

AULO MANINO (*) - AUGUSTO PATETTA (*) - MARCO PORPORATO (*) - MARINO QUARANTA (**)
FRANCESCO INTOPPA (***) - MARIA GIOIA PIAZZA (***) - FRANCO FRILLI (****)

BUMBLEBEE (*BOMBUS LATREILLE*, 1802) DISTRIBUTION IN HIGH MOUNTAINS AND GLOBAL WARMING

(*) Di.Va.P.R.A. - *Entomologia e Zoologia applicate all'Ambiente «Carlo Vidano», Università degli Studi, via Leonardo da Vinci 44, 10095 Grugliasco (Torino).*

(**) CRA - *Istituto Sperimentale per la Frutticoltura, via di Fioranello 52, 00134 Roma.*

(***) CRA - *Istituto Sperimentale per la Zoologia Agraria, Sezione di Apicoltura, via Leonida Reeb 36, 00156 Roma.*

(****) *Dipartimento di Biologia applicata alla Difesa delle Piante, Università degli Studi, via delle Scienze 208, 33100 Udine.*

Manino A., Patetta A., Porporato M., Quaranta M., Intoppa F., Piazza M.G., Frilli F. – Bumblebee (*Bombus Latreille*, 1802) distribution in high mountains and global warming.

The planet's global warming is seriously menacing the survival of a lot of species that are particularly demanding ecologically. Bumblebees include a great number of species with a boreal and/or high mountain, and often disjoint distribution, that appear particularly sensitive to climatic variations. Also in Italy the alticolous species could be exposed in future decades to a progressive reduction of their distribution areas. Therefore it seems convenient to check the presence of the most important species of the Alps and Apennines based on recent observations, even if necessarily limited to a small number of valleys or mountain massifs. In particular we took into consideration *Bombus monticola* and *B. mucidus*, present in cacuminal zones of the Apennines and in the Alps, and *B. alpinus* and *B. mendax* living in the higher zones of the Alps.

B. monticola, represented in the central Apennines by the subspecies *B. m. konradini*, appeared rare, poorly spread and limited to elevations above 2000 m, while the subspecies *B. m. hypsophilus* was abundant in the Alps starting from 1450 m; on the contrary *B. mucidus* was observed in the Apennines at relatively low elevations too, much more frequently than in the Alps. *B. alpinus* was found exclusively in few Piedmontese localities above 2100 m, where it was poorly numerous, while *B. mendax*, more abundant and diffused than the previous one, was observed starting from 2000 m in the central eastern Alps and from 2200 m in the western Alps.

A rise in temperature represents a serious danger for the Apenninic populations of *B. monticola* and *B. mucidus* that risk the extinction for the lack of suitable areas for their survival, while the Alpine species do not seem endangered. The situation of *B. alpinus* and *B. mendax* would seem less compromised, even if a rising of the lower altitude limit of their distribution area would mean a drastic reduction of it and the consequent formation of small isolated populations.

KEY WORDS: Apidae, Alps, Apennines, climate change, endangered pollinators.

INTRODUCTION

The climate change occurring in our planet is obvious and universally recognized. Though the causes determining it remain uncertain and above all the amount of which imputable to human activities, everybody agrees to consider that the consequences of this will be particularly negative for the conservation of biodiversity. Among the effects forecasted, a particular concern is the thermic increase that will involve by the way a drastic decrease of habitats fit to host the species of cold climates. Among these we can include the bumblebees that are concentrated in a great number of species in the circumpolar zone and in the main European, Asian and American mountains.

In Italy 31 species have been identified, belonging to the genus *Bombus*, and all present in North Italy, only 17 in central and South Italy, 10 in Sicily, and 4 in Sardinia. Of these, 5 do not have any subspecies, 7 are represented only by the nominal subspecies, while the remaining 19 ones are present, as far as we know today, with 51 subspecies, and altogether there is a total of 63 *taxa*. Some species, also thanks to the presence of more subspecies, are widespread throughout Italy, from the plains to the highest elevations, while others are present exclusively in mountain areas. However the number and the distribution of the subspecies have not yet been object of an exhaustive study.

Alticolous species are adapted to high mountain environments due to their short life cycle and gyne ability to withstand long overwintering periods; therefore they would be affected by global warming with a shifting towards higher altitudes and a progressive reduction and fragmentation of their distribution areas. Therefore it seemed necessary to verify the presence of some relevant species of the Alps and the Apennines considering the most recent observations, even if they are of course limited to few valleys or mountain massifs.

MATERIALS AND METHODS

The following species have been taken into consideration: *Bombus alpinus* (Linnaeus, 1758), *B. mendax* Gerstaecker, 1869, *B. monticola* Smith, 1849, and *B. mucidus* Gerstaecker, 1869.

