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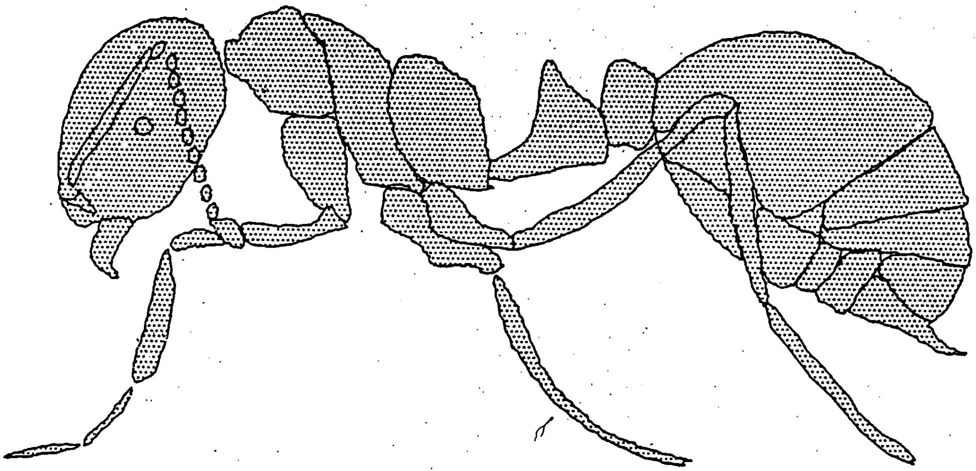

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The parasitic ant, *Solenopsis daguerrei* (Hymenoptera: Formicidae), on fire ants: abundance and field studies in Argentina

by

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Introduction

Research on biological control of the red imported fire ant, *Solenopsis invicta* Buren, in the United States was initiated in the 1960's as part of a program to find a permanent suppression of this serious economic pest (Lofgren et al. 1975). The biological control approach for fire ants has been further encouraged since mirex bait was canceled in 1978 because of the detrimental impact of toxic baits in the environment (Lofgren 1986), and due to efforts to reduce the use of chemicals for insect control.

The workerless parasitic ant, *Solenopsis daguerrei* (Santschi) (formerly *Labauchena daguerrei*), was discovered by Juan B. Daguerre in colonies of *Solenopsis richteri* Forel (formerly *S. saevissima* var. *richteri*) in a pasture of "El Toro" Ranch, Las Flores, Buenos Aires province, Argentina (Bruch 1930). The ant is a permanent parasite and belongs to the most advanced group of social parasites of ants (Hölldobler and Wilson 1990). Observations on the biology, behavior, and distribution of this ant were reported by Bruch (1930), Silveira-Guido et al. (1962 to 1969), and Silveira-Guido et al. (1973). According to Bruch (1930), the parasite can kill the host colony by decapitation of the queens, at least under laboratory conditions. However, Silveira-Guido et al. (1965) never saw any evidence of decapitation. According to Silveira-Guido et al. (1973), the parasite is specific to the *Solenopsis* complex and affects the biotic potential of the fire ant colonies by causing, eventually, the total inhibition of the production of host sexuals. All these findings have made this species a potential candidate for introduction into the United States for the biological control of the red imported fire ant. However, nothing is known about its actual impact on field populations. Jouvenaz (1990) and Wojcik (1990) considered this parasitic ant to be the most promising arthropod candidate for introduction into the United States.

Research on fire ants in South America has been concentrated at the USDA-ARS South American Biological Control Laboratory, Hurlingham, Buenos Aires, Argentina, since 1988. The objective of this work was to detect the abundance of *S. daguerrei*, select a field site for ecological studies, and try to estimate its actual impact on local populations of fire ants.

Part I: Abundance

Materials and Methods

Area Surveyed. We sampled a total of 7,727 fire ant colonies from 241 collecting sites in eastern, central, and northern Argentina (provinces of Buenos Aires, Santa Fe, Entre Rios, Corrientes, Misiones, Chaco, and Formosa) from January 1988 to May 1996. Some collecting sites within the province of Buenos Aires were sampled periodically. In the area of Saladillo (180 km SW of Buenos Aires), we conducted the most intensive sampling in natural pastures, including a total of 1,846 colonies of *S. richteri*. Sampling was done every 30-50 days from October 1988 to July 1990, and every 2-4 month from abundant, and are distributed locally, found only at few sites, and very difficult to locate, thus giving the false impression that they are close to extinction. The abundance of *S. daguerrei* in the different areas surveyed cannot be compared without considering the time and periodicity of the collections. As previously stated, density of this parasite in the area of Las Flores was extremely high in the 1960's (31.6-38.4%) but it was not detected in our surveys.

