Myrmecologische Nachrichten	5	37 - 41	Wien, Dezember 2003

On the geographic distribution of queen polymorphism in *Myrmecina graminicola* (Hymenoptera: Formicidae)

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Abstract

Queen polymorphism, i.e. the occurrence of normally alate/dealate females (gynomorphs) and more or less workerlike intermorphs, both representing functional queens within one species, has been described in the ant *Myrmecina graminicola*. To date, in Europe this phenomenon has been reported only for populations in southern Germany (S-Hesse and NW-Bavaria), although a few instances of probably intermorphic specimens have been mentioned from Switzerland and Italy as well. Here, we report on new data from Germany (Northrhine-Westfalia), Austria (Carinthia, Styria, Lower Austria), Spain (Tarragona, Gerona) and Italy (Mantova): Intermorphs were found as functional queens in five regions (Northrhine-Westfalia, Carinthia, Styria, Lower Austria, Tarragona); in a total of four regions intermorphs were found along with gynomorphs (Northrhine-Westfalia, Styria, Lower Austria, Tarragona); and in two regions (Gerona, Mantova), only a few isolated intermorphic specimens were found, demonstrating that this form occurs there, too. Whether queen polymorphism is a character of the species throughout its range, or whether it is restricted to certain areas in Europe, remains unknown.

Key words: Formicidae, *Myrmecina graminicola*, queen polymorphism, geographic distribution, intermorph, Austria, Germany, Italy, Spain, Europe.

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Introduction

The cryptic ant *Myrmecina graminicola* (LATREILLE, 1802) has a very extended Western Palaearctic distribution range, from northern Africa, Spain, Italy, Greece and Asia Minor to England and southern Scandinavia (Fig. 1; CZECHOWSKI & al. 2002). Apart from workers and males, nearly exclusively alate/ dealate females and queens have been reported from this entire range. Only recently, BUSCHINGER (2001) and BUSCHINGER & SCHREIBER (2002) described a queen-polymorphism of *M. graminicola* in populations in southern Germany (S-Hesse and NW-Bavaria). Along with normal "gynomorphic" females, "intermorphs" – always wingless and morphologically intermediate between workers and gynomorphs – occur. They can be inseminated and are capable of becoming functional queens. Remarkable aspects are: Colonies with gynomorphic queens always are monogynous, while colonies with intermorphic queens are either monogynous or polygynous. The female sexual offspring of gynomorphic queens are either gynomorphs or intermorphs exclusively, while intermorphic queens either produce exclusively intermorphic female sexuals or both gynomorphs and intermorphs simultaneously. The queen polymorphism is genetically based (Buschinger, unpubl.).

To date, the geographic distribution of queen polymorphism within the total range of *M. graminicola* was unknown. Here, we summarize the current knowledge and present the first substantiated records on intermorphs from Austria, Italy, and Spain.

In this contribution, castes are functionally defined (queen = inseminated and laying eggs, independently of its morphological appearance; worker = more or less sterile, working). The different morphs

are called gynomorphs (= alate/dealate, normal female of ants) and intermorphs (= morphologically intermediate form between gynomorph and ergatomorphic worker). Gynomorphs as well as intermorphs can be inseminated and fertile and can thus function as queens (cf. BUSCHINGER & CROZIER 1987).

Material, Methods and Results

Deliberately finding *M. graminicola* is difficult. Relatively warm and damp sites within sparsely wooded areas, near wood margins and at the foot of wooded hills are the best places. The small nests are frequently located beneath big, often partly mossy stones, which are embedded in the soil to depths of c. 10 - 15 cm (BUSCHINGER & SCHREIBER 2002). The colonies can often be collected whole using an aspirator. Some, perhaps even many colonies, however, live in small chambers in the soil, without adjoining stones. These are only rarely found, except when collected by chance within a soil sample. Such hidden nesting may explain why most publications report only single workers, discovered while digging or caught in pitfall traps.

In the following we list hitherto unpublished records of *Myrmecina graminicola* from seven regions, in Germany (Northrhine-Westfalia), Austria (Carinthia, Styria, Lower Austria), Spain (Tarragona, Gerona), and Italy (Mantova; see also Fig. 1):

(1) Wolkenburg vic. Bonn-Bad Godesberg (7°13'E / 50°40'N; Northrhine-Westfalia), 300 m NN, 19. VII.1969, leg. A. Buschinger, coll. Bu #3.292: nest; 1 intermorphic queen, 30 workers.