The first two species were chosen for their presence in the Alps only at very high elevations, and the other two because they were recorded, besides in the Alps, also in the cacuminal areas of the Apennines; other species found in high mountains, but spread with a wider altitudinal range, were not included in this survey because they are presumably less threatened by global warming.

To define the diffusion of the examined species we refer-

red to the specimens collected since 1979 and present in the entomological collections of the University of Perugia and of the scientific institutions where the Authors work.

For each species, the collecting sites were grouped by mountain system, following the «Suddivisione Orografica Internazionale Unificata del Sistema Alpino» (MARAZZI, 2005) at a subsection level for the Alps, and «Italia fisica» by TOURING CLUB ITALIANO (1957) and «Monti d'Italia» (ASCIONE and INSOLERA, 1974) for the Apennines; the specimens were separated by altitudinal belts according to the scheme adopted by COMBA (1960).

RESULTS

We have identified altogether 428 specimens belonging to the investigated species, mostly collected during the years 1993-2006 (fig. 1); the share between the different subspecies and, within each of them, between males, queens and workers is given in table 1.

B. alpinus, represented by the subspecies *belleri*, resulted to be present only in the Piedmontese Alps in sites above 2100 m (table 2).

B. mendax, present with the nominal subspecies, appeared spread in a great part of the Alpine chain at heights over 2100 m in Piedmont and over 1800 m in Lombardy (table 3).

B. monticola proved to be the most widespread species both as localities and as number of specimens collected. In the Piedmontese Alps it is localized at heights generally beyond 2100 m, even if it can be found starting from 1400 m, while in the other Alpine sites considered it is found above all at heights beneath 2100 m; in the Apennines, instead, it is less frequent and spread exclusively at heights over 1800 m (table 4). All the specimens collected in the Alps belonged to the subspecies *hypsophilus*, while those coming from the Apennines belonged to the subspecies *konradini*.

B. mucidus, with the exception of a single specimen of the nominal subspecies coming from the Julian Alps, is represented by the subspecies *mollis*; although it reaches the highest elevations, it was frequent only in the Sibillini mountains between 1800 and 2400 m, while at lower heights and in the other localities it was relatively rare (table 5).

DISCUSSION

B. alpinus belleri is found in the Alps at heights comprised between 1600 and 3000 m (WESTRICH, 1990) and it is found also in the Carpathians and in the Balkans, while the nominal subspecies is present in Fennoscandia (RASMONT, 1988). Concerning Italy, there are few records for Piedmont, Trentino-Alto Adige, and Venetia, some of

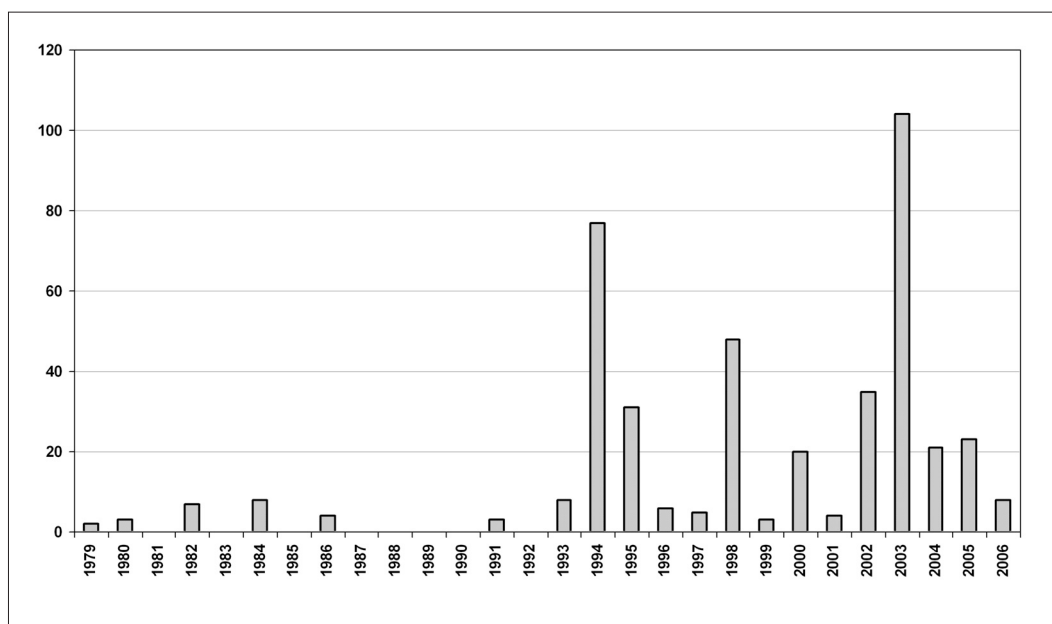


Fig. I - Number of specimens collected in the period considered.

