

## Following the Apennines: updating the distribution of *Formica clara* and *Formica rufibarbis* in Italy (Hymenoptera, Formicidae)

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### SUMMARY

*Formica clara* is an ant species that was historically confused with other congeneric species such as *F. rufibarbis* until recent taxonomic developments. Due to such misunderstanding, while *F. clara* is known to occur across a very large Eurasian range, its actual distribution in the Mediterranean is often scarcely known. The distribution of *F. clara* and *F. rufibarbis* in Italy is remarkably obscure since almost all records, which spanned across the whole Italian peninsula and Sardinia, were published between 1834 and 1969, at times when the two species were treated as a single taxon. The few modern records of the species testify the presence of *F. rufibarbis* in the Alps, and *F. clara* in the Alps, the Po Plain and Sardinia. Here we present some new distributional data on the two species, extending the geographic range of *F. rufibarbis* south to the Northern Apennines (225 km) and that of *F. clara* throughout the Italian Peninsula south to Sicily (900 km). These results significantly change the previous understanding of *F. rufibarbis* as a widespread species while suggesting *F. clara* to be a common mountain species through the whole Apennines. Further investigations will be needed to verify whether *F. rufibarbis* occurs farther south.

### INTRODUCTION

*Formica clara* Forel, 1886, with its huge Eurosiberian range, appears to be one of the most

widespread species of its genus (Seifert 2018). Yet, despite this and its relatively early description (Forel, 1886), its taxonomy has remained confused until 12 years ago, when

Seifert & Schultz (2009) redescribed it and defined a reliable set of diagnostic characters (also see Seifert 2018). Currently, the nominal form is thought to occur from Western Europe (westernmost limit in Spain, see Arcos 2020) east to Central Asia, south to the Himalayas and north to Scandinavia, while the subspecies *F. clara sinae* Emery, 1925, probably requiring further taxonomic investigation, inhabits eastern China (Seifert & Schultz 2009). The rarity of *F. clara* in both France and Spain as well as its absence from the British Isles suggests postglacial spreading from a SE European refuge (Seifert 2018). Eventual nomenclatural changes concerning *F. clara* would imply a different understanding of its relationship with other Asian species, but the status of the European *F. clara* as a different species from *F. rufibarbis* is undisputed (Czechowski et al. 2012).

However, before the revision published by Seifert & Schultz (2009), *F. clara* was broadly confused with *F. rufibarbis* Fabricius, 1793 and probably even *F. cunicularia* Latreille, 1798. Presently, *F. rufibarbis* is thought to occur at least from the Iberian Peninsula to West Siberia, showing less thermophilic attitudes in Central Europe where it occurs sympatrically and appears more common than *F. clara* (Seifert 2017; 2018).

In Italy, the presence of *F. clara* has long gone unnoticed due to confusion with *F. rufibarbis*, which is the sole of the two names to be present in the existing – and rather outdated – Italian checklists (Baroni Urbani 1971; Poldi et al. 1995). In particular, 23 records of *F. rufibarbis* were published between 1834 and 1969 (Baroni Urbani 1971), recording this taxon from the Alps to the southernmost part of the Italian peninsula (Aspromonte, Calabria) in addition to Sardinia (Fig. 1). These records are all unreliable under the contemporary *F. rufibarbis* definition and may as well refer to misidentified *F. clara*, which was first officially recorded in Italy by Rigato & Toni (2011). During the last decade, some new data were published, starting to clarify what the true

distribution ranges of *F. clara* and *F. rufibarbis* in Italy may be. *Formica clara* was recorded from the Alps (Glaser et al., 2012), the Po Plain (Castracani et al. 2020) and Sardinia (there probably replacing *F. rufibarbis* entirely, see Rigato & Toni 2011; Schifani et al. 2021a). On the other hand, *F. rufibarbis* was only found in the Alps (Glaser et al. 2012). Dubious data under “*Formica prope clara*” were also published from Salento (Apulia, SE Italy) (Scupola 2016; Fig. 1). However, according to the most recent discriminant functions (Seifert 2018) these Apulian specimens key out as *F. cunicularia* (Antonio Scupola, pers. comm.).

