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## NEW RECORDS OF THE ENDEMIC SNOW FLY *CHIONEA* (*SPHAECONOPHILUS*) *PYRENAEA* (BOURNE, 1981) AND UPDATED DISTRIBUTION OF SNOW FLY SPECIES IN THE PYRENEES

### *Nuevos registros de la mosca endémica de la nieve Chionea* (*Sphaeconophilus*) *pyrenaea* (Bourne, 1981) y actualización de la distribución de las especies de mosca de nieve en los Pirineos

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**ABSTRACT.**– Wingless snow flies *Chionea* spp are highly specialized winter active arthropods of the supranivean fauna, for which little is known yet about their life history and ecology. Of the seven European species of the subgenus *Chionea* (*Sphaeconophilus*), four are known from or can be expected to occur in the Pyrenees: *C. pyrenaea* Bourne 1981, *C. bezzii* Oosterbroek & Reusch 2008, *C. alpina* Bezzi 1908 and *C. lutescens* Lundström 1907. The former two are possible endemic species only known from one location and only from male individuals. In this paper we update the distribution and illustrate for the first time the habitus of the female of *C. pyrenaea* and give a new synthesis of the current distribution of snow flies in the Pyrenees. In the context of a projected increase in temperature and snowpack reduction in depth and duration, we point the vulnerability of these species to global climate change.

**Keywords:** Pyrenees, supranivean, winter active arthropod, snow pack, climate change.

**RESUMEN.**– Las moscas sin alas del género *Chionea* spp son artrópodos especializados de la fauna supranivea, de los cuales se tiene escasa información ecológica. De las siete especies europeas del subgénero *Chionea* (*Sphaeconophilus*), se sabe que al menos cuatro se distribuirían en los Pirineos: *C. pyrenaea* Bourne 1981, *C. bezzii* Oosterbroek & Reusch 2008, *C. alpina* Bezzi 1908 and *C. lutescens* Lundström 1907. Las dos últimas serían, posiblemente, endémicas ya que están descritas en una única localización y solamente individuos macho. En este trabajo hemos ilustrado por primera vez el habitus de la hembra de *C. pyrenaea* proporcionando además una distribución actualizada de las moscas alpinas en los Pirineos. En el contexto futuro de una subida generalizada de las temperaturas y una reducción de la cubierta de la profundidad y duración de la cubierta de nieve, estos resultados indican la vulnerabilidad de estas especies al cambio climático.

**Palabras clave:** Pirineos, supranivea, artrópodo activo invernal, cubierta de nieve, cambio climático.

## 1. Introducción

“Winter active” arthropod species combine activity and cold-exposure (Zachariassen & Kristiansen, 2003). Several species of spiders, collembolans, snow scorpion-flies (Mecoptera) of the genus *Boreus* Latreille, 1816 and the wing-less snow flies *Chionea* spp (Limoniidae; Diptera) make up this winter active group of species. They are by definition active on snow-covered ground during winter and may be active at temperatures down to  $-6^{\circ}\text{C}$ . They do not accumulate polyols or other osmolytes, implying that their body fluid melting point is about  $-1^{\circ}\text{C}$  and hence appear to supercool by several degrees (Hågvar, 1971; Zachariassen & Kristiansen, 2003). Among the three different microhabitats determined by snow (namely subnivean i.e. below snow; intranivean i.e. within snow and supranivean i.e. above snow), each has its own characteristic arthropod fauna (Aitchison, 2001; Hågvar, 2010). Wing-less snow fly *Chionea* spp belong to the *supranivean* fauna, which is the category of most specialized winter active arthropods, for which little is known yet about their life history and ecology (Vanin & Masutti, 2008).

Of the seven European species of the subgenus *Chionea* (*Sphaeconophilus*), four are known from or can be expected to occur in the Pyrenees (Oosterbroek & Reusch, 2008): *C. pyrenaea* Bourne 1981, *C. bezzii* Oosterbroek & Reusch 2008, *C. alpina* Bezzi 1908 and *C. lutescens* Lundström 1907. The former two are probably endemic to the Pyrenees being only known from one location and only from male individuals. In this paper we update the distribution and illustrate for the first time the habitus of the female of *C. pyrenaea* and give a new synthesis of the current distribution of snow flies in the Pyrenees.

