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Rediscovered after 140 years at two localities: *Myrmica myrmicoxena* FOREL, 1895 (Hymenoptera: Formicidae)

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Abstract

The inquiline ant *Myrmica myrmicoxena* FOREL, 1895 had not been found since its first discovery from the Alp Anzeindaz (Switzerland) in 1869. Two new sites have been discovered in Switzerland (Eggishorn, Fiesch, 2,213 m a.s.l.) in 2009 and Northern Italy (Laas, South Tyrol, 1,700 m a.s.l.) in 2006. The species inhabits subalpine, short-turfed grassland. *Myrmica lobulicornis* NYLANDER, 1857 seems to be the main and probably exclusive host species, which is supported by field data and vertical distribution. Morphometric data from all three sites of *M. myrmicoxena* are presented and compared. There exists no obvious morphological difference between the material from the locus typicus and the specimens from the two new sites.

Key words: *Myrmica myrmicoxena*, Alps, social parasitism.

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Introduction

On 20 August 1869, Mr. Edouard Bugnion collected several gynes and males of a socially parasitic ant in the Swiss Alps (Alp Anzeindaz) (KUTTER 1977, RADCHENKO & ELMES 2003). FOREL (1895) described the gynes of this series as *Myrmica myrmicoxena*. In spite of repeated searches at the type locality, the species was not found during the 20th century (KUTTER 1977). However, in the last few years this enigmatic ant has been rediscovered in two new sites in Switzerland and Italy. In this paper we give an account of this and present data on habitat selection and morphology.

Material and methods

Field sampling: An intensive investigation was made of the ant fauna of the Laaser Tal in the Vinschgau (Val Venosta), Southern Tyrol (Alto Adige), in 2006 and 2007. Information about species composition of different habitats and altitudes were gathered by a combination of methods, including pitfall trapping, netting and beating the vegetation, sieving, collecting by hand and searching nests (see GLASER 2004, 2008 for a full account of the methodology). Nest densities of ants were additionally investigated at the *M. myrmicoxena* site on 6 August 2007 using fourteen 2 m by 2 m plots, totalling 56 m^2. Species were identified using the keys in SEIFERT (2007).

In 2009, a very few ant specimens were collected by hand from the Eggishorn, a mountain in the Valais region of Switzerland. By chance, these included one gyne of *M. myrmicoxena*, which was collected with workers of the host colony. No further visits were made.

Morphological investigation: Investigated material of *M. myrmicoxena*:

Switzerland: Alp Anzeindaz, 20.VIII.1869, leg. E. Bugnion, lectotype and four paralectotype gynes (Museum of Natural History Geneva); Eggishorn, 14.VI.2009, leg. M. J. Lush, one gyne (Senckenberg Museum of Natural History (SMNH) Görlitz). Italy: South Tyrol, vic. Laas, 1.VIII. 2006, leg. F. Glaser, three gynes (SMNH Görlitz).

Morphological investigation of the gynes was performed according to the methods presented by SEIFERT & al. (2009). We present here only short definitions of the morphometric characters.

- CL Maximum cephalic length in median line.
- CS Cephalic size; arithmetic mean of CL and CW.
- CW Maximum cephalic width; always across eyes.
- CWb Maximum cephalic width, measured behind eyes (from RADCHENKO & ELMES 2003).
- FL Maximum anterior divergence of frontal carinae (= maximum frontal lobe width).
- FR Minimum distance between frontal carinae.
- ML Mesosoma length; measured in lateral view from caudalmost portion of propodeum to frontalmost point of anterior pronotal slope.
- MW Maximum mesososomal width before tegulae.
- PEHL Length of longest hair on petiole.

PEW Maximum width of petiole.

PPHL Length of longest hair on dorsal postpetiole.

PPW Maximum width of postpetiole.

SL Maximum straight line scape length. Distal measuring point: distalmost point of dorsal lamella of hinge joint capsule. Proximal measuring point: proximalmost point of scape shaft near neck of articular condyle.

SP Maximum length of propodeal spines as bilateral arithmetic mean. Measured in dorsofrontal view from spine tip to a point at bottom of interspinal meniscus. With the spines' dorsal edge in measuring plane, the spine tip must be focussed at a magnification with low depth of focus. Then, while keeping this focussing, the sharpest point at the bottom of interspinal meniscus is the basal measuring point.

