. aptera from Fontana et al. (2021) (Table 1). One additional specimen of Chelidurella vignai Galvagni, 1995 and another of Chelidurella thaleri Harz, 1980 (from Kirstová et al. 2020; Table 1) were used as closely related outgroups. We also included one specimen of Mesochelidura occidentalis Fernandes, 1973 and another of Anchedula bipunctata (Fabricius, 1781) (from Kirstová et al. 2020; Table 1) as distant outgroups to root the phylogenetic analyses. Gen Bank accession numbers for the newly sequenced specimens are provided in Table 1.

The obtained cox1 partial sequences were aligned with MAFFT v.7 (Katoh et al. 2019) using default parameters. Uncorrected (p) pairwise genetic distances were estimated using PAUP* v.4.0a (Swofford 2002). The best substitution model obtained using PartitionFinder2 (Lanfear et al. 2016) was HKY + I + γ. An XML File was generated with BEAUti v.2.5.0 (Bouckaert et al. 2019) using a birth-death process model, and an uncorrelated relaxed lognormal clock model under default parameters. Bayesian analyses were performed using in MrBayes v.3.2.6 (Ronquist et al. 2012) and BEAST v.2.6.3 (Bouckaert et al. 2019), through the CIPRES Science Gateway v.3 (Miller et al. 2010). The length of MCMC chain was 1,000,000 sampling every 1000. To check for convergence of the Markov chains Monte Carlo (MCMC), posterior trace plots and effective sample sizes (ESS) were examined in TRACER v.1.7 (Rambaut et al. 2018). The first 25% of sampled trees were discarded, and using TreeAnnotator v.1.8.4 (Drummond et al. 2012), the results were summarized in a maximum clade credibility tree (MCC) and selecting a length of the nodes based on the median. Visualization and editing of the phylogenetic tree were carried out in FigTree v.1.4.4 (Rambaut et al. 2018).

Table 1. Specimens used for DNA analyses with their corresponding MNCN Entomology Collection codes (or original publication) and GenBank accession numbers.

<table>
<thead>
<tr>
<th>Species</th>
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<th>Geographic origin</th>
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<th>GenBank COI</th>
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<td>Anchedula bipunctata</td>
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Evolutionary (taxonomic) units within Chelidura were defined using the evolutionary species concept as discussed in Sánchez-Vialas et al. (2020). The evolutionary species concept considers species as “a single lineage of ancestral descendant populations of organisms that maintain its identity from other such lineages and which has its own evolutionary tendencies and historical fate” (Wiley 1978, 1981; Wiley and Mayden 2000).

Results

Based on the phylogenetic analyses, studied specimens of Chelidura compose three well-supported clades (posterior probabilities = 1) (Fig. 2). A clade includes the Pyrenean specimens (PP = 1), a second clade includes the Massif Central specimen, and the third clade includes the Alpine specimens (Valle d’Aosta – Biella – Sondrio – Valais: Grand Saint Bernard) (PP = 1). The Alpine samples are geographically structured in two main subclades, one including samples from Valle d’Aosta and Col du Grand Saint Bernard (PP = 0.99), the second from Biella and Sondrio (PP = 0.94). Uncorrected “p” distances between different groups based on cox1 partial sequences are summarized in Table 2.

Pyrenean specimens (Andorra and Girona) form a monophyletic group of poorly differentiated sequences (uncorrected p distance ranging from 0 to 0.03) (Fig. 2; Table 2). These samples include male specimens from Tossa d’Alp (Girona) and La Rabassa (Andorra) with typical short cerci (MNCN_Ent 296014, 296016) and specimens from Tossa d’Alp (Girona) with very long cerci (MNCN_Ent 296013). The sister taxon relationship of the Alpine clade with respect to the Pyrenean and Massif Central clades is poorly resolved (PP = 0.72) forming a possible polytomy with respect to Chelidurella. Genetic distance between the specimens of the Pyrenean and the Alpine clades is very large (uncorrected p distance = 0.19–0.22) (Table 2). It is almost as high as those found among different genera of Forficulidae (Table 2), suggesting that nucleotide changes in cox1 might be already saturated at that level.