*Chionea (Sphaeconophilus) pyrenaea* (Bourne, 1981) was described after only two individuals, a male holotype and a male paratype, from the eastern Pyrenees (Departement Ariège, see Figure 1 - site 1) at Montferrier in the vicinity of Lavelanet. Those two individuals were found below an old tree stump in a beech forest on 27.XI.1980 at an altitude of 800 m. Both types [C. Besuchet & I. Lôbl leg. (MHNG, alc.)] have been examined, the date on both labels being 28.XI.1980 (Oosterbroek and Reusch 2008).

To date, more than 20 years after its description, the species has not become known from other localities in the Pyrenees or elsewhere and females remained unknown as well. Indeed, unidentified individuals of *Chionea (Sphaeconophilus)* were surveyed by one of us (FDA) in the Ossau valley, about 250 km further west to the historic location. Full examination of both male and female individuals proved that they belong to *Chionea (Sphaeconophilus) pyrenaea*. It is thus the second record for the species in a formerly unknown range and the first occurrence of female individuals.

## 2. New records and current distribution of *C. (S.) pyrenaea*

Formerly known (and described) from eastern Pyrenees (site 1 - Figure 1), the range of the species is proven to extend much further west. New locations<sup>1</sup> for both males and females are in the Ossau valley (site 2 - Figure 1), from different locations (full coordinates at Annex I) at altitudes ranging from 1090 to 1955 m a.s.l. Individuals have always been observed walking on snow surface or found dead, caught in superficial 'melt freeze crust' (i.e. snow grains that have partially melted and then frozen again). Non standardized surveys made by FDA between 2001 and 2012 brought some insights on temporal distribution of the species: earlier observations of individuals on snow were made on 25 November (2001) and the latest record occurred on 12 February (2003). Further description of the Ossau valley and its environment may be found in D'Amico & Besson (1995).

This species of the subgenus *Sphaeconophilus* is clearly separated from all other species (Figure 2). The presence of the mid-ventral comb of fine bristles on sternite 9 separates it from *alpina* and *belgica*. The relatively long aedeagal prolongations separate it from *lutescens* (short prolongations) and *botosaneanui* (prolongations absent). The apparently closely related species *bezzii* has broader tergite 9, not emarginate as in *pyrenaea*.

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<sup>1</sup> N.B.: Individuals collected for identification were caught in sites outside protected area of the National Park of the Pyrénées.