In the cold season (May to August), we observed that only the queens of *S. daguerrei* remained in some parasitized colonies. In these cases, the chances of finding them during a field examination are low and percentages of parasitism could be underestimated. For example, during our sampling at San Eladio in May, June, and July 1996 (fall–winter), we found that 10.3% of the sampled colonies, believed to be parasite-free after the first field examination, were actually parasitized, in other words, they were false negatives. This was discovered once in the laboratory, where those colonies were floated and queens of *S. daguerrei* were found in them.

During the warm season (September to April), it is uncertain whether the immature stages and adults of *S. daguerrei* are always present within parasitized colonies. Some preliminary laboratory work (unpublished) conducted in a rearing chamber at 26-28 °C, suggested that the presence of immature stages of *S. daguerrei* be cyclic. If this also occurs in the field, the absence of sexuals would not indicate the absence of parasitism and percentages of parasitism could be, again, underestimated. The recognition of egg and larval stages of the parasite within the host colony and the host-parasite relationship should be investigated.

In summary, the abundance of *S. daguerrei* can be underestimated due to the collection method used and the apparent cyclic behavior of this parasite. This is especially true when colonies are opened, scattered and examined in the field, because low infestation rates are difficult to detect with this method. Although extremely time consuming, the most efficient collection method to avoid false negatives was the excavation of most part of the colonies and their examination in the laboratory after flotation. We recommend using this method in future collections.

Based on the surveys reported here, the area of San Eladio currently shows the highest abundance of *S. daguerrei* and was selected for ecological studies. Its proximity to the USDA Laboratory at Hurlingham simplifies periodical field trips.

Part II: Field Studies

Materials and Methods

Study Area. The area of San Eladio is topographically flat and the temporary formation of small ponds is common in low spots. The vegetation is composed mainly of gramineae and is used for livestock grazing and annual crops. The mean annual temperature for 1996 was 16.2 °C, annual rainfall 898.2 mm, maximum temperature 39 °C (January), minimum temperature -6 °C (June) and the number of days with frost 81

Results and Discussion

Percentage of Parasitism and Mound Density. Within San Eladio area, *S. daguerrei* was detected in 13 collecting sites from 1.3 to 23.5% of the colonies (Table 2). We found parasitized 102 (5.7%) of the excavated colonies of *S. richteri*. The highest abundance of this parasite (23.5%) corresponded to a small lot with low density of fire ant colonies.

The mound density at parasitized sites was 179 ± 27 mounds per hectare (range, 44-389). This density is significatively lower than the one we registered in other 53 collecting sites selected in 20 parasite-free localities of Buenos Aires Province, 239 ± 15 mounds per hectare (range, 78-600) ($t = 2.27$; df = 63; $P < 0.05$), from November 1995 to February 1996 (Calcaterra et al. unpublished).

Although the regression of mound density against percentage of parasitism was not significant ($r^2 = 0.04$: $F_{1,11} = 0.48$; $P = 0.502$), we found that the mean percentage of parasitism in high-density sites (above the mean) was 3.9% while in low-density sites (below the mean) was 7.0%. This should be further investigated.

Mound Volume. The volume of parasitized colonies was 6.0 ± 0.5 liters (range, 0.3-21.3), similar to the mound volume of non parasitized colonies, 5.9 ± 0.5 liters (range, 0.5-34.6) ($t = 0.08$; df = 144; $P = 0.94$).

Considering all colonies (parasitized and non parasitized), the mound volumes of monogyne and polygyne colonies were similar (5.2 ± 0.5, range 0.3-16.5 vs. 5.3 ± 0.6 liters, range 0.5-21.3; $t = -0.1$; df = 115; $P = 0.92$).

Host Colony Composition. *Polygyny.* Polygyne *S. richteri* colonies were very common in San Eladio. The presence of multiple queens in non parasitized colonies was 53.5%, similar to the 47.2% found in parasitized colonies ($x^2 = 0.656$; df = 1; $P > 0.1$). This is consistent with the high incidence of polygyny reported by Briano et al. (1995) in fire ant populations in South America. They reported for *S. richteri* in Saladillo and Las Flores, 25.7-41.5 and 46% of polygyny respectively. Porter et al. (1991, 1992) reported for *S. invicta* in the United States, 67-80% of polygyny. Surprisingly, this later species has not been found in the polygyne form in Brazil (Jouvenaz et al. 1989; Porter et al. 1992).

We did not find a collecting site exclusively monogyne (all sites were polygyne). We speculate, that the parasite might establish more easily in polygyne than in monogyne populations, due to the lower aggressiveness of the former. This needs further investigation.

