

How does *Myrmica rubra* (Hymenoptera: Formicidae) disperse in its invasive range? Record of male-only swarming flights from Newfoundland

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Abstract

The Eurasian ant *Myrmica rubra* (LINNAEUS, 1758) invaded North America more than 100 years ago. Here, we report the first records of *M. rubra* from Newfoundland, as well as the first North American record of male dispersal swarms. These records, from Carbonear, Corner Brook, and St. John's, are the northernmost (48° 56' N) reliable records of *M. rubra* in North America. Like with other polygynous invasive ants where queen dispersal seems to be limited, we discuss a potential role of male dispersal in maintaining gene flow among colonies in light of observations of male-only swarming in Newfoundland.

Key words: *Myrmica rubra*, dispersal, swarms, Formicidae, invasive ant.

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Introduction

Myrmica rubra (LINNAEUS, 1758), an aggressive ant known for its painful sting, is native to Europe and Asia and was first recorded in North America in Massachusetts in 1900 (WHEELER 1908). In North America, the ant is found between latitude 41° 30' N to 46° 48' N, while in its native Palaearctic region its range is much larger; from latitude 39° N to 70° N. This disparity in latitudinal range has led WETTERER & RADCHENKO (2011) to suggest that the North American populations may have been introduced from a single European population with a narrow latitudinal range. However, the patchy distribution of *M. rubra* throughout the Northeastern U.S. has led others to believe that multiple introductions of *M. rubra* have occurred in North America (GRODEN & al. 2005). Up to now, this ant has been recorded from six eastern US states (Massachusetts, New York, Rhode Island, Vermont, New Hampshire and Maine) as well as from Washington State (WETTERER & RADCHENKO 2011). In Canada, it is established in Quebec, Ontario, New Brunswick, Nova Scotia, Prince Edward Island (WETTERER & RADCHENKO 2011) and recently in British Columbia (A. Francoeur, pers. comm.). While *M. rubra* has a broad range in Eurasia extending from Ireland and Portugal in the west to eastern Siberia and from Italy in the south to northern Scandinavia (SEIFERT 1988), its distribution in North America is not as widespread.

The species is both polygynous (many queens per nest) and polydomous (many smaller nests combining to make a larger nest) and its nesting habitats are variable. They prefer moist habitat, nesting under stones or decayed logs (DONISTHORPE 1915). In Maine, they were located in lawns and gardens, old fields, shrubland, wetland and deciduous forest (GRODEN & al. 2005). While these ants may be found

under stones and / or tree roots, GRODEN & al. (2005) found that the majority of nests (88%) were under or within downed woody debris or in leaf litter. Nests were not observed within dense spruce-fir coniferous forest and GRODEN & al. (2005) suggested that coniferous forest as well as roads and streams provided natural barriers to their movement. The anthropogenic movement of soil (i.e., through contaminated nursery stock) is believed to be the most common method of introduction to new regions (GRODEN & al. 2005). This is why WETTERER & RADCHENKO (2011) suggested that the North American range of *Myrmica rubra* will continue to spread, and stated that "there appears to be no geographic barriers that would prevent *M. rubra* from spreading across the US and Canada, from coast to coast".

Many temperate *Myrmica* ants including *Myrmica rubra* overwinter as larvae and adults. They produce worker ants in the same season (rapid brood) but also a slow brood that has delayed development as larvae, overwinter in diapause and pupate in the next summer to produce workers, queens and males (KIPYATKOV 2001, KIPYATKOV & al. 2005).

One important feature of ant reproductive biology is the nuptial flight. Here the males and queens depart on a mating flight where the coupling normally occurs on-the-wing. This behavior provides a mechanism for dispersal of the ants plus it prevents inbreeding of siblings. Several ant species have female reproductives with reduced dispersive abilities where mating occurs within the colony (intranidal mating) (see PASSERA & KELLER 1994 and examples there in). In polygynous species, inbreeding has been shown to be low mainly because queens preferentially mate with unrelated males (PASSERA & KELLER 1993). In the highly poly-



Fig. 1: Location of *M. rubra* in Newfoundland, Canada.

gynous Argentine ant, *Linepithema humile* (MAYR, 1868) mating occurs in the nest (PASSERA & KELLER 1992). For male ants there are two mating strategies; stay in the colony and hope to mate with a newly emerged queen or leave the nest hoping to find another nest with unmated queens.