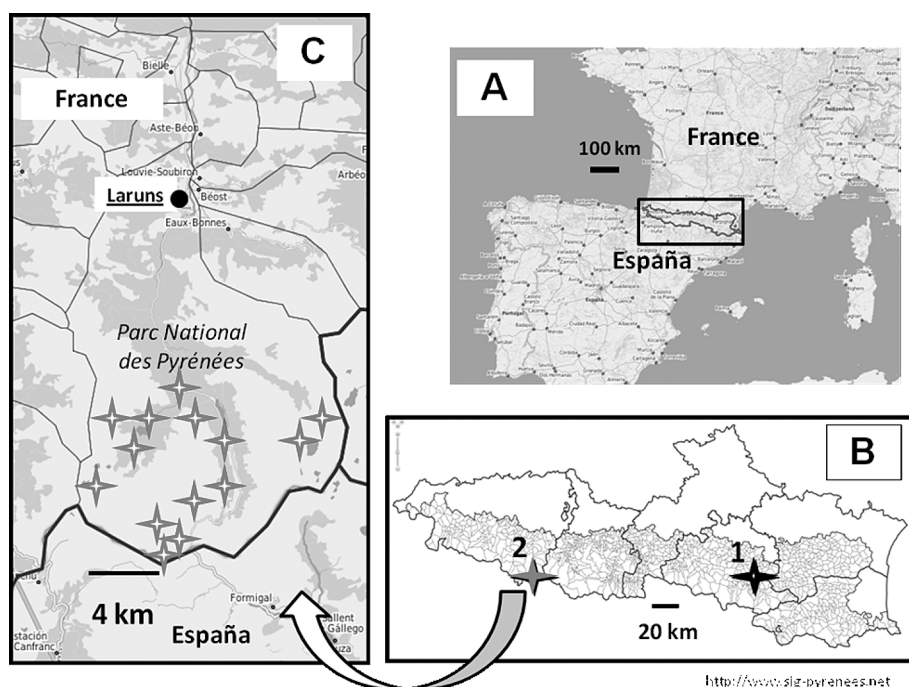


Figure 1. Updated distribution of *Chionea (Sphaeconophilus) pyrenaea* (Bourne, 1981). This species is known only for the French Pyrénées (delineated by the red line on Fig. 1-A). First described in eastern Pyrénées (site 1 – Fig. 1-B) the range of the species extends indeed further west (site 2 – Fig. 1-B). New locations (site 2) for both males and females are in the Ossau valley (Figure 1-C).  
 Figura 1. Distribución actualizada de *Chionea (Sphaeconophilus) pyrenaea* (Bourne, 1981). Esta especie es conocida solamente en el Pirineo Francés (delimitado por la línea roja en la Fig. 1-A). Descrita por primera vez en el Pirineo oriental (site 1 – Fig. 1-B), el rango de distribución se extiende en la actualidad hacia el Oeste (site 2 – Fig. 1-B). Las nuevas localizaciones para machos y hembras (site 2) se encuentran en el Valle de Ossau (Figure 1-C).

*Male*: Sternite 9 medially with a comb of fine bristles, at least on one third of the posterior half. Narrow prolongations of aedeagus tubular and long, at least one third of length of aedeagus itself; lower corner of aedeagus well developed and apical hook large (see also Fig. 12 and Fig. 19 in Oosterbroek & Reusch, 2008).

*Female*: Of the same colouration as the males. General habitus as in figures 3 and 4. Ovipositor with the cerci having an acute apex, as typical for the subgenus *Chionea (Sphaeconophilus)*. Discriminating characters with females of other *Sphaeconophilus* species are not known.

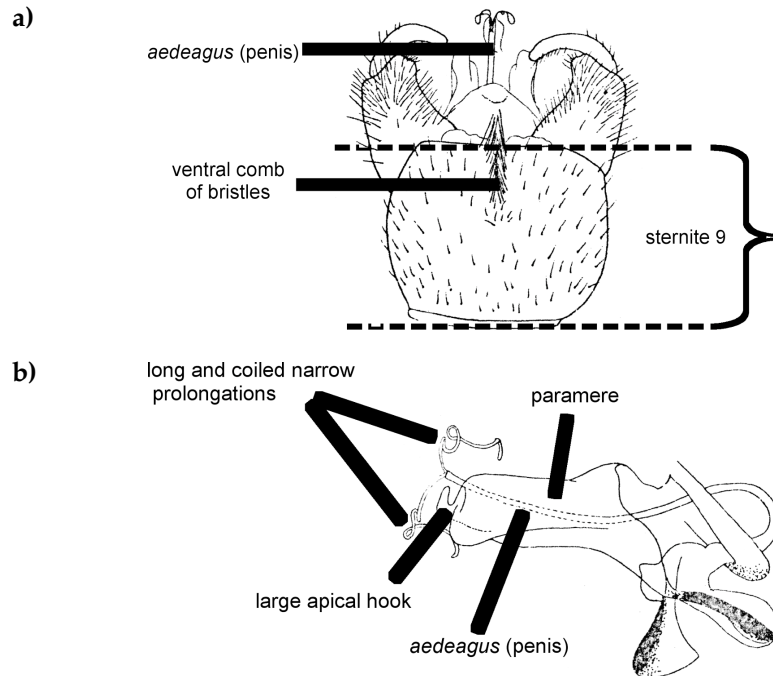


Figure 2. Illustrations showing diagnosis features that separate *Chionea* (*Sphaeconophilus*) *pyrenaea* (Bourne 1981) from the other species, namely the presence of the comb and the relatively long aedeagal prolongations. a) Ventral view of the hypopygium and b) Paramere and aedeagus.

Figura 2. Las ilustraciones muestran las características físicas que diferencian *Chionea* (*Sphaeconophilus*) *pyrenaea* (Bourne 1981) de las otras especies del subgenero; en particular la presencia de la cresta (comb) y las relativamente largas prolongaciones aedeagales. a) Vista ventral del hypopygium y b) Paramere and aedeagus.

### 3. Updated distribution of snow fly species in the pyrenees

Now that it is apparent that *C. (S.) pyrenaea* has a wider distribution in the Pyrenees than was known before, it is of interest to evaluate our knowledge of the distribution of the other *Chionea* species in the Pyrenees. The two European species of the subgenus *Chionea* (*Chionea*) are not known from France or the Iberian Peninsula.

