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Formica paralugubris (Hymenoptera: Formicidae) in the Italian Alps from new data and old data revisited

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Abstract

We provide evidence that *Formica paralugubris* SEIFERT, 1996, a species of wood ant recently described from Switzerland, is present in the Italian Alps. Until 1996, this species was confounded with *F. lugubris* ZETTERSTEDT, 1838. We examine the wood ant collection deposited at the University of Pavia (Italy) and collect new samples within the Italian Alps. *Formica paralugubris* seems to be more abundant than *F. lugubris*. Moreover, both species are found in sympatry in some localities.

Key words: *Formica rufa* group, *Formica paralugubris*, *Formica lugubris*, sympatry, entomological collections.

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Introduction

Red wood ants (*Formica rufa* LINNAEUS, 1761 group) have been one of the most studied groups of ants in Europe during the last century (COTTI 1963, 1995, 1996). Under the direction of Prof. Mario Pavan (1918 - 2003), several studies examining the biological control, distribution and ecology of red wood ants were conducted in Italy (PAVAN 1959, 1981, RONCHETTI & GROPPALI 1995).

Wood ant species are morphologically very similar and consequently difficult to distinguish. Moreover, they are able to hybridize (SEIFERT 1991, CZECHOWSKI 1996, SEIFERT & GOROPASHNAYA 2004). As a result, the taxonomy of the *F. rufa* group has always been difficult and controversial (VEPSÄLÄINEN & PISARSKI 1981, COLLINGWOOD 1987, SEIFERT 1991). At the present time, this group is considered to number six species in Europe (SEIFERT 1996a, 1996b, GOROPASHNAYA & al. 2004): *F. rufa*, *F. polyctena* FÖRSTER, 1850, *F. lugubris* ZETTERSTEDT, 1838, *F. paralugubris* SEIFERT, 1996, *F. aquilonia* YARROW, 1955, and *F. pratensis* RETZIUS, 1783.

Since the discovery of a super-colony of *F. lugubris* (now identified as *F. paralugubris*) in the Swiss Jura (GRIS & CHERIX 1977) we have investigated several aspects of wood ant biology and ecology. In particular, we have focused on the reproductive strategies of the two species *F. lugubris* and *F. paralugubris* (see CHERIX & al. 2004 for a review, MAEDER 2006).

Formica paralugubris has been described recently as a sibling species of *F. lugubris* on the basis of morphological criteria (SEIFERT 1996b). A high level of experience is necessary for species identification and the method is time consuming even for specialists. Before 1996 the two species were considered as a single one under the name of *F. lugubris*, referred to as *F. lugubris* sensu lato in this paper. For that reason, the distribution of each species remains unclear. *Formica lugubris* sensu lato was considered as a boreo-alpine species ranging from 600 m up to 2200 m (GÖSSWALD & al. 1965, GÖSSWALD 1989) and widely distributed in Europe (PAVAN 1981, RONCHETTI 1981). Since its description, *F. paralugubris* has been found in the Pyrenees (A. MAEDER unpubl.), in Austria (SEIFERT 1996a, GLASER 2000, 2001, 2005, STEINER & al. 2002), in the Swiss Alps (MAEDER & CHERIX 2001, NEUMEYER & SEIFERT 2005), the French Alps (Isère, Hautes-Alpes, A. Maeder unpubl.), the Italian Alps (Vinschgaus / Val Venosta, GLASER 2003), and in the Swiss and French Jura Mountains (SEIFERT 1996a, MAEDER & CHERIX 2001, NEUMEYER & SEIFERT 2005). Unfortunately, data on its distribution in the Southern Alps and in other European regions are rare (CHERIX & al. 2004, C. Bernasconi unpubl.). However, *F. lugubris* sensu lato has been reported almost everywhere in the Italian Alps (RONCHETTI & GROPPALI 1995). Our objectives are first to confirm the presence of *F. paralugubris* in the Italian Alps and, second, to make an initial survey of its distribution on a wide range. Therefore we decided to investigate the collection of red wood ants made by Prof. M. Pavan and colleagues that are archived at the University of Pavia (Italy) and to re-sample some areas of the Italian Alps.