Here we report and discuss new distribution records of *F. clara* and *F. rufibarbis* from Italy, significantly extending their ascertained distribution range and clarifying their occurrence throughout the Apennines.

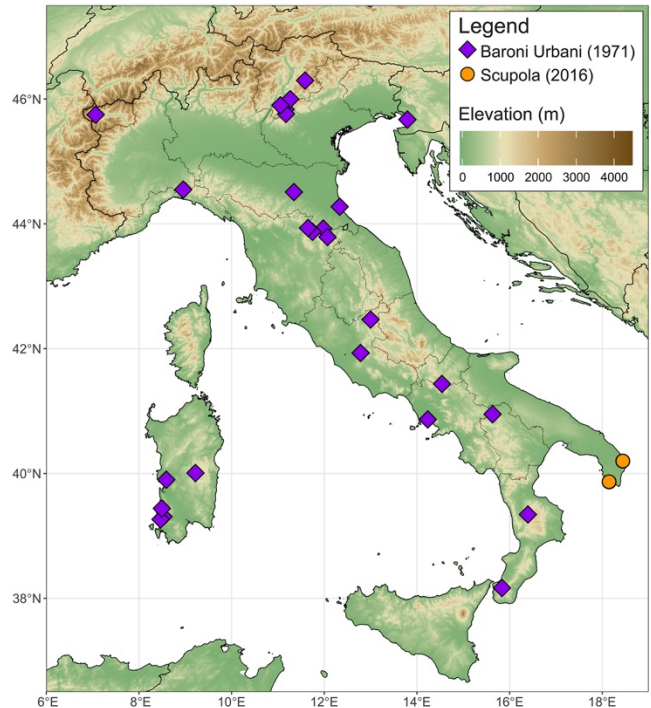


Figure 1. Doubtful records possibly representing *F. clara* or *F. rufibarbis* in Italy.

## MATERIALS AND METHODS

Ant collection was performed by direct sampling. Specimens were stored under 96% ethanol (apart from a single older sample collected in 1993 and kept under 70% ethanol) and deposited in the authors' personal collections (E. Schifani pers. coll., Palermo, Italy - ESPI; A. Alicata pers. coll., Catania, Italy - AACI; M. Menchetti pers. coll., Barcelona, Spain - MMBS). Their study was performed with the aid of a stereoscopic microscopes at 45-180x magnification, in addition to photography-based morphometry. Species-level identification was achieved based on the keys provided by Seifert & Schultz (2009) and Seifert (2018).

## RESULTS

We identified *F. clara* from 8 sites across 5 Italian regions (Abruzzo, Calabria, Emilia-Romagna, Sicily, Tuscany) and *F. rufibarbis* from 4 sites and 3 regions (Emilia-Romagna, Tuscany, Veneto). The southernmost *Formica clara* record is 37.9° N in Sicily, while that of *F. rufibarbis* is 44.0° N in Tuscany (Figs. 2, 3). Almost all sites of both species are from hilly to montane from 660 to 1,470 m asl, with the exception of the two Po Plain sites (Emilia-Romagna) which are lowland sites at  $\leq 50$  m asl. Nests were found in meadows neighboring streams, forests or urban habitats. Detailed data are given in Tab. 1.