Results and discussion

Sites: Detailed locations have not been provided for conservation reasons; Figure 1 provides an overview.

Laas, Italy: The Italian site is situated approximately 4.5 km south of the village Laas (Lasa) in the Laaser Tal and approximately 270 km east of the Swiss type locality. The Laaser Tal is a southward branch of the upper Vinschgau Valley (Val Venosta), formed by the river Etsch (Adige) and extends between 950 m and 3,400 m a.s.l. The upper part of the valley is glaciated (Laaser Ferner). The Laaser Tal shows distinctly higher annual precipitations (> 1,000 mm) than the Etsch Valley (500 mm in the colline zone, 700 mm in the montane zone). Glaciation and high mountains towards the South result in a relatively cool local climate (FISCHER 1974).

The woodland vegetation is dominated by *Picea abies*, *Larix decidua* and *Pinus cembra* at higher altitudes, with local pioneer stands of *Alnus viridis* and *Betula pendula*. The timber line reaches 2,250 m (locally up to 2,400 m a.s.l.). Woodland succession is locally disturbed by rocky areas, scree and avalanche slopes, and grazing by goats and sheep. Consequently, open grassland and dwarf-shrub heath occur frequently.

Eggishorn, Switzerland: The Swiss Site is situated on the southeast-facing slope of the Eggishorn in the Rhone Valley, 2.5 km west of the village of Fiesch and approximately 70 km east of the type locality. The Eggishorn is to the northwest of Fiesch and rises from about 1,000 m at Fiesch to 2,934 m a.s.l.

Records of *Myrmica myrmicoxena*: Laas: Seven alate gynes and one male were collected on 1 August 2006 in a mixed sample, including also spiders, beetles and different ant species (e.g., *Myrmica lobicornis* NYLANDER, 1846 and M*yrmica lobulicornis* NYLANDER, 1857). On 6 August 2007, an additional male was collected in a colony of *M. lobulicornis* at the same locality. One dealate gyne was caught in a pitfall trap between 3 September and 18 October 2006 about 15 m downhill of this locality.

Eggishorn: One dealate gyne was collected from within a colony of *M. lobulicornis* on 14 June 2009. The colony was located under a flat stone on a southeast-facing slope at 2,200 m a.s.l. When the stone was disturbed, most of the workers fled, except for a group clustered around the *M. myrmicoxena* gyne. This group of about 20 workers had the gyne pinned to the spot so that she was unable to move, though they did not appear to be attacking the gyne or causing her any significant harm. This cluster of ants, including the *M. myrmicoxena* gyne, was collected as part of the nest series.

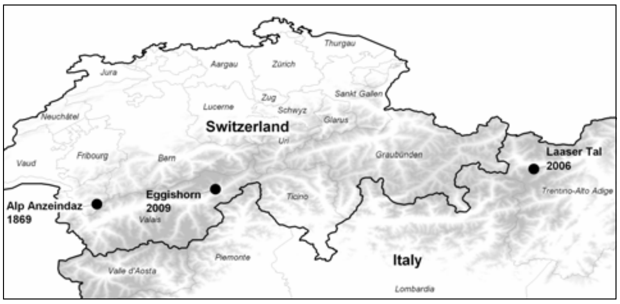

Fig. 1: Location of the locus typicus of *Myrmica myrmicoxena* (Alp Anzeindaz) and the two new sites.

Habitat characters: Laas: *Myrmica myrmicoxena* occurred only in an area of less than 1000 m^2. The ants were recorded at 1,700 m a.s.l. along an approximately 10 m wide band of subalpine grassland. Ellenberg indicator values show that the vegetation was dry oligotrophic grassland: T = 3.2, F = 5.0, N = 3.2, R = 6.2 (M. Hotter, unpubl.). The site is situated between dense thickets of young *Larix* sp. and a steep slope leading to a torrent. The area had very short vegetation, with approximately 15% stone cover, and young larch trees. The soil consisted of alluvial scree of calcareous (marble) and silicate origin. The site had a generally western aspect, though a small part had a northeast aspect. The succession of the grassland site to woodland was prevented by a combination of avalanches and grazing by goats and sheep.