Male specimens included in the Pyrenean clade (Girona and Andorra) present large variability in the shape of the cerci. Cerci range from long, almost straight convergent cerci (Figs 3A, 4A), to very curved, broad, short cerci (Fig. 3D). Short cerci present the maximum curvature at the middle, forming an angle of approximately 90°; cerci are wider at the base, strongly narrowed at the area of greatest curvature (Fig. 3D, E), and maintaining a more or less constant width up to the apex (Fig. 3D). Long cerci are sub-cylindrical, slightly curved at their maximum width near the base, progressively narrowed towards the apex, acuminate at the end (Fig. 3A). Cerci may present a ridge on the inner margin (Fig. 3B–F) or not (Fig. 3A). This ridge, when present, arises after the point of greatest curvature of the cerci and can continue to the apex of the cerci (Fig. 3D, E) or ending earlier, resembling a broad tooth (Fig. 3F). Intermediate specimens between these extreme shapes also occur (Figs 3B, C, F, 4C, D). In the same way, the diameter of the cerci is variable, including specimens with thick cerci compared to others with finer cerci. In all the individuals studied, cerci diameter expands over half or more of the width of the last segment. Males raised under controlled conditions from a single group of last instar nymphs from...
Table 2. Uncorrected (p) pairwise genetic distance matrix between specimens (short – long cerci) and taxa used in the phylogenetic analyses.

<table>
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<th>Chelidura aptera</th>
<th>Chelidura pyrenaica</th>
<th>Chelidurella vignai</th>
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<td>0.08-0.09</td>
<td>0.02</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sondrio</td>
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<td>0.03-0.04</td>
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</tr>
<tr>
<td>C. pyrenaica</td>
<td>Long cerci</td>
<td>0.19-0.21</td>
<td>0.19-0.22</td>
<td>0.00-0.03</td>
<td>0.02-0.03</td>
<td></td>
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<tr>
<td></td>
<td>Short cerci</td>
<td>0.19-0.22</td>
<td>0.15</td>
<td>0.14-0.15</td>
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<td></td>
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<tr>
<td>C. arverna</td>
<td></td>
<td>0.18-0.21</td>
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<td>0.21-0.21</td>
<td>0.20</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>0.21-0.21</td>
<td>0.19-0.20</td>
<td>0.19-0.20</td>
<td>0.21</td>
<td>0.15</td>
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<tr>
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<td>0.21</td>
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<tr>
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<td>A. bipunctata</td>
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<td>0.22</td>
<td>0.22</td>
<td>0.20</td>
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<tr>
<td>Mesochelidura</td>
<td>M. occidentalis</td>
<td>0.24-0.25</td>
<td>0.20</td>
<td>0.20</td>
<td>0.21</td>
<td>0.23</td>
</tr>
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</table>

Figure 3. Cerci variation in *Chelidura pyrenaica* (Gené, 1832) males. Specimens from: (A) Puigcerdà (Girona, Spain) (MNCN_Ent_122637); (B) Pyrenees (Spain) (MNCN_Ent_122719); (C) Camprodon (Girona, Spain) (MNCN_Ent_122738); (D) Pyrenees (MNCN_Ent_283424); (E) Caldes de Boí (Lleida, Spain) (MNCN_Ent_122732); (F) Montseny (Barcelona, Spain) (MNCN_Ent_122721). Scale bar = 1 mm.

Tossa d’Alp present long, short and intermediate cerci (Fig. 4A, C, D).

