APPLIED MYRMECOLOGY

A World Perspective

edited by
Robert K. Vander Meer, Klaus Jaffe, and Aragua Cedeno

Westview Studies in Insect Biology

1

Major Ant Problems of South America

H.G. Fowler, J.V.E. Bernardi, J.C. Delabie, L.C. Forti and V. Pereira-da-Silva

INTRODUCTION

South America has one of the world's richest ant faunas (Kempf 1972), and consequently should also have its share of ant problems. However, except for the notoriety of the leaf-cutting ants, little information is available on other economically-important ants. After reviewing the available literature, a list of the principal ant problems in South America has been compiled for this study. This review is not definitive but, rather, representative. The majority of the South American ant literature is not indexed, nor in what is considered periodical scientific publications, and much of this information is anecdotal--weak in scientific merit. This has caused additional problems when misleading information is taken seriously (Zenner de Polania and Ruiz Bolanos 1983). For brevity's sake, only non leaf-cutting ant pests (see Cherrett 1986, Fowler et al. 1986) have been reviewed.

Control of *Solenopsis invicta* in the United States has a long and well-documented history (Banks et al. 1985); however, South American ant control has only a fragmentary history. The evolution of control methodologies pieced together (Table 1) suggest that ant control in South America is changing slowly due to insufficient research funds. Even when baits are used for ant control, as for leaf-cutting ants, little attention has been directed towards environmental concerns, such as bait specificity (Williams 1986). For ants other than leaf-cutting ants, control measures seem to be almost casual extensions of leaf-cutter control, and utilize unsuitable leaf-cutting ant toxicants (Costa 1937, Monte 1931, Fonseca 1936, 1953, Fowler 1981, Anonymous 1953).

Based upon available literature and personal experience, a list of South America's problem ants (Table 2) has been drawn up. Each of these shall be discussed briefly.

ACROPYGA SPP.

This genus has global representation as do all species associated with root scales (Pseudococcidae). In South America, several *Acropyga* species affect coffee (Bunzli 1935, Weber 1944, Costa Lima 1931, 1932) and cocoa (Strickland 1945, Weber 1944, Delabie and Mantovani 1988). The scales

TABLE 1. The evolution of ant control, especially leaf-cutting ant control, in South America, fire ant control in the United States and the development of control products in the world.

Year:	1900		1920		1940		1960		1980
Leaf-cutting ant control	A	A	A	B	B	C	C	C	C
Fire ant control (United States)				B	C	C	C	CD	DEF
Product development	A	A	A	B	B	C	D	E	F

Control groups:

A = arsenicals; lime-sulfur; petroleum oils; nicotine; cyanides

B = flourine CMPS; certain synthetic organics (e.g., dinitro CMPDS; thiocyanates); rotenone; pyrethrum

C = cholorinated hydrocarbons (e.g., DDT, BHC, toxaphene, chlordane, aldrin, dieldrin); organo-phosphates (e.g., parathion)

D = synthetics (e.g. allethrin) pyrethrum + synergists; carbamates

E = chemosterilization; juvenile hormones

F = insect growth regulators; avermectins

protected by *Acropyga* are known vectors of several root diseases and are true trophobionts of these ants, forming symbiotic associations in which both partners are obligatorily linked throughout their entire life cycles. The ants rear their brood with the scales. Galleries are constructed around roots to house the scales; in return, the scales supply the ants with honeydew, apparently their only food source. However, the ants may crop excess scales for food and thus regulate scale populations (Delabie and Mantovani 1988). The symbiosis between *Acropyga* and scales is so complete that during swarming, female Acropyga carry reproductively active adult female scales in their mandibles (Eberhard 1978, Campos and Morais 1986, Delabie, this volume). Both ants and scales are hypogaeic. Ant nests are formed by anamostising galleries filled with "rearing cells" for scales, which are only found there as nymphs (Delabie and Mantovani 1988, Bunzli 1935). *Acropyga* species are polygenic, a trait which may explain their exceedingly high densities in certain regions (Delabie and Mantovani 1988, Strickland 1945). This trait also creates additional problems for their control. Currently no products or recommendations are available for control of this underestimated pest.

AZTECA SPP.

Of the rich *Azteca* fauna in South America, *A. paraensis* and *A. chartifex* have been the most studied. These Dolichoderinae are exclusively arboreal and restricted to forested areas from the Amazon basin throughout Brazil's north-eastern region. Economically important crops, such as cocoa and cashew nuts, are cultivated in this area, generally under a canopy of emergent vegetation. *A. chartifex*'s nest is of carton and forms an extended cone, similar to the nest of the arboreal termite, *Nasutitermes*. *A. paraensis* does not construct carton nests, but instead associates with certain epiphytic plants of the families Araceae, Bromeliaceae, Orthidaceae and Gesneriaceae, to produce ant gardens. These ant gardens are tended and planted by ants, which in turn receive a nesting site in the rounded root mass created by the ant gardens. *A. paraensis* apparently favors the growth of their ant gardens by removing leaves, which opens the tree canopy. Leaf sap is used to physically support the ant garden.

Both *Azteca* species depend heavily upon Homopteran honeydew, especially the dew produced by fruit-attacking Membracids. A swarming mass of ant workers protects these honeydew producers, and they are often further protected by an ant-built carton shelter. In cocoa plantations, the heavy nests of *A. chartifex* break branches. By building carton galleries on branches, the ants interfere with flowering and reduce potential fruit yield. On some cocoa plantations, A. paraensis tends ant gardens located on the largest branches and also interferes with flowering, although it does not produce carton galleries (Bondar 1923, 1934a, 1934b).