In its native range, nuptial flights of *Myrmica rubra* occur in August or September (DONISTHORPE 1915, HUBBARD & NAGELL 1976); however, GRODEN & al. (2005) did not find convincing evidence of nuptial flights in North America (e.g., Maine, USA). Even though alate males were observed they saw very few alate queens (one alate queen in three years of study) in an area of intensive study. No males or alate queens were captured in sticky traps or pan traps placed in infested areas throughout the summer and into the autumn. Nuptial flights are localized events in its native range (DONISTHORPE 1915, HUBBARD & NAGELL 1976, ELMES 1991). In North America, mating flights are most likely infrequent and GRODEN & al. (2005) suggested that new queens probably mate and remain within their nests. GRODEN & al. (2005) and ELMES (1973) indicated that with reduced long-range flight dispersal in its invasive and native ranges, respectively, dispersal of *M. rubra* colonies is likely accomplished by budding. This behavior is known from other invasive ant species (MARKIN 1970, TSUTSUI & SUAREZ 2003).

The question of how *Myrmica rubra* disperses in its invasive range is discussed in light of recent observations of male-only swarming behavior.

Materials and methods

Myrmica rubra in Newfoundland appears to be widespread on the west and east coast of the island (Fig. 1). Direct observations of the ant's activities occurred at Carbonear (47° 44' N; 53° 13' W), Corner Brook (48° 56' N; 57° 56' W) and St. John's (47° 34' N; 52° 43' W), Newfoundland, Canada. The search for ant nests involved turning over flat stones and leaf mulch.

This insect first generated media attention in July 2010 when a man in Corner Brook was stung severely. Some specimens from that locality were received in early September and were identified as *Myrmica rubra*. Dr. A. Francoeur (University of Quebec, Chicoutimi) verified the identifications. Subsequent to that identification, *M. rubra* was found in Carbonear on 16 September 2010. A collection trip was organized for Corner Brook on 18 September 2010. Voucher specimens of workers, dealate queens and males have been deposited in the collection of Senckenberg Museum of Natural History Görlitz, Germany.

Results

On 18 September, sampling in the Corner Brook area, around the locality where it was first reported, revealed many nests along trails that surrounded a small man-made pond in the center of the city. Ants in Corner Brook appeared to be confined to areas adjacent to the pond and the stream exiting the pond (total area was 0.2 km²); however, one unconfirmed report indicated that the ant may be in other parts of the city.

In Carbonear, workers were collected and nests observed only from the north side of the town in a confined area consisting of about 0.5 km² even though other parts of the town were extensively searched.

At 8:30 a.m. on 29 September a swarm of flying ants was observed directly over the location of the first nest that was located in Carbonear. I returned at 8:50 a.m. with a camera but while the swarm was still visible it was not as prominent as earlier. I attributed it to the fact that the wind had increased slightly. There were many winged male ants all over the cars parked below and many ants landed on me while I watched. All of the ants that I saw and collected were male. At 8:30 a.m. on the following day (30 September) I witnessed a swarm in the same location. This time, the winds stayed low all morning. I undertook a systematic search of the town looking for swarms where 3.5 km² of the entire town was searched thoroughly by car and 57 swarms were located. The swarming behavior occurred only in the morning as no swarms were observed at the areas after 1 p.m. In each case, the swarms were located on the leeward side of Maple trees (*Acer* spp.) and always occurred just below the apex of the tree, about 6 - 9 m from the ground. The swarms were easily seen against the bright sky. The swarming activity was observed on the mornings of 29, 30 September and 1 October but the peak of the swarming activity appeared to be 30 September. The weather during these days was similar. On 30 September it was warm (15°C) fully overcast with a light wind (11 km/h) from the west and high humidity (RH = 100%). There was low cloud and mist on the tops of the hills surrounding the town. Atmospheric pressure was 101.66 KPa and rising. The 57 swarms recorded occurred in the same general area where worker ants and nests were located. In fact the densest swarms occurred at trees in the center of the area.

On 2 October no swarms were found even though the weather conditions were similar (temp = 20°C, RH = 100%, cloudy). However during that day the wind was higher (33 km/h) from the west with stronger gusts. I attributed the stronger winds for curtailing the flight activity mainly because I discovered thousands of winged males crawling over the ground near the eastern entrance to a school in the center of the previous days' observed flight activity. In this instance, many of the winged males were being carried by worker ants. I did not see any winged females but there were several dealate queens in the group. This ground activity only occurred on the east side of the building.

Another notable observation on the weather is that a strong hurricane (Igor) moved through the area one week before I witnessed the flight activities. This storm was the strongest that the area witnessed in many years and the high winds and heavy rains toppled trees and caused localized flooding.

Upon recording *Myrmica rubra* in Newfoundland, I looked back through some pinned ant specimens that I had in my collection and discovered two *M. rubra* worker specimens collected in Carbonear in May 2000 by a past student of mine (Keith Moore). These specimens were part of his general insect collection for a university entomology course. In addition, I contacted some home owners in the area of Carbonear where I first saw the ant activity. One resident described how the ant had been on her property from the time that she built the house (18 years previous) and that she and other family members were stung many times throughout the summer months. In addition, I contacted the gardener at Corner Brook House which is a large estate in the area of Corner Brook where the ant was located. He remembered being stung by these ants at least 25 years ago. He was able to recount the time because he and the lady of the house were planting flowers and were forced to abandon the activity because of ant stings.

