

Social and genetic structure of the ant *Leptothorax risii* Forel, 1892 (Insecta, Hymenoptera, Formicidae) from Gran Canaria

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Social and genetic structure of the ant Leptothorax risii Forel, 1892 (Insecta, Hymenoptera, Formicidae) from Gran Canaria.— The colony structure of *Leptothorax (Myrafant) risii*, a little known ant belonging to the *L. rottenbergi* group and endemic to the Canary Islands, was investigated by enzyme electrophoresis. In a preliminary investigation of only eight colonies from Gran Canaria, worker relatedness was found to be 0.77 ± 0.07 , suggesting that at least these colonies of *L. risii* were monogynous and monandrous, i.e., contain only a single, singly-mated queen. *L. risii* thus appears similar in this respect to most other species of *Leptothorax (Myrafant)*.

Key words: *Leptothorax*, Formicidae, Monogyny, Colony structure, Relatedness.

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Introduction

Data on the social and genetic structure of ant colonies are of interest for the understanding of the evolution and the phyletic distribution of life history strategies. It is often believed that most ant societies contain only a single, singly-mated queen and that nestmate workers are fullsisters with a degree of relatedness of 0.75. However, many investigations have shown that polygyny, i.e., the occurrence of multiple queens per colony, or polyandry, i.e. multiple mating of queens, are by far more common than expected, and nestmate relatedness is often much lower than 0.75 (e.g. BUSCHINGER, 1968; HÖLDOBLER & WILSON, 1990; HERBERS, 1993; KELLER, 1995).

The ant genus *Leptothorax* is especially well studied in this respect. Colonies of all species in the boreal subgenus *Leptothorax* (s. str.) may contain multiple queens, whereas the majority of *Leptothorax* (*Myrafant*) species in Central Europe and the Mediterranean appear to be strictly monogynous, i.e. have only one queen per colony (HEINZE & BUSCHINGER, 1988). Comparatively little is known on the social structure of species in the *Leptothorax* (*Myrafant*) *rottenbergi* group, a complex or rather large, robust *Leptothorax*, most of which occur around the Mediterranean (SANTSCHI, 1909).

Leptothorax risii is a medium-sized, reddish-brown member of this latter group endemic to the Canary Islands (WHEELER, 1927; WELLENIUS, 1955) and has previously been recorded from various localities on Gran Canaria.

Material and methods

Colonies of *Leptothorax risii* were collected with an aspirator in spring 1996 and transferred to the laboratory in glass collecting vials. A total of 12 colonies were found nesting under flat rocks in Artenara at an elevation of 1250 m and in decaying *Aeonium* stems in Barranco de Agaete near San Pedro at an elevation of 150 m. For electrophoresis, individual ants were killed by freezing and crushed in 40 μ l of homogenization buffer (0.5M Tris/HCl pH 8.0, 10% glycerine, 0.01% bromothymol blue), of

which approximately 10 μ l were applied to 12.5 cm long 7.5% polyacrylamide slab gels (LKB Multiphor; gel buffer 0.125M Tris/HCl pH 8.0; running buffer 0.16M glycine, 0.025M Tris, pH 8.3). Proteins were separated for 1 1/2 hours at 10°C and 10 mA per gel. Of a total of ten enzymes visualized using standard histochemical staining solutions (MURPHY et al. 1990), glucose-6-phosphate isomerase (GPI, EC 5.3.1.9) and phosphoglucomutase (PGM, EC 5.4.2.2) showed sufficient variation for a more detailed examination of genetical colony structure. For staining GPI and PGM, gels were placed in Petri dishes containing 3 ml staining buffer, 200 μ l NADP, 200 μ l MTT, 200 μ l PMS, 3 to 10 μ l Glucose-6-Phosphate dehydrogenase and a few crystals of substrate (PGM. Glucose-1-phosphate; GPI. Fructose-6-phosphate).

Mean nestmate relatedness was calculated according to PAMILO (1984, 1990), using a computer program by P. Pamilo. Standard errors were estimated by jackknifing.

Results and discussion

In eight colonies, a single queen was present, whereas in the others no queen was found, probably due to incomplete collecting. Colonies contained between 30 and 100 workers. A total of 72 workers and virgin queens was investigated by electrophoresis in polyacrylamide gels. Both GPI and PGM were found to be variable, with three alleles each (allele frequencies: GPI 0.062, 0.803, 0.135; PGM 0.387, 0.189, 0.424). The inbreeding coefficient averaged about -0.07 ± 0.13 (GPI -0.04 ± 0.13 , PGM -0.09 ± 0.16). The 95% confidence interval (-0.39 to 0.24) clearly overlaps zero, suggesting that mating among male and female sexuals occurs at random.

From allele frequencies of workers within the eight colonies with queen and the background allele frequencies, a mean relatedness of 0.77 ± 0.07 was calculated (GPI 0.79 ± 0.10 , PGM 0.75 ± 0.09), giving a 95% confidence interval for the mean of 0.61 to 0.93. The mean value is not significantly different from 0.75 (two-tailed t-test, $df = 7$, $t = 0.253$, $P \gg 0.1$), but is much higher than 0.5, the hypothetical value for colo-

nies with a doubly inseminated queen where both males contribute equally to the queen's diploid offspring ($t = 3.98$, $P < 0.01$). Though the sample size is very small and the results of this investigation therefore must be considered to be preliminary, the present data suggest that at least the collected colonies of *L. risii* were monogynous and monandrous. *L. risii* therefore is presumably similar in its sociogenetic structure to other *Leptothorax* (*Myrafant*), which have also been shown to have only one, singly-mated queen per colony. From collection data it appears that colonies of other species in the *L. rottenbergi* group also typically contain a single queen (*L. bugnioni*, *L. hesperius*, *L. marocana*, *L. mauritanicus*, and *L. semiruber*, X. Espadaler, pers. comm., BUSCHINGER et al., 1988). This corroborates the idea that in *L. (Myrafant)*, polygyny is restricted mostly to species inhabiting alpine or boreal environments (HEINZE & BUSCHINGER, 1988).

Nevertheless, in at least two colonies, a few workers showed genotypes which could not be explained by the assumed monogynous-monandrous colony structure. In one colony, where the genotype of the queen was determined, 3 of a total of 19 workers most probably were not her offspring. Though the aspirator was cleaned after each colony had been collected to prevent the accidental transfer of larvae sticking in the tubes of the aspirator to other colonies, this surprising result might be a collection artifact. On the other hand, it has recently been shown that colonies of *L. (Myrafant) nylanderii* occasionally fuse or adopt a new, unrelated queen (FOITZIK & HEINZE, in press). This also leads to genetic heterogeneity of colonies despite regular monogyny and monandry.

Resumen

Estructura social y genética de la hormiga Leptothorax risii Forel, 1892 (*Insecta, Hymenoptera, Formicidae*) de Gran Canaria

Se ha estudiado mediante electroforesis enzimática la estructura de la colonia de *Leptothorax (Myrafant) risii*, una especie poco conocida perteneciente al grupo de *L.*

rottenbergi y endémica de las Islas Canarias. En una investigación preliminar con sólo ocho colonias de Gran Canaria se encontró que la afinidad entre reina y obreras era de $0,77 \pm 0,07$, este dato sugiere que al menos estas colonias de *L. risii* eran monogínicas y monándricas, es decir, que contienen una única reina fecundada por un sólo macho. Así pues, *L. risii* se parece en este aspecto a la mayoría de especies del género *Leptothorax (Myrafant)*.

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