Methods

In March 2003, we examined the red wood ant collection (University of Pavia, Italy) that was initiated in 1955 under the supervision of Prof. M. Pavan and Prof. G. Ronchetti. This collection consists of about 2860 wood ant samples (mounted specimens) that were collected from about 500 stations within the Italian Alps (PAVAN 1959). We selected and reanalyzed 36 samples previously identified as *F. lugubris* coming from 14 different stations throughout the Italian Alps. In order to have rapid and relatively reliable species identification, only samples with queens were se-

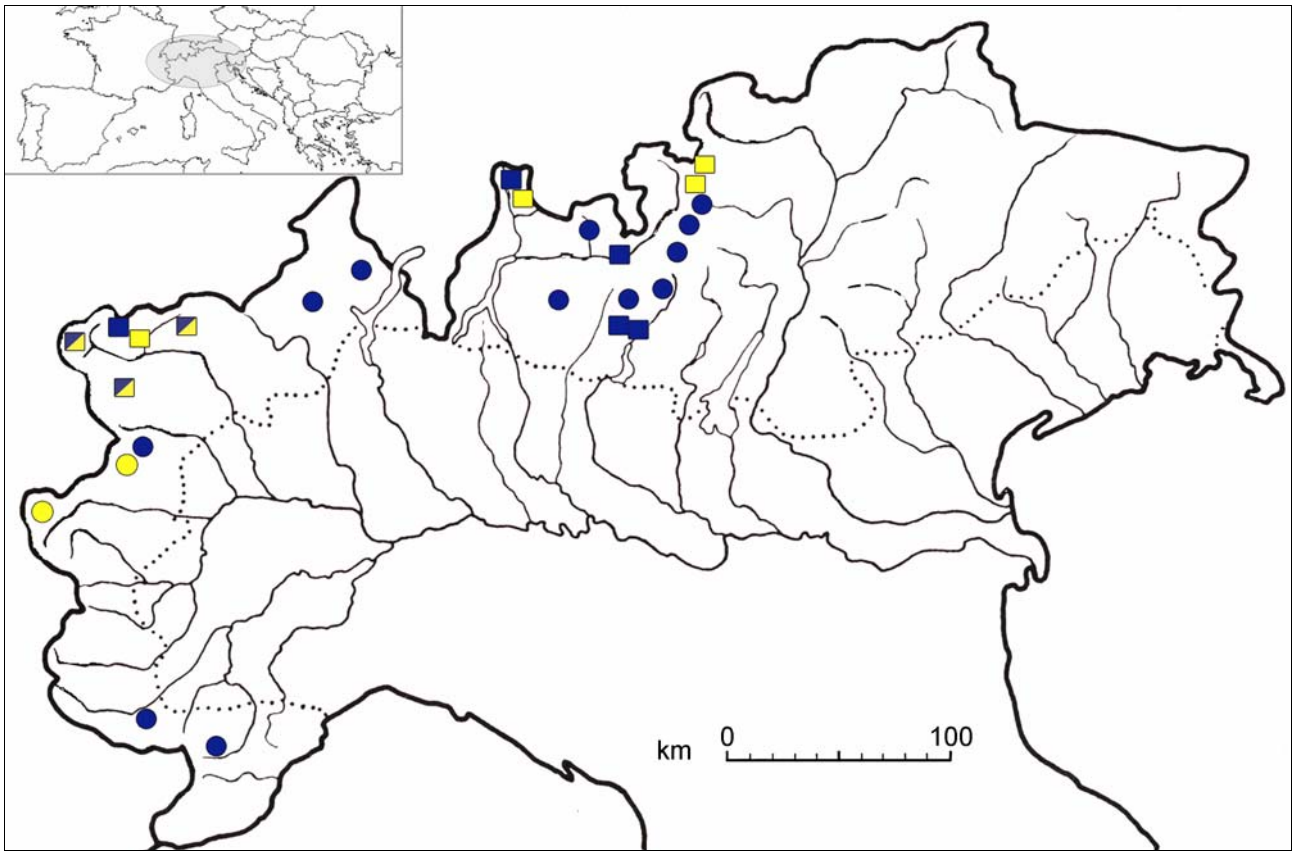

Fig. 1: Location of *Formica paralugubris* (blue) and *F. lugubris* (yellow) in the Italian Alps. Circles: samples collected in the 1950's. Squares: new field samples collected in 2005. Bicolor squares: stations in which the two species were found in sympatry. Dotted line: southern limit of the Italian Alps.