The specimens studied from the Alpine clade present long cerci with little curvature, cylindrical apically, progressively narrowed towards the apex and the inner margins without teeth or with one tooth. The diameter of the cerci of those specimens studied is generally smaller than that of the specimens of the Pyrenean clade. However, our sample is not representative of the variability already reported for the Alpine clade (Burr 1912; Amiet 1961; David and Van Herreweghe 1973; Sakai 1973; Caussanel and Albouy 1987; Albouy and Caussanel 1990; Herrera-Mesa 1999). Fontana et al. (2021) indicated that cerci variability in *C. aptera* is larger than previously considered, pending of a detailed geographic analysis.

The Pyrenean clade is sister to the single sequence representing the Massif Central clade (PP = 0.87). The
genetic distance between Pyrenean and Massif Central populations is quite large (uncorrected $p_{\text{distance}} = 0.14–0.15$). Among the large series of Pyrenean specimens studied we did not find the cerci morphology described for *C. p. arverna* by David & Van Herrewege (1973), Kirstová et al. (2020) and Fontana et al (2021). Cerci of the specimen included in the Massif Central clade, from Chalmazel (France), are more robust, relatively wider and less curved than cerci of the specimens of the Pyrenean clade. David and Van Herrewege (1973) confirmed that the morphology of the Pyrenean populations and those of the Massif Central (morphometric traits and male cerci), differ statistically.

Male genitalia from specimens of the Pyrenees, Alpine and Massif Central clades, including the lectotype of *C. pyrenaica*, the neotype of *C. aptera* and the holotype of *C. p. arverna*, were studied in detail and photographed by Fontana (1999) and Fontana et al. (2021). Maccagno (1933) also provided an illustration of the male genitalia of Pyrenean specimens corresponding to *C. pyrenaica*. The genitalia of the male specimens of *C. pyrenaica* we examined (Virgen de Ares, Lleida) match the description presented by Maccagno (1933) and Fontana (1999); variability is however large, including size of parameres. They differ from those of the Alpine specimens, by showing thinner parameres with almost parallel margins (shorter and curved on the external margin in Alpine specimens). Male genitalia of typical *C. pyrenaica* and the holotype of *C. p. arverna* do not differ significantly, although *C. p. arverna* seems to present a more arcuate vesicle.

Species accounts

*Chelidura arverna* David & Van Herrewege, 1973 stat. nov.


Published records. **France**: Cantal (Chopard 1922 sub *C. aptera*; Chopard 1951 sub *C. aptera*; Sakai 1973 sub *C. aptera*; Harz and Kätenbach 1976 sub *C. aptera*); Le Lioran (Burr 1904 sub *C. aptera*); Le Lioran, prairies voisines de la station (Finot 1890 sub *C. aptera*). **Haute-
Loire: Massif Central (Amiet 1961 sub C. aptera); Caussanel and Albouy 1987 sub C. aptera and C. pyrenaica; Albouy and Caussanel 1990 sub C. aptera and C. pyrenaica; Herrera-Mesa 1999 sub C. pyrenaica); Mont Mézenc (David and Van Herrewege 1973; Albouy and Caussanel 1990 sub C. pyrenaica spp. averna [averna]). Loire: Chalmazel: Station de Chalmazel, 1137 m, 45°40′33″N, 3°49′32″E (Fontana et al. 2021). Lorraine: (Chopard 1922 sub C. aptera; Chopard 1951 sub C. aptera; Sakai 1973 sub C. aptera; Harz and Kaltenbach 1976 sub C. aptera). Puy-de-Dôme (Chopard 1922 sub C. aptera; Chopard 1951 sub C. aptera; Sakai 1973; Harz and Kaltenbach 1976 sub C. aptera); Mont Doré (Fontana et al. 2021).

**Dubious assignment:** France: Ardèche (Harz and Kaltenbach 1976 sub C. aptera); Astet (Chopard 1951 sub C. aptera).

**Chelidura pyrenaica** (Gené, 1832)

*Forficula* simplex Germar, 1825: pl. 17 (nomen oblitum) syn. nov. Terra typica: “...in Pyrenaeis...”


*Forficula dilatata* Burmeister, 1838: 755. Terra typica “In den Pyrenäen”?