Eggishorn: Here, *M. myrmicoxena* was recorded from short-turfed alpine grassland. The composition of the grassland at this locality was not recorded.

Syntopic ant species and nest densities in the Laaser Tal are shown in Table 1. *Myrmica lobulicornis* and *Formica lemani* BONDROIT, 1917 showed the highest nest densities, whilst nest densities of *M. lobicornis* were low. The syntopic occurrence of *M. lobicornis* and *M. lobulicornis* was not particularly unusual considering their broadly overlapping vertical distribution (SEIFERT 2005). In the Laaser Tal, *M. lobicornis* occurred at altitudes between 1,520 and 1,700 m, whereas *M. lobulicornis* occurred between 1,500 and 2,100 m a.s.l. (F. Glaser, unpubl.).

Biological notes: At the Eggishorn site (2,213 m a.s.l.), *M. lobulicornis* represents the single host species and the occurrence of ***M.** lobicornis* is most unlikely due to high altitude. At the Laas site, however, *M. lobicornis* occurs syntopically, but in much lower densities than *M. lobulicornis* (see Tab. 1). *Myrmica myrmicoxena* has not been found outside of the geographical range of *M. lobulicornis*, which would be expected if *M. lobicornis* was also a host. The known vertical distribution of *M. myrmicoxena* ranges from 1,700 to 2,213 m a.s.l. while that of the purported host species *M. lobulicornis* ranges between 1,000 and 2,700 m (SEIFERT 2007). These facts all indicate that *M. lobulicornis* is the primary, possibly the exclusive host, which is supported by the presence of a male (Laas) and of a gyne (Eggishorn) of *M. myrmicoxena* within nests of *M. lobulicornis*.

The situation in which the Eggishorn specimen was found may provide additional insights into host colony in-

Tab. 1: Ant species composition and nest densities at the *Myrmica myrmicoxena* site in the Laaser Tal (South Tyrol, Italy), based on sampling of fourteen 2 m by 2 m plots, totalling 56 m^2. * The *Formica lugubris* colony is nominally referred to an area of 1000 m^2 to achieve a realistic value. x Just single foraging workers.

Species	**Number of colonies**	**Number of plots with colonies**	**Colonies per 100 m²**
Myrmica myrmicoxena FOREL, 1895	1	1	1.8
Myrmica sulcinodis NYLANDER, 1846	1	1	1.8
Myrmica lobicornis NYLANDER, 1846	1	1	1.8
Myrmica lobulicornis NYLANDER, 1857	9	7	16.1
Formica lemani BONDROIT, 1917	30	10	53.6
Formica lugubris ZETTERSTEDT, 1838	1	1	0.1*
Formica aquilonia YARROW, 1955	x	x	x
Total	42	13	75.2

Tab. 2: Morphological data of *Myrmica myrmicoxena* and *M. hirsuta*. *Myrmica hirsuta* data from RADCHENKO & ELMES (2003). n = number of gynes measured. Upper values: arithmetic mean ± standard deviation; lower values, in brackets: minimum, maximum. All measurements in mm.