(2) Wolkenburg vic. Bonn-Bad Godesberg, same location as nest (1), 3.VI.1970, leg. A. Buschinger, coll. Bu #3.714: nest; 1 gynomorphic queen, numerous workers, larvae. Fostering the larvae in the lab yielded gynomorphic females (along with further workers).

(3) Saager vic. Gallizien (14°55'E / 46°56'N; Carinthia), 410 m NN, 17.VI.2003, leg. A. & R. Buschinger, coll. Bu #16.125: nest; 1 intermorphic queen, 17 workers, eggs, larvae and prepupae.

Four further records from the same location only contained a few workers each.

(4) Steinberg vic. Mühldorf (15°54'E / 46°55'N; Styria), 390 m NN, 18.VI.2003, leg. A. & R. Buschinger, coll. Bu #16.130: nest; 1 gynomorphic queen, 28 workers, eggs, larvae and prepupae.

(5) Steinberg vic. Mühldorf, same location as nest (4), 18.VI.2003, leg. A. & R. Buschinger, coll. Bu #16.131: nest; 2 intermorphic females, 46 workers, eggs, larvae and prepupae.

(6) Ridge E Schildhütten vic. Heudürr (15°29'E / 48°24'N; Lower Austria), 28.IV.2003, 350 m NN, leg. B.C. Schlick-Steiner & F.M. Steiner, coll. b&f #12.418: nest; 1 gynomorphic queen, 51 workers.

(7) Pfaffenmaiß vic. Heudürr (15°28'E / 48° 25'N; Lower Austria), 660 m NN, 3.IX.2003, leg. B.C. Schlick-Steiner & F.M. Steiner, coll. b&f #12.771 and #12.772: nest; 1 gynomorphic queen, 20 alate gynomorphs, 56 workers.

(8) Pfaffenmaiß vic. Heudürr, same location as nest (7), 3.IX.2003, leg. B.C. Schlick-Steiner & F.M. Steiner, coll. b&f #12.773 and #12.774: nest; 5 intermorphic females, 365 workers.

This colony was unusually big. Colonies with several intermorphic queens in S-Hesse/NW-Bavaria contain an average of 57.2 (± 34.3) workers, but a maximum of 136. If a colony is kept in the lab for several years, similarly high numbers of workers can be obtained, however (Buschinger, unpubl.).

(9) Pfaffenmaiß vic. Heudürr, same location as nest (7), 3.IX.2003, leg. B.C. Schlick-Steiner & F.M. Steiner, coll. b&f #12.775 and #12.776: nest; 1 gynomorphic queen, 64 workers.

(10) Ridge W Förthofgraben vic. Stein an der Donau (15°33'E / 48°24'N; Lower Austria), 430 m NN, 3.IX.2003, leg. B.C. Schlick-Steiner & F.M. Steiner, coll. b&f #12.788 and #12.789: nest; 1 intermorphic queen, 72 workers.

(11) Ridge W Förthofgraben vic. Stein an der Donau, same location as nest (10), 3.IX.2003, leg. B.C. Schlick-Steiner & F.M. Steiner, coll. b&f #12.790 and #12.791: nest; 13 intermorphic females, 13 workers.

(12) Ridge W Förthofgraben vic. Stein an der Donau, same location as nest (10), 3.IX.2003, leg. B.C. Schlick-Steiner & F.M. Steiner, coll. b&f #12.793 and #12.794: nest; 1 gynomorphic queen, 131 workers.

(13) Ridge W Förthofgraben vic. Stein an der Donau, same location as nest (10), 3.IX.2003, leg. B.C. Schlick-Steiner & F.M. Steiner, coll. b&f #12.795 and #12.796: nest; 1 gynomorphic queen, 85 workers.

Two further records from the same place exclusively contained workers (48 and 47, respectively).

(14) Cave vic. Sant Feliu de Pallarols (2º30'E / 42º 05N'; Gerona), 453 m NN, 6.XI.1979, leg. X. Bellés, coll. Espadaler: pitfall trap catches; 2 intermorphs.