lected. Species identification was carried out according to SEIFERT (1996b) by measuring morphological traits in queens and also by comparing queens with reference material coming from the Swiss Jura and Swiss Alps. This reference material (workers and queens) was identified based on the morphological traits of workers (SEIFERT 1996b, B. Seifert pers. com.). We encountered some ambiguous queen specimens that were thus discarded from our study, only very clear specimens were considered. Some of these problematic specimens are stored at the museum of zoology in Lausanne and are available for future careful analysis.

In addition, in 2005 we collected 50 new samples from 12 different stations within the northwestern Italian Alps. The sampling regions were selected on the basis of previous work (PAVAN & al. 1971). Only areas where wood ants were previously confirmed were selected. Within each selected region we collected workers from nests along the pathways in order to sample along an altitudinal transect from about 1200 m to the upper limit of the forest. From each nest we collected about 20 workers. Ten ants were prepared for collection and ten were stored in ethanol 95 % for future genetic analysis. The new samples are stored at the Museum of Zoology (Lausanne, Switzerland) as voucher specimens.

Results

According to species re-identification we found that 33 / 36 (92 %) samples of *F. lugubris* sensu lato (Pavia's collection) belong to *F. paralugubris*, while only 3 / 36 (8 %) were identified as *F. lugubris* (Tab. 1, Fig. 1). Within the new samples 34 / 50 (68 %) have been recognized as *F. paralugubris* and 16 / 50 (32 %) as *F. lugubris* (Tab. 2, Fig. 1). The two species were found in sympatry in three stations from the new field samples, which were all located in the Aosta Valley (Fig. 1).

Discussion

Our results show that the wood ant *F. paralugubris* is present and widely distributed in the Italian Alps. Both deposited samples and fieldwork seem to indicate that *F. paralugubris* is more abundant than *F. lugubris* in term of occupied localities. However, this apparent dominance is relative because of potential biases in the sampling methods and differences in the social structure of the two species. *Formica paralugubris* forms obligately large colonies of numerous interconnected nests (polydomy) containing a huge number of laying queens (polygyny) (CHERIX 1980). On the other hand, *F. lugubris* is socially polymorphic with both monogynous and polygynous colonies (discovered at present only in the Swiss Alps, BERNASCONI & al. 2005). Re-analyzed samples of the Pavia collection were selected according to the presence of queens. These queens were collected at the nest surface during the sunny period in spring for 44 % of the samples. Consequently, as it was probably very difficult to find the *F. lugubris* queen from the monogynous nests during the sunny period, and thus, there was probably a bias toward *F. paralugubris* samples. Visited localities during the fieldwork were not select-

Tab. 1: Samples of *Formica lugubris* sensu lato collected by Professors M. Pavan and G. Ronchetti (PAVAN 1959) and deposited at the University of Pavia (Italy) that have been re-identified as *F. lugubris* or *F. paralugubris*. Province, station, locality, altitude of the station and sampling date are noted. Geographic coordinates were not available.