*Forficula pyrenaica* Herrich-Schäffer, 1840: 31. Terra typica not indicated. A synonym of either *C. pyrenaica* or *Pseudocheleidura simia* (Germain, 1825) (Herrich-Schäffer 1840).

Chelidura dilatata (Burmeister, 1838): Brunner von Wattenwyl 1882: 25

Chelidura pyrenaica (Gené, 1832): de Bormans and Krauss 1900: 108. Sakai (1973: 175) wrote by mistake “Chelidura pyrenatica”.

**Published records. Andorra** (David and Van Herrewege 1973; Steinmann 1981 sub *C. aptera*). – **France:** Ariège (Dubrony 1878 sub *C. aptera*; Finot 1890 sub *C. dilatata*; Azam 1901 sub *C. dilatata*; Chopard 1951; Sakai 1973): 1500 m (Chopard 1922; Anglade [Cirque d’Anglade] (David and Van Herrewege 1973); L’Hôpital-près-Andorre (Dusoulier 2004); Montagnes de l’Ariège (Marquet 1877 sub *C. pyrenaica*); hospital de Canigou, a partir de 1000 mètres (Xambeu 1907 sub *C. dilatata*; Chopard 1951; Canigó, à partir de 1200 m d’altitude, jusqu’à 2400 m (Xambeu 1903 sub *C. dilatata*); Céuta, haute vallée de la Carença (Hamon 1956); Val d’Eyne (Chopard 1951; Hamon 1956); Vallée supérieure du Tech (Borelli 1905 sub *C. dilatata*; Sakai 1973). Pyrénées (département not indicated) (Serville 1839 sub *F. aptera* et *F. simplex*; Fieber 1853 sub *F. simplex* et *F. dilatata*; Dubrony 1878 sub *C. aptera* et *C. a. var. simplex*; Brunner von Wattenwyl 1882 sub *C. dilatata*; de Bormans and Krauss 1900; Azam 1901 sub *C. aptera*; Kirby 1904; Borelli 1905 sub *C. dilatata*; Amiet 1961; David and Van Herrewege 1973; Caussanel and Albouy 1987; Albouy and Caussanel 1990): les parties élevées (Azam 1901 sub *C. dilatata*); localités élevées (Houlbert 1900 sub *C. dilatata*); southern Europe from Pyrenees and Southern France (Sakai 1973 sub *C. aptera*). – **Spain** (province not indicated): Espagne en montagne, entre 1000 et 2500 m d’altitude (Albouy and Caussanel 1990 sub *C. aptera*); Norte de España (Cazorru Ruiz 1888 sub *C. dilatata*). Aragón: Huesca: Coll de Basíbé, 2000–2200 m (Borelli 1926; Sakai 1973); Hospital de Benasque, Maladeta, 1775 m (Borelli 1926; Sakai 1973); Valibierne-Tal bei Benasque, 2000–2400 m (Borelli 1926; Sakai 1973). Catalunya: Barcelona (Herra-Mesa 1999): Espinalbet (Lapeira and Pascual 1980); Montseny (Lapeira and Pascual 1980). Girona (Herra-Mesa 1999): Campodrón (Cazorru Ruiz 1888 sub *C. dilatata*; Novellals 1901); Campodrón 950 m (Lapeira and Pascual 1980); Campodrón (“a native of the upper regions of the Pyrenees, where it occurs at an elevation of 6000ft...8000ft.”) (Burr 1904); Col de Tosas [Collada de Toses] (David and Van Herrewege 1973); Nuria [Vall de Núria] (Lapeira and Pascual 1980); Nuria, pinar de la Virgen, a más de 2000 metros (Navás 1921); Puigcerdá (Lapeira and Pascual 1980); Puigmal [Puigmal d’Er], 2909 m (Lapeira and Pascual 1980); Riba Freser [Ribes de Freser] (Harz and Kaltenbach 1976; Albouy and Caussanel 1990; Fontana 1999);
Figure 5. Live specimens of *Chelidura pyrenaica* (Gené, 1832) from Andorra and typical habitat. A. Female with eggs from Coll de la Gallina (Andorra). B. Early instar nymph from Coll de La Rabassa (Andorra). C. Late instar nymph from Coll de la Rabassa (Andorra). D. Typical habitat where *C. pyrenaica* complete its development (Coll de la Gallina, Andorra; June). E. Slopes of Tossa d’Alp (Girona; July) where specimens of *C. pyrenaica* showing a wide variability of cerci shape coexist. Photographs by M. G.-P.