Species	***Myrmica myrmicoxena***				***Myrmica hirsuta***
Series	Alp Anzeindaz (n = 5)	Laas (n = 3)	Eggishorn (n = 1)	All (n = 9)	(n = 27)
CS	1.039 ± 0.015 [1.026, 1.056]	1.051 ± 0.006 [1.045, 1.055]	1060	1.046 ± 0.014 [1.026, 1.060]	1.127 ± 0.051 [1.000, 1.220]
CL / CW	0.994 ± 0.011 [0.982, 1.005]	1.000 ± 0.015 [0.982, 1.010]	1.021	0.999 ± 0.014 [0.982, 1.021]	0.978 ± 0.017 [0.949, 1.006]
SL / CS	0.668 ± 0.010 [0.651, 0.678]	0.691 ± 0.005 [0.687, 0.697]	0.717	0.681 ± 0.019 [0.651, 0.717]	0.748 ± 0.014 [0.715, 0.770]
FL / CS	0.499 ± 0.004 [0.496, 0.505]	0.501 ± 0.002 [0.499, 0.502]	0.515	0.502 ± 0.006 [0.496, 0.515]	0.454 ± 0.014 [0.424, 0.473]
FR / CS	0.420 ± 0.003 [0.417, 0.424]	0.415 ± 0.004 [0.411, 0.419]	0.425	0.419 ± 0.004 [0.411, 0.425]	0.374 ± 0.011 [0.347, 0.391]
PEW / CS	0.299 ± 0.008 [0.287, 0.308]	0.298 ± 0.006 [0.291, 0.302]	0.301	0.299 ± 0.006 [0.287, 0.308]	0.348 ± 0.024 [0.310, 0.430]
PPW / CS	0.517 ± 0.009 [0.509, 0.526]	0.490 ± 0.008 [0.482, 0.497]	0.499	0.503 ± 0.015 [0.482, 0.526]	0.549 ± 0.032 [0.509, 0.674]
PEHL / CS	0.174 ± 0.009 [0.161, 0.184]	0.184 ± 0.009 [0.175, 0.192]	0.180	0.178 ± 0.009 [0.161, 0.192]	no data
PPHL / CS	0.165 ± 0.009 [0.156, 0.174]	0.168 ± 0.007 [0.163, 0.176]	0.177	0.168 ± 0.008 [0.156, 0.177]	0.240 ± 0.014 [0.216, 0.276]
SP / CS	0.242 ± 0.009 [0.227, 0.251]	0.253 ± 0.006 [0.249, 0.260]	0.257	0.247 ± 0.010 [0.227, 0.260]	0.280 ± 0.026 [0.234, 0.337]
ML / CS	1.484 ± 0.029 [1.457, 1.527]	1.455 ± 0.013 [1.444, 1.470]	1.519	1.478 ± 0.030 [1.444, 1.527]	1.627 ± 0.064 [1.571, 1.737]
MW / CS	0.813 ± 0.032 [0.760, 0.843]	0.746 ± 0.009 [0.740, 0.756]	0.810	0.790 ± 0.040 [0.740, 0.843]	0.854 ± 0.053 [0.808, 0.945]

vasion. The gyne was not obviously under attack, as none of the normal signs of aggression were observed and the specimen was undamaged. This might suggest that the gyne would have been eventually accepted. However, similar behaviour has been observed by Graham W. Elmes (pers. comm.) in other socially parasitic *Myrmica* species that resulted in the death of the gyne.

The parasitisation rate seems low at the Italian site and our data suggest that less than 10% of host nests may be infested. However, bearing in mind that inquilines are difficult to find, the parasitisation rate could also be higher.

Morphology: Considering a putatively high degree of isolation between populations of rare social parasites, the overall morphology of the series from all three sites is surprisingly similar. This is also reflected by morphometric data (Tab. 2). The coefficient of variation over all characters is lower than in gynes of independent and socially parasitic species. For comparison, we give the data of a better

Fig. 2: Habitus of a *Myrmica myrmicoxena* gyne from Laas (Italy). © Hannes Müller.

Fig. 3: Lateral view of a *Myrmica myrmicoxena* gyne from Laas (Italy). © Senckenberg Museum, Görlitz.

studied social parasite: *Myrmica hirsuta* ELMES, 1978. The big variation of mesosoma width seen in *M. myrmicoxena* is a normal feature in gynes of any investigated ant genus.

The gynes of this species can not be confused with any other W-Palaearctic *Myrmica*. The drawings in KUTTER (1977) and RADCHENKO & ELMES (2003) provide a realistic picture of the species (see also Figs. 2 - 4). All gynes (the five measured type gynes, three from Laas and one from the Eggishorn) show the following diagnostic character combination:

(a) Small body size (ML 1.546 ± 0.034 mm).
(b) Scape relative to frontal lobe width shorter than in any other species (SL / FL < 1.399); scape base in angle and structure comparable to *M. rubra*, but whole scape much more thickset.
(c) Petiole very high and short, with large subpetiolar process and small (± 70°) angle between linear portions of anterior and dorsocaudal profiles in lateral view.
(d) Postpetiole very high and short, with prominent ventral bulge.
(e) Longest postpetiolar setae shorter than 20% of CW.