Province	**Station**	**Locality**	**Date**	**Altitude (m)**	**Species**
Cuneo	Ormea	Navette	9.IV.1955	1400	*F. paralugubris*
Cuneo	Ormea	Navette	9.IV.1955	1600	*F. paralugubris*
Cuneo	Valdieri	Casermetta	29.VII.1956	1600	*F. paralugubris*
Novara	Ceppo Morelli	Pizzo Camino	7.VI.1955	1110	*F. paralugubris*
Novara	Ceppo Morelli	Pizzo Camino	7.VI.1955	1160	*F. paralugubris*
Novara	Ceppo Morelli	Pizzo Camino	7.VI.1955	1260	*F. paralugubris*
Novara	Malesco	Capretto	23.IV.1955	1100	*F. paralugubris*
Novara	Malesco	Faedo	23.IV.1955	1300	*F. paralugubris*
Novara	Malesco	Orsera	11.IV.1955	1300 / 1600	*F. paralugubris*
Novara	Malesco	Riolata	11.IV.1955	1300 / 1600	*F. paralugubris*
Torino	Ala di Stura	Regione Rio Chiesa	11.IV.1955	1700	*F. lugubris*
Torino	Chialamberto	Pessé-Comba Creus	11.IV.1955	1600	*F. paralugubris*
Torino	Chialamberto	Pessé-Comba Creus	21. VI.1956	1650	*F. paralugubris*
Torino	Chialamberto	Leisan-Inv. Leisan	26. VI.1956	1500	*F. paralugubris*
Torino	Bardonecchia	Bacini	29.V.1957	1900	*F. lugubris*
Torino	Bardonecchia	Prà Reimond	28.V.1957	1800	*F. lugubris*
Bergamo	Vilminore	Clusorina	26.V.1955	1400	*F. paralugubris*
Bergamo	Vilminore	Paghera di Polzone	9.V.1956	1200	*F. paralugubris*
Bergamo	Vilminore	Giovetto	11.VI.1954	1300 / 1400	*F. paralugubris*
Bergamo	Vilminore	Giovetto	4.VI.1958	1200 / 1450	*F. paralugubris*
Bergamo	Piazza Brembana	Zucco Stremareggia	22.V.1953	1400	*F. paralugubris*
Bergamo	Piazza Brembana	Paris	21.V.1953	1600	*F. paralugubris*
Bergamo	Piazza Brembana	Foppabona	25.VI.1955	1400	*F. paralugubris*
Bergamo	Piazza Brembana	Foppabona	25.VI.1955	1400	*F. paralugubris*
Bergamo	Piazza Brembana	Foppabona	25.VI.1955	1400	*F. paralugubris*
Brescia	Cedegolo	Fontana Suta	19. VII.1956	1600	*F. paralugubris*
Brescia	Edolo	Paghera Lezza	04.VI.1955	1650	*F. paralugubris*
Brescia	Edolo	Paghera Lezza	04.VI.1955	1600	*F. paralugubris*
Brescia	Ponte di legno	Gasso	03.V.1954	1300	*F. paralugubris*
Brescia	Ponte di legno	Gasso	03.V.1954	1500	*F. paralugubris*
Brescia	Ponte di legno	Gasso	03.V.1954	1400	*F. paralugubris*
Brescia	Vezza d'Oglio	Fondo val Paghera	11.VI.1959	1300	*F. paralugubris*
Brescia	Vezza d'Oglio	Fondo val Paghera	12.VI.1959	1301	*F. paralugubris*
Brescia	Vezza d'Oglio	Fondo val Paghera	13.VI.1959	1302	*F. paralugubris*
Sondrio	Valmolenco	Gaspoggio	28.V.1953	1450	*F. paralugubris*
Sondrio	Valmolenco	Gaspoggio	28.V.1953	1450	*F. paralugubris*

Tab. 2: Field samples collected in 2005 and deposited at the Museum of Zoology (Lausanne, Switzerland). Province, station, locality, date, geographic coordinates and altitude of the station are given.