Tab. 1 - Number of specimens separated into subspecies, sex, and caste.

	males	queens	workers	total
<i>Bombus alpinus belleri</i> Dalla Torre, 1882	7	1	22	30
<i>Bombus mendax mendax</i> Gerstaecker, 1869	16	9	38	63
<i>Bombus monticola hypsophilus</i> Skorikov, 1912	66	16	128	210
<i>Bombus monticola konradini</i> Reinig, 1965	8	2	17	27
<i>Bombus mucidus mucidus</i> Gerstaecker, 1869			1	1
<i>Bombus mucidus mollis</i> (Pérez, 1879)	54	17	26	97
	151	45	232	428

Tab. 2 – Number of *Bombus alpinus helleri* specimens divided by elevation belts and collection zones.

	1000-1399	1400-1799	1800-2099	2100-2399	> 2400
4.III Northern Cottian Alps				5	22
7.I South-Eastern Graian Alps					1
9.III Monte Rosa Alps					2

Tab. 3 – Number of *Bombus mendax mendax* specimens divided by elevation belts and collection zones.

	1000-1399	1400-1799	1800-2099	2100-2399	> 2400
4.I Southern Cottian Alps					1
4.II Central Cottian Alps				3	1
4.III Northern Cottian Alps				2	23
7.I South-Eastern Graian Alps				1	4
9.III Monte Rosa Alps					1
28.I Ortler Alps			9		12
28.III Adamello-Presanella-Alps			1		1
29.I Orobic Alps			1	3	

Tab. 4 – Number of *Bombus monticola* specimens divided by elevation belts and collection zones.

	1000-1399	1400-1799	1800-2099	2100-2399	> 2400
4.II Central Cottian Alps			1	18	22
4.III Northern Cottian Alps		14	3	7	22
7.I South-Eastern Graian Alps			1	8	4
16.I Ötztal Alps		2	4		
17.I Zillertal Alps		6			
17.III Deferegger Alps			4		
28.I Ortler Alps		8	14	1	
28.III Adamello-Presanella-Alps	12	21	2		1
28.IV Brenta Group			2		
29.I Orobic Alps		1	2	2	
31.I North-eastern Dolomites		7		1	
33.I Carnic Alps	5	6	4		
34.I Julian Alps		3			
34.II Julian pre-Alps	2				
Sibillini mountains			14	9	1
Gran Sasso d'Italia			2		

Tab. 5 – Number of *Bombus mucidus* specimens divided by elevation belts and collection zones.

	1000-1399	1400-1799	1800-2099	2100-2399	> 2400
4.II Central Cottian Alps			2	2	4
4.III Northern Cottian Alps		1	1		2
7.I South-Eastern Graian Alps					1
16.I Ötztal Alps		1			
34.I Julian Alps		1			
Sibillini mountains	2	2	46	22	
Gran Sasso d'Italia					2
Le Mainarde			9		

which date back even to the second half of the XIXth century (INTOPPA *et al.*, 1995). The data collected in this work show that it is a not particularly rare species, but rather wanting as per climatic conditions of the sites where it lives. It is wellknown that, the elevation being equal, the southern slope of the Alps is warmer than the northern one and this could justify the fact that in this area the lower distribution

limit is higher than what is given in the literature. However the comparison between the data given in this work and those of the literature for the Italian sites seem to point out a certain influence of the global warming; this phenomenon could be responsible of the apparent decrease of its distribution area too, because this species was recorded in Trentino still in relatively recent times (BONELLI, 1966).

B. mendax mendax is the typical subspecies of the Alps, while the species is also present in the Pyrenees with the subspecies *latofasciatus* Vogt, 1909. In Italy it is spread in the whole Alpine chain, from Piedmont to Trentino-Alto Adige (INTOPPA *et al.*, 1995). The specimens we refer to come from localities situated between 2000 and 2930 m of elevation, while in the Swiss Alps this species was reported at heights between 1600 and 2700 m (BEAUMONT, 1958); such a difference seems remarkable even keeping in mind the different exposure of the slopes, supporting the hypothesis of an effect of the thermic increase that occurred in the last fifty years. Like the former species, it seems that its distribution area has diminished on the eastern border.

B. monticola is spread in Scandinavia (ssp. *scandinavicus* Friese, 1912), in the British Isles with the nominal subspecies, in the Pyrenees (ssp. *rondoui* Vogt, 1909), Alps, Balkans, Carpathians, and Mount Olympus (ssp. *hypsophilus*), and finally in the Apennines with the subspecies *konradini*.