Myrmica myrmicoxena is obviously closely related to *Myrmica arnoldii* DLUSSKY, 1963 from South Siberia and Mongolia, which is probably a temporary social parasite in one or several species of the *M. lobicornis* group (RADCHENKO & ELMES 2003). According to the drawings given by RADCHENKO & ELMES (2003), gynes and males are most similar in overall body shape and size. The brief statements in the key (a comparative table of measurements was not given) indicate that the gynes of *M. arnoldii* differ in having a larger head width behind the eyes (CWb; *M. arnoldii* 1.04 - 1.08 mm, *M. myrmicoxena* 0.93 - 0.97 mm) and a larger frontal index (FR / CWb; *M. arnoldii* 0.47 - 0.50, *M. myrmicoxena* 0.45 - 0.46). The four *M. myrmicoxena* gynes from Laas and Fiesch match this definition quite well with CWb of 0.939, 0.941, 0.946 and 0.954 mm and FR / CWb of 0.464, 0.450, 0.456 and 0.471.

The characters of the investigated male from Laas agree very well with those shown in the drawing of a type series male given in KUTTER (1977: Fig. 64). Both males have short scapes and show the normal number of 13 antennae segments (see Fig. 5). The detail of Kutter's drawing makes it unlikely that he could have erroneously depicted more

Fig. 4: Frontal view of the head of a *Myrmica myrmicoxena* gyne from Laas (Italy). © Senckenberg Museum, Görlitz.

Fig. 5: Frontal view of the head of a *Myrmica myrmicoxena* male from Laas (Italy). Montage of three separate z-stack photos. Scapes shown in full length. © Senckenberg Museum, Görlitz.

antennae segments than really existed as was discussed by RADCHENKO & ELMES (2003). They stressed this point, because males of *M. arnoldii* have a reduced antennal segment number of 12. This difference between *M. arnoldii* and *M. myrmicoxena* would be significant if it was consistent throughout the geographic range of both species. Apart from this uncertain point, the sum of available information provides enough arguments to assume a heterospecifity of *M. myrmicoxena* and *M. arnoldii*.

Conservation aspects: In the national Red List of Switzerland (AGOSTI & CHERIX 1994), *M. myrmicoxena* is listed under level 4 (near threatened), in spite of missing records since 1869. In the IUCN red list, the species is categorized as vulnerable D2 (SOCIAL INSECTS SPECIALIST GROUP 1996). However, the two new locations in the Alps do not provide sufficient evidence to justify a change in threat status and further studies will be necessary.

Perspectives: Like in other *Myrmica* inquilines, the opportunities to detect *M. myrmicoxena* are limited. The best time to discover the species is when alates have emerged, though the precise timing of this is not known beyond the June to August dates given here. Investigations should also include west- or north-exposed slopes with high nest densities of the host species *M. lobulicornis.*

Myrmica myrmicoxena is most likely under-recorded due to the relatively low intensity of sampling undertaken by myrmecologists in higher altitudes of the Alps. When working at higher altitudes, most myrmecologists prefer to sample south-facing mountain sides, expecting to find higher species richness, and neglect north- and west-facing slopes.

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Zusammenfassung

Die inquiline Knotenameise *Myrmica myrmicoxena* FOREL, 1895 war seit ihrer Entdeckung in den Schweizer Alpen im Jahr 1869 nicht wieder gefunden worden. Wir stellen zwei neue Nachweise der Art in der Schweiz (Eggishorn, Fiesch, 2213 m Seehöhe) und Norditalien (Laas, Südtirol, 1700 m Seehöhe) vor. Die Art besiedelt subalpines, kurzrasiges Grasland. *Myrmica lobulicornis* NYLANDER, 1857 scheint die (wahrscheinlich) einzige Wirtsart zu sein, was aufgrund von Feldbeobachtungen und der Höhenverbreitung beider Arten bestätigt wird. Morphometrische Daten von allen drei Fundorten werden präsentiert und verglichen. Es wurden keine morphologischen Unterschiede zwischen der Typenserie und dem neu gesammelten Material festgestellt.

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