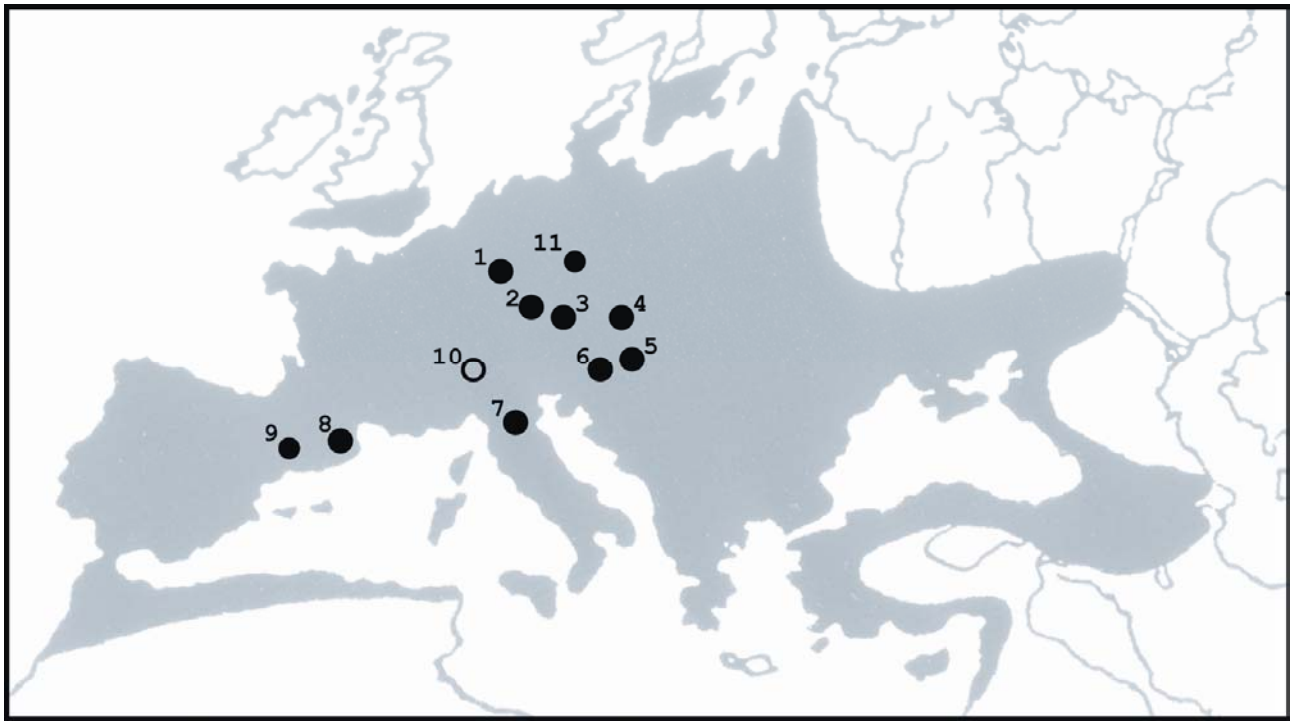

Fig. 1: Range of *Myrmecina graminicola* in the Western Palaearctic (following CZECHOWSKI & al. 2002, altered), and regions where intermorphs have been found (black dot: substantiated record, black circle: probable record, but without voucher specimen). 1 = Northrhine-Westfalia, 2 = Hesse (BUSCHINGER & SCHREIBER 2002), 3 = Bavaria (BUSCHINGER & SCHREIBER 2002), 4 = Lower Austria, 5 = Styria, 6 = Carinthia, 7 = Mantova, 8 = Gerona, 9 = Tarragona, 10 = Tessin (KUTTER 1916, 1977), 11 = Thuringia (B. Seifert, personal communication[1]).

(15) La Mussara (1º02'E / 41°15'N; Tarragona), 900 m NN, 23.III.1978, leg. X. Espadaler, coll. Espadaler: nest (incompletely dug out); 3 intermorphs, 3 gynomorphs, some larvae and pupae.

(16) Bosco Fontana (10º47'E / 45º11'N; Mantova), 25 m NN, 8.IX.1966, leg. B. Poldi, coll. Espadaler: collection method unknown; 1 intermorph.

Nest records exist from five regions (Tab. 1, Northrhine-Westfalia, Carinthia, Styria, Lower Austria, Tarragona), and in all of these regions intermorphs were found within nests. In a total of four regions (Northrhine-Westfalia, Styria, Lower Austria, Tarragona) both morphs – intermorphs and gynomorphs – were found. Two regions have currently yielded only a few intermorphs (Gerona, Mantova).

Discussion

The above data are the first proof of the presence of intermorphs of *Myrmecina graminicola* for Austria (north of the Alps in Lower Austria, and in Carinthia and Styria) and for Spain (Tarragona, Gerona) (Fig. 1). In addition, the record from Italy is the first substantiated record based on a stored voucher specimen. In some nests in Lower Austria and Styria, the only female sexuals were intermorphs: their slightly extended gaster allows them to be addressed as functional queens. In these populations, colonies with gynomorphic queens were also found. Based on the current knowledge on the biology of *M. graminicola* (BUSCHINGER & SCHREIBER 2002), summarized in

Tab. 1: Nest records of *Myrmecina graminicola* in the studied regions, with the occurrence of intermorphs and gynomorphs (n = number of nests per region).