Of the seven European species of the subgenus *Chionea* (*Sphaeconophilus*), three others are known from or can be expected to occur in the Pyrenees (fig 5; for details on records see Oosterbroek & Reusch 2008):

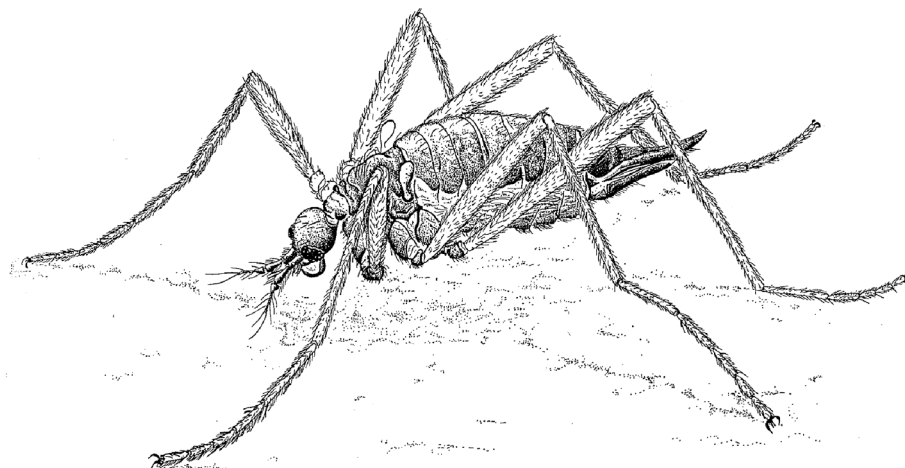


Figure 3. Female habitus of *Chionea (Sphaeconophilus) pyrenaea* (Bourne 1981). Original drawing by F. D'Amico.

Figura 3. Habitus de la hembra de *Chionea (Sphaeconophilus) pyrenaea* (Bourne 1981). Dibujo original de F. D'Amico.

- *C. (S.) alpina* Bezzi 1908 is so far known in France from the southeastern part of the country but is present in Andorra and northwest Spain, south of Andorra in the provinces Girona (Serra del Cadi) and Lleida (Port del Comte, Josa del Cadi). It is thus to be expected in the French Pyrenees as well.
- *C. (S.) bezzii* Oosterbroek & Reusch, 2008 is only known after the male holotype from the southern slopes of the Central Pyrenees, in northwest Huesca near Pont de Suert. This location being some 50 km south of the French border, it doesn't entail that the species could occur in the French Pyrenees as well.
- *C. (S.) lutescens* Lundström, 1907 has a wide distribution in Europe but is not known in France further south than the departments of Puy-de-Dôme and Isère, so at quite some distance from the Pyrenees. The species has been mentioned from Spain but those Spanish records could not be confirmed. Interestingly, the species is with certainty known from Portugal (prov. Guarda). Therefore, and given the very large distribution of this species in Europe, it is not unlikely that the species also occurs in Spain and the Pyrenees.

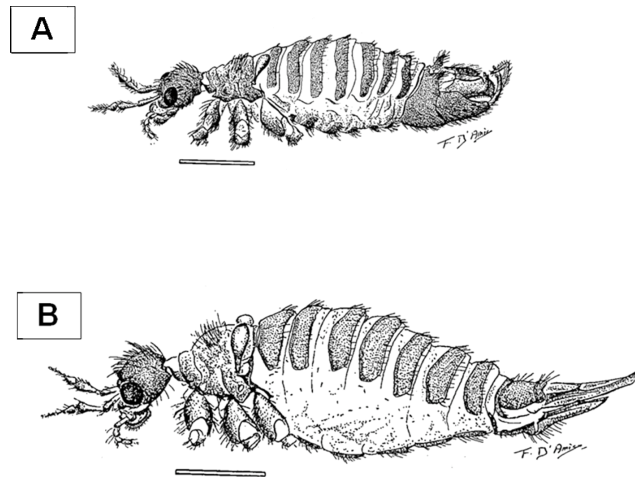


Figure 4. Close-ups of male (A) and female individuals (B) of *Chionea* (*Sphaeconophilus*) *pyrenaea* (Bourne 1981). Original drawings by F. D'Amico. Scale: 1 mm. Legs are not represented.  
 Figura 4. Detalles del macho (A) y de la hembra (B) de *Chionea* (*Sphaeconophilus*) *pyrenaea* (Bourne 1981). Dibujos originales de F. D'Amico. Escala: 1 mm. Las patas no están representadas.