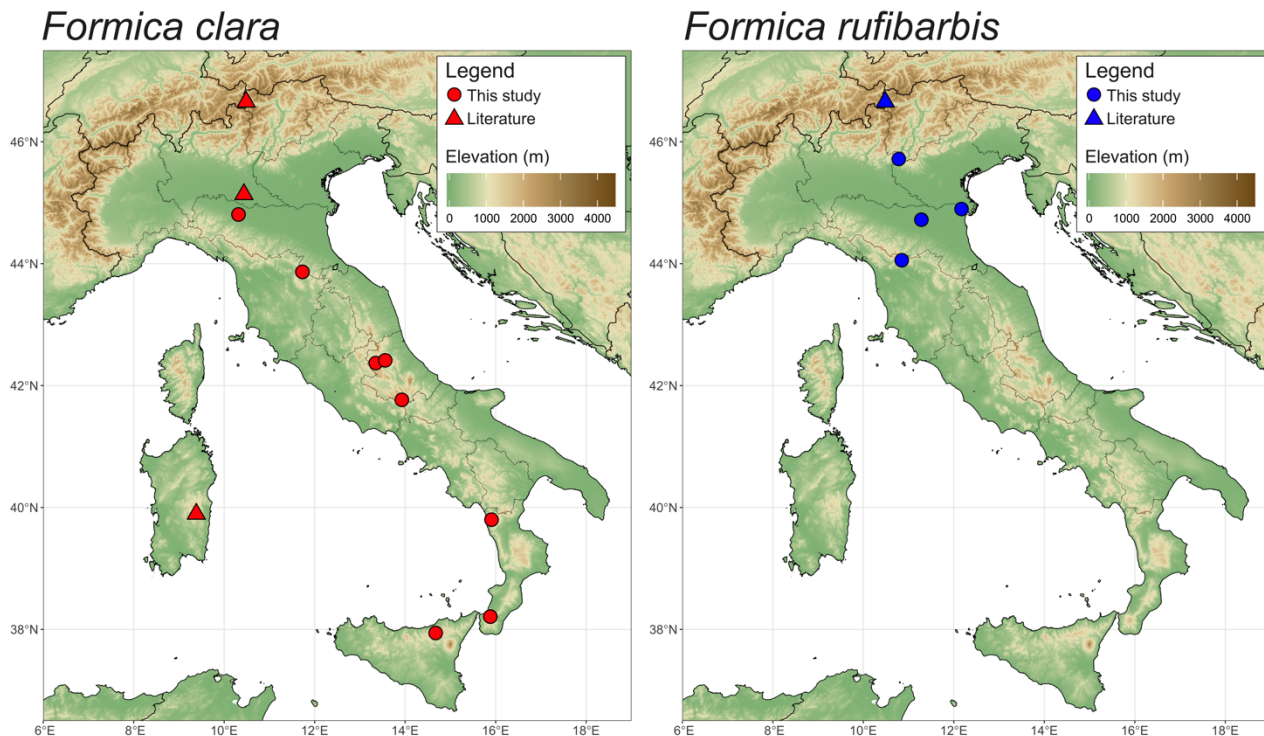


Figure 2. Italian records of *F. clara* and *F. rufibarbis* published under the current taxonomic framework.



Figure 3. *Formica clara* worker from the southernmost site of its Italian distribution in Sicily: lateral view (above) and head view (below).

Table 1. New records of *Formica clara* and *F. rufibarbis* in Italy. Altitude data for samples whose GPS error is >10 m are preceded by the symbol “~” and indicatively report the altitude corresponding to the given latitude and longitude without taking into account the error.