B. monticola hypsophilus was recorded in the Alps at heights between 700 and 2400 m (REINIG, 1972); for Italy it is recorded in the literature as widespread in the whole Alpine chain (INTOPPA *et al.*, 1995). During this survey this subspecies showed to be the most abundant one with the greatest altitudinal range, and considering also its vast area of distribution it does not seem to be threatened. The altitudinal range appears however shifted towards higher elevations than what is given in the literature, even if the records in Italian sites at relatively low heights are several decades old (COBELLI, 1903; PITTIONI, 1940). As already highlighted for *B. mendax*, this change could not be due only to the climatic differences between the two Alpine slopes.

B. monticola konradini was described and considered as a subspecies typical of the Apennines (REINIG, 1965), from the province of Parma to that of L'Aquila. It seems to be a high-elevation subspecies, the distribution area of which risks a drastic reduction because of global warming, considering the fact that most of the Apenninic peaks do not exceed 2000 m.

B. mucidus is spread in the Pyrenees, Alps, Apennines, and Balkans. It is found in the Alps at heights comprised between 1200 and 2300 m (WESTRICH, 1990); also for this species the data given in this work show, in spite of the small number of findings, a remarkable increase of the elevation. A similar phenomenon could be hypothesized, based on records dating back to the first half of last century, also for the central Apennines, where this species is decidedly more abundant especially in shrubby areas above the beechwood limit.

The overview of the pattern composed by the bumblebee species examined arouses the suspicion, though it cannot be affirmed with certainty, that the rise in temperature of the Planet, that occurred in the last decades, has caused a shift of bumblebees towards higher elevations. However, referring to the hypothesis of a global warming that is comprised, according to previsional models and to the possible mitigation interventions adoptable, between 1.4 and 5.8 °C (WATSON and THE CORE WRITING TEAM, 2001), we can maintain that the distribution area of the typical Alpine species *B. alpinus* and *B. mendax* will go through a drastic reduction and fragmentation that could seriously compromise their survival chances. On the contrary, the Alpine populations of *B. mucidus* and *B. monticola*, being able to live at lower heights too, seem to be less

exposed to these risks, while the Apenninic ones, owing to the lower height and the lower latitude of this mountain chain, could be subject to extinction; this would be particularly serious for *B. m. konradini*, a subspecies typical of the Apennines.

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RIASSUNTO

DISTRIBUZIONE DEI BOMBI (BOMBUS LATREILLE, 1802) IN ALTA MONTAGNA E RISCALDAMENTO GLOBALE

Il riscaldamento globale del pianeta sta minacciando seriamente la sopravvivenza di molte specie particolarmente esigenti dal punto di vista ecologico. I bombi annoverano numerose specie con distribuzione boreale e/o di alta montagna, spesso disgiunta, che appaiono particolarmente sensibili alle variazioni climatiche. Anche in Italia le specie alticole potrebbero essere esposte, nei prossimi decenni, ad una progressiva riduzione dei loro areali. Pertanto è sembrato opportuno effettuare una verifica della presenza delle specie più significative delle Alpi e degli Appennini sulla base di osservazioni recenti, anche se necessariamente riferite a un limitato numero di vallate o di massicci montani. In particolare sono stati presi in considerazione *Bombus monticola* e *B. mucidus*, presenti sia nelle zone cacuminali degli Appennini sia sulle Alpi, e *B. alpinus* e *B. mendax* propri delle zone più elevate di quest'ultima catena montuosa.

B. monticola, rappresentato negli Appennini centrali dalla sottospecie *B. m. konradini*, è apparso raro, poco diffuso e limitato a quote superiori ai 2000 m, mentre la sottospecie *B. m. hypsophilus* è risultata abbondante sulle Alpi a partire dai 1450 m; al contrario *B. mucidus* è stato osservato sull'Appennino centrale, anche a quote relativamente basse, molto più frequentemente che sulle Alpi. *B. alpinus* è stato rinvenuto esclusivamente in poche località piemontesi sopra i 2100 m, dove era poco numeroso, mentre *B. mendax*, più abbondante e diffuso del precedente, è stato osservato a partire dai 2000 m sulle Alpi centro-orientali e dai 2200 m sulle Alpi occidentali.

L'aumento delle temperature rappresenta un serio pericolo per le popolazioni appenniniche di *B. monticola* e *B. mucidus* che rischiano l'estinzione per la mancanza di aree idonee alla loro sopravvivenza, mentre quelle alpine non appaiono minacciate. La situazione di *B. alpinus* e *B. mendax* sembrerebbe meno compromessa, anche se un innalzamento del limite altitudinale inferiore del loro areale di distribuzione ne comporterebbe una drastica riduzione e la conseguente formazione di piccole popolazioni isolate.

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