Province	Station	Locality	Date	Latitude	Longitude	Altitude	Species
Brescia	Borno	Giovetto	2.V.2005	N 45°57'28"	E 10°07'19"	1294 m	*F. paralugubris*
Brescia	Borno	Giovetto	2.V.2005	N 45°57'30"	E 10°07'26"	1332 m	*F. paralugubris*
Brescia	Borno	Giovetto	2.V.2005	N 45°57'28"	E 10°07'28"	1354 m	*F. paralugubris*
Brescia	Borno	Giovetto	2.V.2005	N 45°57'28"	E 10°07'30"	1405 m	*F. paralugubris*
Brescia	Borno	Giovetto	2.V.2005	N 45°57'28"	E 10°07'31"	1360 m	*F. paralugubris*
Brescia	Borno	Giovetto	2.V.2005	N 45°57'28"	E 10°07'32"	1374 m	*F. paralugubris*
Brescia	Borno	Giovetto	2.V.2005	N 45°57'28"	E 10°07'46"	1433 m	*F. paralugubris*
Brescia	Borno	Giovetto	2.V.2005	N 45°57'29"	E 10°07'46"	1432 m	*F. paralugubris*
Bergamo	Azzone	Giovetto-Giuadel	3.V.2005	N 45°57'36"	E 10°07'10"	1181 m	*F. paralugubris*
Bergamo	Azzone	Giovetto-Giuadel	3.V.2005	–	–	–	*F. paralugubris*
Bergamo	Azzone	Giovetto-Giuadel	3.V.2005	–	–	–	*F. paralugubris*
Bergamo	Azzone	Giovetto-Giuadel	3.V.2005	–	–	–	*F. paralugubris*
Bergamo	Azzone	Giovetto-Giuadel	3.V.2005	N 45°57'51"	E 10°07'17"	1183 m	*F. paralugubris*
Sondrio	Campodolcino	Gualdera	3.V.2005	N 46°23'29"	E 09°21'44"	1430 m	*F. lugubris*
Sondrio	Madesimo	Pian del Lanzo	4.V.2005	N 46°25'13"	E 09°20'52"	1577 m	*F. paralugubris*
Sondrio	Madesimo	Pian del Lanzo	4.V.2005	N 46°25'09"	E 09°20'56"	1574 m	*F. paralugubris*
Sondrio	Madesimo	Pian del Lanzo	4.V.2005	N 46°25'09"	E 09°20'56"	1622 m	*F. paralugubris*
Sondrio	Madesimo	Pian del Lanzo	4.V.2005	N 46°25'03"	E 09°20'56"	1565 m	*F. paralugubris*
Sondrio	Madesimo	Pian del Lanzo	4.V.2005	N 46°25'05"	E 09°20'56"	1567 m	*F. paralugubris*
Sondrio	Aprica	Magnolta	1.VIII.2005	–	–	–	*F. paralugubris*
Sondrio	Aprica	Magnolta	1.VIII.2005	N 46°08'39"	E 10°08'24"	1396 m	*F. paralugubris*
Sondrio	Aprica	Magnolta	1.VIII.2005	N 46°08'20"	E 10°08'05"	1561 m	*F. paralugubris*
Sondrio	Aprica	Magnolta	1.VIII.2005	N 46°08'23"	E 10°08'23"	1643 m	*F. paralugubris*
Sondrio	Aprica	Magnolta	1.VIII.2005	N 46°08'07"	E 10°08'21"	1804 m	*F. paralugubris*
Sondrio	Aprica	Magnolta	1.VIII.2005	N 46°08'11"	E 10°08'36"	1716 m	*F. paralugubris*
Sondrio	St.Caterina	Passo di Gavia	2.VIII.2005	N 46°23'57"	E 10°29'43"	2123 m	*F. lugubris*
Sondrio	St.Caterina	Passo di Gavia	2.VIII.2005	N 46°24'01"	E 10°29'54"	2056 m	*F. lugubris*
Sondrio	St.Caterina	Passo di Gavia	2.VIII.2005	N 46°27'16"	E 10°29'55"	1531 m	*F. lugubris*
Aosta	Etroubles	Pozon	27.VI.2005	N 45°48'36"	E 07°13'40"	1567 m	*F. lugubris*
Aosta	Etroubles	Pozon	27.VI.2005	N 45°48'36"	E 07°13'39"	1584 m	*F. lugubris*
Aosta	Etroubles	Pozon	27.VI.2005	N 45°48'35"	E 07°13'36"	1616 m	*F. lugubris*
Aosta	Courmayeur	Val Vény	27.VI.2005	N 45°48'03"	E 06°55'27"	1516 m	*F. lugubris*
Aosta	Courmayeur	Visailles	28.VI.2005	N 45°46'58"	E 06°53'43"	1730 m	*F. paralugubris*
Aosta	Courmayeur	Visailles	28.VI.2005	N 45°46'47"	E 06°53'22"	1831 m	*F. paralugubris*
Aosta	Courmayeur	Visailles	28.VI.2005	N 45°46'39"	E 06°53'01"	2008 m	*F. paralugubris*
Aosta	Courmayeur	Visailles	28.VI.2005	N 45°46'41"	E 06°53'01"	2007 m	*F. paralugubris*
Aosta	Courmayeur	Visailles	28.VI.2005	N 45°46'43"	E 06°53'10"	2026 m	*F. paralugubris*
Aosta	Courmayeur	Visailles	28.VI.2005	N 45°47'28"	E 06°54'35"	1561 m	*F. lugubris*
Aosta	Valsavarenche	Crottes	28.VI.2005	N 45°35'35"	E 07°11'56"	1816 m	*F. lugubris*
Aosta	Valsavarenche	Crottes	28.VI.2005	N 45°35'34"	E 07°11'55"	1817 m	*F. lugubris*
Aosta	Valsavarenche	Crottes	28.VI.2005	N 45°35'29"	E 07°11'53"	1879 m	*F. paralugubris*
Aosta	Valsavarenche	Le Pont	29.VI.2005	N 45°33'25"	E 07°12'41"	1740 m	*F. lugubris*
Aosta	Valtournenche	La Magdeleine	29.VI.2005	N 45°47'53"	E 07°36'40"	1540 m	*F. paralugubris*
Aosta	Valtournenche	La Magdeleine	29.VI.2005	N 45°49'10"	E 07°36'27"	1864 m	*F. paralugubris*
Aosta	Valtournenche	La Magdeleine	29.VI.2005	N 45°49'21"	E 07°36'45"	1980 m	*F. paralugubris*
Aosta	Valtournenche	La Magdeleine	29.VI.2005	N 45°49'20"	E 07°36'49"	1981 m	*F. lugubris*
Aosta	Valtournenche	La Magdeleine	29.VI.2005	N 45°49'21"	E 07°37'01"	1984 m	*F. lugubris*
Aosta	Valtournenche	La Magdeleine	29.VI.2005	N 45°48'07"	E 07°36'48"	1575 m	*F. lugubris*
Aosta	Bourg-St.Rhémy	–	29.VI.2005	N 45°50'35"	E 07°10'33"	1806 m	*F. paralugubris*
Bolzano	Stelvio	–	3.VIII.2005	N 46°36'30"	E 10°32'33"	1632 m	*F. lugubris*