Species	Region	Site	Latitude	Longitude	GPS error (m)	Altitude (m)	Habitat	Date collected	Legit	Det. by	Det. date	Deposit
<i>F. clara</i>	Abruzzo	Civitella Alfedena (AQ)	41.7661	13.9268	1,000	>1,000	-	09.V.2014	M. Menchetti, E. Mori	E. Schifani, M. Menchetti	03.IX.2021	MMPS
<i>F. clara</i>	Abruzzo	Coppito (AQ)	42.369715	13.350075	100	~660	-	08.VII.2019	M. Menchetti	E. Schifani, M. Menchetti	04.IX.2021	MMPS
<i>F. clara</i>	Abruzzo	Fonte Cerreto (AQ)	42.413947	13.558342	200	~1,470	-	08.VII.2019	M. Menchetti	M. Menchetti	04.IX.2021	MMPS
<i>F. clara</i>	Calabria	Torrente Vasi, Sinopoli (RC)	38.209869	15.882231	500	~950	meadow/riparian veg.	01.VI.1993	A. Alicata, A. Adorno	A. Alicata	18.VIII.2021	AAPS
<i>F. clara</i>	Calabria	C.da Campolongo, Mormanno (CS)	39.847804	15.984383	10	1,015	meadow/agricultural areas	28.VIII.2021	A. Alicata	A. Alicata	05.IX.2021	AAPS
<i>F. clara</i>	Emilia-Romagna	Parma (PR)	44.806678	10.315946	10	50	meadow/urban park	23.VII.2017	E. Schifani	E. Schifani	13.VIII.2021	MMPS
<i>F. clara</i>	Sicily	Lago Maulazzo (ME)	37.942146	14.674091	10	1,445	meadow/stream/ <i>Fagus sylvatica</i>	09.VIII.2021	E. Schifani	E. Schifani	11.VIII.2021	ESPS
<i>F. clara</i>	Sicily	Lago Maulazzo (ME)	37.940944	14.674213	10	1,450	meadow/stream/ <i>Fagus sylvatica</i>	09.VIII.2021	E. Schifani	E. Schifani	11.VIII.2021	ESPS
<i>F. clara</i>	Sicily	Lago Maulazzo (ME)	37.942146	14.674091	10	1,455	meadow/ <i>Fagus sylvatica</i> forest	10.VIII.2021	E. Schifani	E. Schifani	11.VIII.2021	ESPS
<i>F. clara</i>	Tuscany	Prati della Burraia (AR)	43.865332	11.728782	200	~1,100	-	25.VI.2018	M. Menchetti	E. Schifani, M. Menchetti	04.IX.2021	MMPS
<i>F. rufibarbis</i>	Emilia-Romagna	Cento (FE)	44.721059	11.283373	50	~15	meadow/urban park	22.VI.2019	D. Cioppa	M. Menchetti	25.VIII.2021	MMPS
<i>F. rufibarbis</i>	Emilia-Romagna	Dune Fossili di Massenzatica (FE)	44.899044	12.165022	50	~0	meadow/urban park	02.V.2021	P. Ferruzzi, S. Menchetti	M. Menchetti	05.XI.2021	MMPS
<i>F. rufibarbis</i>	Tuscany	Maresca (PT)	44.056299	10.849051	50	~1,100	meadow/urban park	11.VIII.2017	M. Menchetti, G. Bruni	M. Menchetti, E. Schifani	03.IX.2021	MMPS
<i>F. rufibarbis</i>	Veneto	San Zeno di Montagna, Mount Baldo (VR)	45.647248	10.757191	-	830	-	09.VIII.2020	A. Scupola	M. Menchetti	XII.2021	MMPS

## DISCUSSION

Our new data considerably extend the geographical range of *F. clara* along the peninsula by about 900 km, demonstrating its presence through the Apennines south to Sicily (Fig. 3). The verified range of *F. rufibarbis* in Italy (here referring to Glaser et al. 2012) is also expanded, by about 225 km, as its presence is recorded south of the Alps for the first time. Our *F. clara* sites in Tuscany and Calabria are very close to historical sites of *F. rufibarbis* (Baroni Urbani 1964; Zangheri 1969). On the other hand, the discovery of *F. clara* in Sicily represents the first record from the island for any of the two species (Schifani et al. 2021b). Our results may suggest that *F. clara* extends through the Central and Southern Apennines, while *F. rufibarbis* is restricted to more northern latitudes. Such biogeographic differences could be reasonable in light of the different ecological niches the two species occupy across their sympatric Central European range (Seifert 2017; 2018; Wagner 2020). It is notable that Seifert (2017; 2018) describes *F. cunicularia* as a less thermophilic species of *F. clara* in Central Europe, while in Italy the first is not only more common but also found at much lower latitudes even in the warmest regions (see for example recent data from Sicily by Schär et al. 2020). Data from Greece and Poland also suggest that *F. cunicularia* may be adapted to a wider range of environmental conditions compared to *F. clara* (Lech Borowiec, pers. comm.).

The results we presented show how unreliable old distribution data have become as ant taxonomy evolved in the last decades. The distribution range of *F. rufibarbis* was greatly overestimated while the presence of *F. clara* remained unrecognized for a long time (Baroni Urbani 1971). Unfortunately, lack of distribution data verified under modern taxonomy is a common issue for Italian ants, well beyond the case examined in this study, with the distribution of many diverse and ecologically important genera such as *Lasius* strongly requiring new investigation (e.g. Schifani et al. 2021b).

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