Discussion

This is the first record of *Myrmica rubra* occurring in Newfoundland and it extends its present range in North America to 48.56° N. WETTERER & RADCHENKO (2011) previously recorded it as far north as 47.36° N in North America. The observation of male-only swarming behavior in Newfoundland is the first record of such in North America. Male-only swarming of *M. rubra* is known to occasionally occur in its native range, too, although swarming of queens and males have been observed more frequently (B. Seifert, pers. comm.). ELMES (1991) suggested that typical *Myrmica* swarming behavior begins in mid-afternoon in late August and early September in Britain. The swarming activity observed in Newfoundland occurred in late September and may be the result of prolonged warmer temperatures into late September experienced by Newfoundland due to its maritime climate. The swarms observed here occurred in the early morning and were finished by mid-afternoon. On the days when flight activity was observed, the morning winds in the area were not as strong as later in the day and this may have influenced the activity. The observations that the swarms appeared to be composed of male ants supports the findings of LEPRINCE & FRANCOEUR (1986) who suggested that *Myrmica* swarms are highly male-biased in Quebec.

With the observation of flight activity in the area, one would think that the distribution of the ants locally would be more widespread but I did not find that to be the case. Foraging ants and nests were located only in a small area within the town of Carbonear. DONISTHORPE (1915) mentioned that the polygyny of *Myrmica rubra* nests in Britain was caused by the re-seeking of the original nests by females which have been fertilized near their own nests. GRODEN & al. (2005) did not witness nuptial flights of *M. rubra* in Maine and suggested that if such flights did take place in North America that they were very rare and localized. According to B. Seifert (pers. comm., based on observations by A. Buschinger and B. Seifert), there is rare evidence for intranidal mating in its native range as numerous mated alate (!) macrogynes were found inside some nests in spring but the general behaviour is that mating occurs during swarming outside the nest. In Europe, mating swarms of *M. rubra* are generally considered to occur more closely to the nest site and have led some to suggest long-

distance dispersal of females rarely occurs (ELMES & CLARKE 1981, ELMES 1991). Molecular studies using allozymes have shown that there is restricted dispersal of *M. rubra* females (SEPPÄ & PAMILO 1995, WALIN & al. 2001). In Finland, *M. rubra* had a low F_{st} value ($F_{st} = 0.2$) indicating significant genetic differentiation between populations (SEPPÄ & PAMILO 1995). They claim that new nests are founded close to the mother nest by budding of existing nests, a view taken by GRODEN & al. (2005) for the ant in North America. Additionally, for *M. rubra* in its native range, STEINER & al. (2006) used a combination of data from microsatellites of nuclear DNA and mitochondrial DNA to show that dispersal by females was not as great as dispersal by males.

This raises the question of what the role is of the swarming behavior observed in *Myrmica rubra* males in Newfoundland. Is it a vestige of the typical ant nuptial flight or is it an important mechanism to ensure gene flow among colonies in a species where there is limited dispersal by queens? The environmental conditions experienced may have determined the male-only swarm. In its native range, *M. rubra* shows considerable year-to-year variation in queen and male production. A very cold spring and early summer followed by a very hot midsummer may result in a complete failure to produce queens and even in "normal" years, nests with males only and no alate female sexuals may be found in late summer (B. Seifert, pers. comm). It is possible that in Newfoundland, the new queens may have flown off in the days before the hurricane leaving behind the males. However, the restricted local distribution of the ant tends to indicate that dispersal on the wing (at least over long distances) by new queens does not occur. Further sampling in the coming seasons will determine if the range expansion of *M. rubra* in localized areas of Carbonear is enough to consider winged dispersal by queens.

The importance of male-only swarms to ensure gene flow among colonies cannot be overlooked. In another polygynous ant species (*Linepithema humile*), where the queens do not take part in the nuptial flight but remain in the nest to mate (PASSERA & KELLER 1992), the male-only swarms observed (MARKIN 1970) are believed to mediate gene flow between colonies and thus account for the significant lack of inbreeding in this species (PASSERA & KELLER 1994). In the invasive range of *M. rubra*, it has been suggested that intranidal mating occurs exclusively (GRODEN & al. 2005). However, similar to *L. humile*, it is possible that male *M. rubra* may disperse in an attempt to mate with gynes from different nests. The data from STEINER & al. (2006) in its native range suggests that the dispersal of the males and mating with queens from distant nests does occur.

While this may be the first published record of *Myrmica rubra* in Newfoundland, there are indications that it has been in Newfoundland for several years before now. In addition to specimens collected from Carbonear in May 2000, the reports from residents in the area indicate that this ant has been at some locations in Newfoundland for at least 20 years. Additional studies are ongoing to determine the extent of its distribution in Newfoundland and to determine the possible routes of introduction.

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