Number of Queens per Colony. The mean number of queens per colony was 5.7 ± 1.2 (range, 2-40) in parasitized colonies and 10.2 ± 3.4 (range, 2-180) in non parasitized colonies, but the difference was not significant ($U = 1343.0$, $n_1 = 34$, $n_2 = 54$, $P = 0.14$). Due to a high variability, a larger sample size is needed to detect statistical significance.

The reduction in the number of queens in parasitized colonies, if confirmed, would support Bruch' s observation (1930) of decapitation and would determine and important detrimental effect of *S. daguerrei* on fire ant populations. Further research on this matter is underway.

Worker Brood. The percentage of colonies with worker brood during the complete

Parasite Colony Composition. *Polygyny and number of queens.* We found multiple queens of *S. daguerrei* in 65.5% of the colonies examined. The mean number of queens per colony was 3.8 ± 0.9 (range, 1-64). However, the mean number of queens was higher in polygyne host colonies than in monogyne ones (7.7 ± 3.4, range 1-64 vs. 1.8 ± 0.3, range 1-7 respectively; $U = 174.5$; $n_1 = 15$; $n_2 = 18$; $P < 0.005$).

In parasitized colonies kept in the laboratory, we observed (unpublished) the emergence of new parasite queens. This would agree with Silveira-Guido et al. (1973), who reported that mating occurs inside the tumulus, at the exit-holes, or on top of the tumulus. It is also consistent with Wilson (1971), who reported that, in rare ant species, there is no evidence of mating with members of other colonies (exogamia). According to him, this would insure that many queens will be fecundated in each colony and that the loss of virgin reproductive females will be reduced.

Weight of queens. The mean weight of queens of *S. daguerrei* was 1.86 ± 0.06 mg (range 0.6-3.2) and no differences were observed between monogyne and polygyne host colonies (2.2 ± 0.13 vs. 1.9 ± 0.12 mg, respectively; $t = 1.66$; df = 31; $P = 0.11$). We found, like in the host, physogastric queens from September to early December (spring).

Presence of sexuals. We found males and females in May, June (fall), December (late spring) of 1996, and in January and February (summer) of 1997. In July and August (winter) 1996, we found only a few females; and during September, October and November (spring) only queens of *S. daguerrei* (fastened to *S. richteri* queens) were present in the colony. This agrees with Silveira-Guido et al. (1963), who, in August, found only wingless females attached to the neck of the host queens of *S. richteri.*

According Silveira-Guido et al. (1973) *S. daguerrei* has in this latitude two well-defined oviposition periods: the first from July to October (winter-spring) and the second from January to March (summer). We detected again the presence of parasite sexuals (females and males) in the first week of December (spring) 1996, a month later than the sexuals of the host. In this month, according Silveira-Guido et al. (1973), starts the second cycle of oviposition.

Sex Ratio. Males were less numerous than females, in most colonies of *S. daguerrei* sampled. The average sex ratio was approximately 1:3 (23.2% males vs. 76.8% females). However, high variation was observed among the colonies. Percentages of males within a colony ranged from 0 to 95.3% (percentages of females ranged from 4.6 to 100%). The sex ratio reported here agrees with Silveira-Guido et al. (1963 to 1964), who stated that the males represent 25% of the population of *S. daguerrei.*

Conclusions

The low presence of *S. daguerrei* in Argentina has made field work difficult and discourages future research. Also, it will make researchers argue about the actual incidence that this parasite has in the natural control of fire ants in their native land. However, we speculate that biotic and/or abiotic factors may limit its populations. If so, once introduced in a new habitat, (in the United States?) and released from natural restrictions, *S. daguerrei* could establish and propagate. The presence of these

References Cited

Banks, W. A., C. S. Lofgren, D. P. Jouvenaz, C. E. Stringer, P. M. Bishop, D. F. Williams, D. P. Wojcik and B. M. Glancey. 1981. Techniques for collecting, rearing and handling imported fire ants. USDA. Sci. and Educ. Admin.. Adv. in Agric. Tech. AAT-S-21, 9 p.

Briano, J. A., R. S. Patterson, and H. A. Cordo. 1995. Relationship between colony size of *Solenopsis richteri* (Hymenoptera: Formicidae) and infection with *Thelohania solenopsae* (Microsporida: Thelohaniidae) in Argentina. J. Econ. Entomol. 88: 1233-1237.

Bruch, C. 1930. Notas preliminares acerca de *Labauchena daguerrei* Santschi. Rev. Soc. Entomol. Argentina 3 (2): 73-82, Plates 1-2.