Ripollès: Toses [Collada de Toses] (Lapeira and Pascual 1980); Riu (BVdb 2021); Ull de Ter [Ulldeter] (Lapeira and Pascual 1980). **Lleida** (Herrera-Mesa 1999): Aransa [Arànser] (BVdb 2021); Bellver [Belliver de Cerdanya] (Lapeira and Pascual 1980); Bellver de Cerdanya (BVdb 2021); Bor (BVdb 2021); Caldas Bohí [Caldes de Boi] (Lapeira and Pascual 1980); Martinet (Boeorman 1954; Sakai 1973; Sakai 1973 sub *C. aptera*); Parque Nacio-
nal de Aigues Tortes (Balcells et al. 1962); Pto. Payás [Pallars]: Virgen de Ares [Alt Àneu] (Lapeira and Pascual 1980); Tirvia (BVdb 2021); Tornafort (BVdb 2021); Valle de Arán [Val d’Aran] (Lapeira and Pascual 1980); Val d’Aran: Port de Viella (Borelli 1926; Sakai 1973; Lapeira and Pascual 1980); Val d’Aran: Salaradè, 1260 m (Lapeira and Pascual 1980). Pirineos (provincia not indicated) (Fischer 1853 sub C. dilatata; Bolívar 1878 sub C. apertura; Martorell Peña 1879; Cazurro Ruiz 1888 sub C. apertura and C. dilatata; Burr 1910; Popham 1968; Sakai 1973; Harz and Kaltenbach 1976; Lapeira and Pascual 1980; Causseaul and Albuoy 1987; Steinmann 1989; Fontana 1999; Herrera-Mesa 1999; Guillet and Vancassel 2001; Kirstová et al. 2020 sub Chelidura; Fontana et al. 2021) (Fig. 1).

Fontana et al. (2021: fig. 13) commented on a specimen morphologically assignable to C. pyrenaica from the Sierra Nevada Mountains in Southern Spain (Picacho de Veleta; Museum National d’Histoire Naturelle, Paris). As Fontana et al. (2021) discussed, it is quite possible that the specimen could be mislabelled, as it has already happened with other specimens of Dermaptera labelled erroneously from the Sierra Nevada Mountains, otherwise a quite well explored mountain chain (García-París 2017). The presence of Chelidura in the Sierra Nevada Mountains should be treated as doubtful until additional specimens come to light.

Notes on Natural History

Chelidura pyrenaica is found in mountain slopes, between 1000 and 2500 m, usually in pastures in areas covered by flat stones, near the forest edge or in open areas (Fig. 5D, E) (Borelli 1905; Chopard 1922; Chopard 1951; David and Van Herrewege 1973; Albouy and Caussanel 1990). The geologic substrates of the area are diverse and complex, dominated by schists and limestone (see for a general overview Dendaletche 1982). Adult specimens are usually found under stones, bark of fallen trees and clods of earth in summer and fall (Azam 1901; Xambeu 1903; Chopard 1922; Albouy and Caussanel 1990). Xambeu (1903, 1907) and Chopard (1951) mentioned that C. pyrenaica can be also found in spring. Mating takes place in April or May, in galleries that earwigs dig under their shelters. Females lay the eggs grouped in a shallow place in April or May, in galleries that earwigs dig under their mandibles. Herter (1943) indicates that females may lay 40–45 eggs per clutch. Diverse nymphal stages were observed in the second half of June in Andorra and in the first half of July in Coll d’Ares (Girona) also attended by females (Fig. 5B, C).