Region	**Nests n**	**with gynomorphs**	**with intermorphs**
Northrhine-Westfalia	2	1	1
Carinthia	1		1
Styria	2	1	1
Lower Austria	8	5	3
Tarragona	1	1	1

[1] Communicated while the article was in press.

the introduction, the occurrence of 3 intermorphs and 3 gynomorphs within one nest in Tarragona indicates that one or several intermorph(s) was/were the functional queen(s) of this nest and the gynomorphs were probably virgin offspring. In this region, however, gynomorphs, due to the few available samples, were not found as functional queens. Thus, in Austria a queen polymorphism in the species, as it had been demonstrated for southern Germany (BUSCHINGER & SCHREIBER 2002; S-Hesse and NW-Bavaria), was proved, for Spain it is highly probable. The records from Bonn-Bad Godesberg show that this polymorphism also exists in Northrhine-Westfalia.

Myrmecina kutteri FOREL, 1915 was described from Tessin, Switzerland (KUTTER 1916). Interpreting the respective figure in KUTTER (1977, fig. 166) according to our definition, this taxon probably refers to intermorphs. A further specimen in KUTTER (1977, fig. 167, "microgyne") is definitely an intermorph. BROWN (1951) synonymised *M. kutteri* with *M. graminicola*. It was Forel himself who suspected that this taxon actually could be a "kind of an ergatogyne" (STITZ 1939). According to EMERY (1916), Forel had seen similar specimens in Italy. Our record of an intermorph from Mantova supports the interpretation of these literature data as intermorphs of *M. graminicola*. Queen polymorphism might thus be well distributed south of the Alps. It remains unclear, however, though probable, that these intermorphs are functional queens.

The range of *Myrmecina graminicola* in East-Asia, according to the distribution in CZECHOWSKI & al. (2002), is inhabited by the subspecies *M. graminicola nipponica*, which is currently regarded as a separate species by some authors (e.g. MURAKAMI & al. 2002). According to OHKAWARA & al. (1993) and MURAKAMI & al. (2002), this taxon also exhibits queen polymorphism, although this is restricted to the northern parts of its range. From southern Europe (Sardinia, Sicily), two further species – *M. melonii* and *M. sicula* – have been described, but only workers are known (Rigato 1999).

Further study is needed to address the issue of whether queen polymorphism occurs within the entire range of *Myrmecina graminicola* or whether it is restricted to some areas. Only then will we be able to determine whether climatic or other ecological factors trigger the evolution of such queen polymorphism.

Acknowledgements

To W. Czechowski, B. Seifert, and M. Stachowitsch.

Zusammenfassung

Königinnenpolymorphismus, also das Auftreten von normalerweise ge- oder entflügelten Weibchen (Gynomorphen) und von mehr oder weniger arbeiterähnlichen Intermorphen, beides funktionelle Königinnen innerhalb einer Art, wurde vor kurzem für die Ameisenart *Myrmecina graminicola* beschrieben. Bisher war dieses Phänomen innerhalb von Europa nur für Populationen in Süddeutschland (S-Hessen und NW-Bayern) bekannt, obwohl vereinzelt Hinweise auf wahrscheinlich intermorphe Individuen in der Schweiz und in Italien in der Literatur existieren. Wir präsentieren hier neue Daten aus Deutschland (Nordrhein-Westfalen), Österreich (Kärnten, Steiermark, Niederösterreich), Spanien (Tarragona, Gerona) und Italien (Mantova): Intermorphe wurden als funktionelle Königinnen in fünf Regionen festgestellt (Nordrhein-Westfalen, Kärnten, Steiermark, Niederösterreich, Tarragona). In insgesamt vier Regionen wurden sowohl Intermorphe als auch Gynomorphe angetroffen (Nordrhein-Westfalen, Steiermark, Niederösterreich, Tarragona). Aus zwei Regionen (Gerona, Mantova) liegen ausschließlich Funde vereinzelter intermorpher Individuen vor, was zeigt, dass diese Form dort ebenfalls vorkommt. Ungeklärt bleibt, ob der Königinnenpolymorphismus im gesamten Verbreitungsgebiet der Art vorkommt, oder auf bestimmte Gebiete Europas beschränkt ist.

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