Hölldobler, B. and E. O. Wilson. 1990. The Ants. Belknap Press of Harvard University Press, Cambridge, Massachusetts.

Jouvenaz, D. P. 1990. Approaches to biological control of fire ants in the United States, pp. 620-627. *In* R. K. Vander Meer, K. Jaffe & A. Cedeño [eds.], Applied Myrmecology: A World Perspective. Westview Press, Boulder, Colorado.

Jouvenaz, D. P., D. P. Wojcik, and R. K. Vander Meer. 1989. First observation of polygyny in fire ants, Solenopsis spp., in South America. Psyche 96: 161-165.

Jouvenaz, D. P., D. P. Wojcik, M. A. Naves, and C. S. Lofgren. 1988. Observations on a parasitic nematode (Tetradonematidae) of fire ants, *Solenopsis* (Formicidae), from Mato Grosso. Pesq. Agropec. Brasil. 23: 525-528.

Kusnezov, N. 1956. Claves para la identificacion de las hormigas de la fauna argentina. Ministerio de Agricultura y Ganaderia. IDIA, 56 p.

Lofgren, C. S. 1986. History of imported fire ants in the United States, pp. 36-47. *In* C. S. Lofgren & R. K. Vander Meer [eds.], Fire Ants and Leaf-Cutting Ants: Biology and Management. Westview Press, Boulder, Colorado.

Lofgren, C. S., W. A. Banks, and B. M. Glancey. 1975. Biology and control of imported fire ants. Annual Rev. Entomol. 20: 1-30.

Ministerio de Asuntos Agrarios. 1996. Informe Agrometeorologico. Estacion Experimental Mercedes, Año XI, no. 1-6.

Porter, S. D. 1992. Frequency and distribution of polygyne fire ants (Hymenoptera: Formicidae) in Florida. Fla. Entomol. 75: 248-257.

Porter, S. D., H. G. Fowler and W. P. Mackay. 1992. Fire ant mound densities in the United States and Brazil (Hymenoptera: Formicidae). J. Econ. Entomol. 85: 1154-1161.

Porter, S. D., A. Bhatkar, R. Mulder, S. B. Vinson, and D. J. Clair. 1991. Distribution and density of polygyne fire ants (Hymenoptera: Formicidae) in Texas. J. Econ. Entomol. 84: 866-874.

Silveira-Guido, A., J. Carbonell and C. Crisci. 1973. Animals associated with the *Solenopsis* (Fire ants) complex, with special reference to *Labauchena daguerrei*. Proc. Tall Timbers Conf. Ecol. Anim. Control Habitat. Manage. 4: 41-52.

Silveira-Guido, A., P. San Martín, C. Crisci-Pisano, and J. Carbonell-Bruhn. 1962, 1963, 1964, 1965. Investigations on the biology and biological control of the fire ant

Table 1. Abundance of *S. daguerrei* in Argentina

Province	Sampling area	No. of collecting sites	No. of colonies examined	No. (%) of colonies parasitized
Buenos Aires	**San Eladio**	**9**	**828**	**58 (7.0)**
	Mercedes	7	173	6 (3.5)
	Suipacha	6	250	7 (2.1)
	Chivilcoy	5	149	3 (2.1)
	Luján	1	96	2 (2.0)
	Duggan	2	56	1 (1.8)
	Lobos	5	58	1 (1.7)
	Saladillo	13	1,846	26 (1.4)
	Others	88	2,498	0
Santa Fe	Reconquista	9	366	10 (2.7)
	Others	28	423	0
Entre Rios	C. Hughes	3	94	2 (2.1)
	Others	28	353	0
Corrientes-Misiones-Chaco-Formosa	Several	37	537	0
Total		241	7,727	116 (1.5)

Table 3. Abundance of brood and sexuals in parasitized and non-parasitized colonies of *S. richteri* in San Eladio, 1996-97.

PARASITIZED COLONIES

Presence of	Fall (n=53)	Winter (n=11)	Spring (n=31)	Summer (n=14)	Total (n=109)
Worker brood	5.7	27.3	93.9	100	44.9
Sexual brood	0	0	32.2	14.3	12.8
Winged females	7.5	18.2	6.4	21.4	11.0
Winged males	1.9	9.1	3.2	14.3	4.6

NON-PARASITIZED COLONIES

Presence of	Fall (n=48)	Winter (n=89)	Spring (n=23)	Summer (n=8)	Total (n=169)
Worker brood	25.0	47.8	100	100	50.9
Sexual brood	0	12.4	21.7	12.5	11.2
Winged females	8.3	4.5	8.7	25	7.1
Winged males	6.2	2.2	8.7	12.5	4.7