ed following a randomized and stratified sampling protocol which may also introduce a potential species-specific bias.

In addition, this study reveals that in Italy both species also live in local sympatry, in accordance with previous observations made in Switzerland (MAEDER & CHERIX 2001, CHERIX & al. 2004).

Considering our results, we strongly recommend caution in further studies on wood ants. For example, it is surprising that a very recent work (BOUDJEMA & al. 2006) completely ignored current wood ant taxonomy and related literature. Fortunately, since our visit to Pavia, some studied wood ant colonies located in the Giovetto natural reserve (see Tab. 2) were appropriately reattributed to *F. paralugubris* (GROPPALI & BONERA 2004).

Besides morphological identification, sometimes difficult even for specialists, it is possible to ensure species identification by using complementary tools. For instance, we demonstrated that the two species can be discriminated by their cuticular hydrocarbons profiles (Chemotaxonomy, MAEDER 2006) and by their worker behaviour (Pupa carrying test, MAEDER & al. 2005). Moreover, a genetic tool is in development (C. Bernasconi unpubl.).

This study is a first survey of the distribution of the two wood ant species *F. lugubris* and *F. paralugubris* confounded as *F. lugubris* sensu lato before 1996. With respect to conservation biology, their respective distributions are obviously more fragmented than what was previously thought. Correct species identification should ensure appropriate conservation measures and is paramount in any scientific study.

Finally, our work once more demonstrates the importance of voucher specimens and collections deposited in museums of natural history or other institutions (FRANCOEUR 1976, ALBERCH 1993, SCHLICK-STEINER & al. 2003). Thanks to the huge work carried out by Professors M. Pavan, G. Ronchetti and colleagues (PAVAN 1959) we had the opportunity to report that *F. paralugubris* was already sampled in Italy about 50 years ago.

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Zusammenfassung

Wir berichten über Vorkommen der Waldameise *Formica paralugubris* SEIFERT, 1996 in den italienischen Alpen. Die Art wurde erst in jüngerer Zeit aus der Schweiz beschrieben. Bis 1996 wurde sie als *F. lugubris* ZETTERSTEDT, 1838 aufgefasst. Wir untersuchten die Waldameisensammlungen, die an der Universität Pavia (Italien) deponiert sind und machten neue Aufsammlungen in den italienischen Alpen. *Formica paralugubris* ist offenbar häufiger als *F. lugubris*. Beide Arten kommen an einigen Stellen syntop vor.

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