Discussion

There is a strict correspondence between mtDNA clades and geographic areas, with all samples from the Pyrenees included in a well-supported clade, sister to the Massif Central specimen, and those, in turn, related to the Alpine specimens. Sequences of the specimens from Tossa d’Alp (with short and long cerci respectively) are closer to each other than to the short cerci specimens from Andorra, therefore, at the molecular level, specimens with short and long cerci from the Pyrenees correspond to a single taxon. Results from the nymphs raised under controlled conditions, with adult males including long (see for example MNCN_Ent 296013; Fig 4A), short, and intermediate cerci (MNCN_Ent 269481; Fig. 4C) also support that cerci variability corresponds to a single taxon.

Populations of Chelidura from the French Massif Central have been treated as a differentiated subspecies, C. pyrenaica arverna (David and Van Herrewege 1973; Kirstová et al. 2020). The large genetic distance observed between Pyrenean and Massif Central populations of Chelidura suggests that they have been isolated for long time. Lasting isolation between the Pyrenean and Central Massif populations is also supported by the morphological differentiation observed in male cerci. Reciprocal monophyly, long isolation reflected by large sequence divergence, and cerci morphological differentiation at morphometric level, suggest that C. arverna likely represents a separate taxonomic unit with respect to C. pyrenaica as previously suggested by Fontana et al. (2021). Using the evolutionary species concept (Wiley 1978, 1981; Wiley and Mayden 2000), there is little doubt that the Massif Central populations of Chelidura can be considered to represent an independent species: Chelidura arverna David and Van Herrewege, 1973 stat. nov.

Intraspecific variability of morphological structures, as pygidium or cerci, is well known in earwigs (Srivistava 1970; Simpson and Mayer 1990; Tomkins and Simmons 1996; García-París 2017; Kirstová et al. 2020). Many species of Dermaptera show large variability in the size and shape of male cerci (Dohrn 1867; Diakonov 1925; Ollason 1970; Srivistava 1970; Mourier 1986; Simpson and May er 1990; González-Miguens et al. 2020; García-París et al. in press). The level of variability found in Pyrenean Chelidura is apparently higher than the levels of variability found by these previous authors in other taxa (Fontana et al. 2021; Fig. 3). This large variability in male sexual characters might be a consequence of strong sexual selection (Kawano 2006; Brown 2007). Alternatively, the large variability observed could be a consequence of the absence of directional selective pressures as Kirstová et al. (2020) mentioned as a possible explanation for the variability of the shape of the pygidium in some species of Chelidurella. The taxonomic implications of the large shape variability in male cerci need to be addressed in the case of Pyrenean Chelidura. The presence of specimens of C. pyrenaica in the Pyrenees with long cerci was already mentioned by Borelli (1905), who said: “Parmi les in-
dividus trouvé sur les flancs du Canigou, trois ont les branches de la pince très allongées, légèrement arquées, ne se touchant pas à l’extrémité et pourvues en dedans, vers le milieu, d’une petite dent à peine visible...”.

Forficula pyrenaica (Germar, 1825) has been recorded in the Alps (Burr 1912; Amiet 1961; David and Van Herrewege 1973; Sakai 1973; Caussanel and Albouy 1987; Albouy and Caussanel 1990; Herrera-Mesa 1999) and C. aptera in the Massif Central (Finot 1890; Burr 1904; Chopard 1922; Chopard 1951; Amiet 1961; Sakai 1973; Harz and Kaltenbach 1976; Caussanel and Albouy 1987; Albouy and Caussanel 1990), but we conclude, totally in agreement with Fontana et al. (2021), that the reports of C. pyrenaica from the Alps, and those of C. aptera in the Massif Central, should be disregarded, and assigned to C. aptera and C. arverna respectively.

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