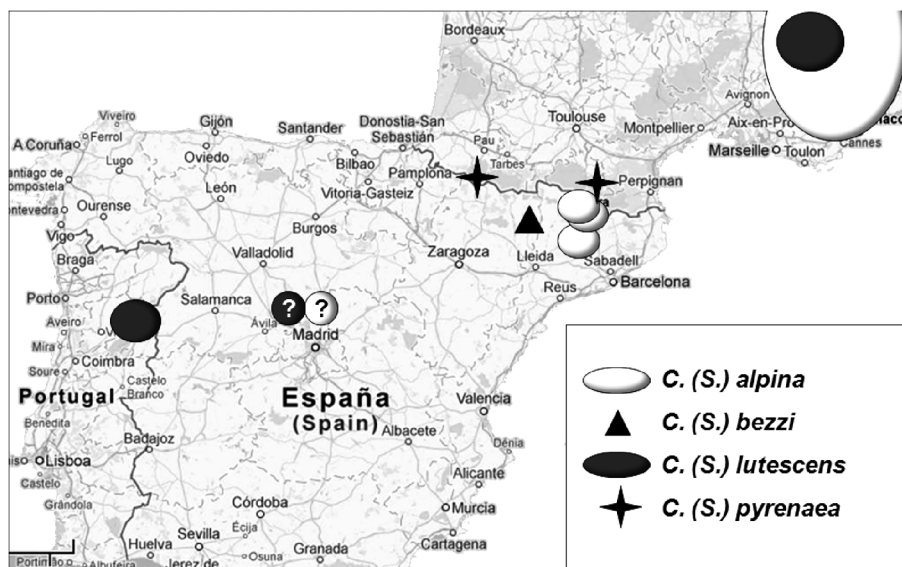


Figure 5. Updated distribution of the known species of the genus *Chionea* in the Pyrenees.  
 Figura 5. Distribución actualizada de las moscas conocidas del genero *Chionea* en los Pirineos.

#### 4. Conclusion: being a supranivean species in the context of climate warming

Impact of climate warming on biodiversity is now well documented. Several species-specific attributes have been identified as increasing species' vulnerability to climate change such as phenology (Charmantier *et al.*, 2008) and ecological specialization (Heikkinen *et al.*, 2010) with subsequent projected changes in distributions (Thomas *et al.*, 2004; Parmesan 2006). Indeed, species are not equally at risk facing climate change. Being a highly specialized "winter active" arthropod species, and having an extremely scattered and fragmented distribution *Chionea* snow flies should be at extreme risk of extinction.

In the Pyrenees, the thickness and the duration of snowpack is expected to decrease dramatically over the next century, especially in the central and eastern sectors of the Spanish Pyrenees (López-Moreno, Goyette & Beniston, 2009). The magnitude of these impacts should follow a marked altitudinal gradient: the season with snow cover may be reduced by up to 70% at 1500 m a.s.l. and the magnitude of the impacts should decrease markedly with increasing altitude whereas snowpack characteristics will remain largely similar in the highest sectors. Our preliminary survey shows that *C. pyrenaea* is found between 1090 and 1955 meters a.s.l. (where high changes in snow conditions and expected) and dwells mostly on snow between late November and early February. *C. pyrenaea* and *C. bezzii* share several ecological and physiological attributes making them extremely sensitive to the consequences of climate change: highly specialized supranivean species, development of cold-hardiness strategy, extremely fragmented populations, possible rarity, endemism, very low dispersal ability (wingless species). Projected increase in temperature and snowpack reduction in depth and duration should add to those specific attributes and act in concert to bring *C. pyrenaea* to the brink of close extinction.

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**Annex I:** Coordinates of new records over the period 2001-2012 in the Ossau Valley (France). Rec.: F. D'Amico.

Commune Laruns: N42°48'15.3" W000°25'36.5"; N42°48'11.5" W000°25'48.5"; N42°48'09.6" W000°25'52.3"; N42°48'06.9" W000°25'57.1"; N42°48'05.4" W000°25'58.1"; N42°48'06.3" W000°26'06.0"; N42°48'11.8" W000°26'11.3"; N42°49'31.5" W000°26'39.4"; N42°50'05.6" W000°24'21.9"; N42°51'17.9" W000°24'15.0"; N42°51'22.5" W000°23'25.6"; N42°52'22.7" W000°25'01.8"; N42°52'38.3" W000°27'34.8"; N42°50'40.8" W000°28'02.2"; N42°50'54.5" W000°29'27.2"; N42°52'24.0" W000°26'48.2"; N42°53'15.0" W000°25'19.5"; N42°57'36.3" W000°19'46.1" - Commune Eaux-bonnes/Gourette: N42°57'06.4" W000°20'08.5"; N42°56'59.4" W000°19'39.4".