Both species are aggressive, and rural workers are wary about working on plantations where these ants are present, thus making fruit harvest and plantation maintenance more costly and irregular. Often these ants are associated with nesting social wasps, aggressive and active stingers of the genera *Polybia* and *Apoica*. This association further hinders rural workers (Bondar 1925, 1939, 1920, 1930, Silva 1945, 1955, Silva and Barbosa 1948).

From 1950 to 1960, countless *Azteca* nests were destroyed in insecticidal

control programs (Silva and Barbosa 1948, Silva 1955, Gallo et al. 1978). These control programs apparently favored the expansion of other ants in Brazil's cocoa-growing region, especially *Wasmannia auropunctata* (Delabie 1988). However, by comparing production records from trees with Azteca nests to trees without nests, Vello and Magalhaés (1971) proposed that the odors of these ants attracted pollinators, increasing flower visitation and fruit set. However, as this ant dominates the canopy, increased fruit production may be due to its role as a predator of phytophagous insects. As a result of the new evidence, several growers have recently established *A. chartifex* nests in their cocoa plantations.

More evidence is needed to determine if Azteca species are pestiferous or beneficial. Nevertheless, the history of their control in cocoa demonstrates that ill-informed massive control programs based upon easily-applied insecticides may be unnecessary and ecologically harmful.

WASMANNIA AUROPUNCTATA

This Myrmicinae is one of the most prevalent Neotropic ants. The small ant is about 1.5 mm in length and yellowish. However, *W. auropunctata* is polygynous, a good colonizer, quite aggressive and is an active protector of Homoptera.

Currently, the species has a pan-tropical distribution, and is found in almost all South American countries (Kempf 1972). Because of its good colonizing ability and rapid colony growth due to the presence of multiple queens, colonies expand rapidly - they have recently invaded and decimated the fauna of the Galapagos Islands (Clark et al. 1982, Lubin 1984). This species prefers disturbed regions. In the cocoa-growing region of Bahia, Brazil, *W. auropunctata* lives in the cocoa canopy, and has apparently expanded following massive control programs against *Azteca* spp. in the 1950s and 1960s (Delabie 1988).

Because of its polygyne nature, *W. auropunctata* colonies frequently and easily divide. Where it occurs, this ant dominates and is an active predator of herbivorous insects and other ants, with the exception of *Camponotus* species (Delabie 1988). However, *W. auropunctata* also depends upon honeydew of scales, especially *Plannococcus citri*, which breed and multiply on the fruit of many tree species, especially cocoa and Citrus. These scales can reach populations which completely cover fruits and promote their early abortion. Because of their aggressivity and strong stings, which can result in allergic reactions, fruit-pickers are reluctant to work in areas in which these ants occur, and this further complicates management practices (see Ulloa-Chacon and Cherix this volume).

TAPINOMA MELANOCEPHALUM

This introduced Dolichoderinae occurs throughout the Americas (Kempf 1972), in locally abundant populations. Because of its small size, this ant, like other small species such as *W. auropunctata* and *Monomorium* spp., is also a domestic pest, and may transmit hospital infections. *T. melanocephalum* also associates with root scales (Smith 1936), and--in Sao Paulo's banana-growing region--fruit scales. It is the most abundant ant present in these heavily-sprayed crops. Because *T. melanocephalum* is also

polygenic, with easily-dividing colonies, control is difficult and, apparently, like *W. auropunctata*, *T. melanocephalum* is favored by insecticidal control of other pests (see Harada this volume).

CAMPONOTUS SPP.

This is one the largest and most heterogeneous ant genera in the Neotropics (Kempf 1972) and, consequently, it is difficult to determine which species may be of economic importance, especially since identification of species is difficult. In South America, the subgenus *Camponotus*, notorious for Holarctic wood destruction is not present, and the majority of pest citations deal with honeydew collections by representative species of other subgenera (Trujillo Pelluffo 1942, Anonymous 1950, Moreira 1918, 1919). These ants can be household pests and some species have also been cited as apiary pests (Emelen 1924).

Of the larger species, such as *Camponotus rufipes* and *C. brasilensis*, ants protecting associated Homoptera may create problems in fruit producing areas due to their aggressiveness (Scarpellini et al. 1986). See related chapters in this volume.

IRIDOMYRMEX HUMILIS

The Argentine ant, known as the Brazilian ant in Argentina, has spread from South America throughout the world. Even though exotic species are generally more problematic than native species, *I. humilis* can be pestiferous in South America. This polygynous Dolichoderinae is a recorded tender of Homoptera (Trujillo Peluffo 1942, Nasca et al. 1982, Gallo et al. 1978). In Caribbean areas where it was accidentally introduced, *I. humilis* has displaced other ant species (Erickson 1971, Crowell 1968, Haskins and Haskins 1965), due partly to its good colonizing ability and polygynous nest structure.

Because of its small size and the capacity of colonies to divide easily, *I. humilis* is a common household pest (Dade 1974), and has been shown to be an important vector of hospital infections in Chile (Ipinza et al. 1981). See related chapters in this volume.

PHEIDOLE SPP.

This genus is also represented by many South American species (Kempf 1972). Some of the smaller *Pheidole* species can be of occasional importance in households as domestic pests, but the introduced *Pheidole megacephala* is undoubtedly the genus' most important representative pest, as it is in other tropical regions (Chang et al. 1980). This ant is known as an active displacer of native fauna in regions where it was introduced (Haskins and Haskins 1965, Fowler 1988b). Densities may reach such levels in these modified faunas that *P. megacephala* becomes a domestic and household pest, often damaging structures such as electrical cables (Fowler 1988b).

MONOMORIUM SPP.

The genus' three exotic species (Table 2) are generally associated only with human structures. Like *Wasmannia auropunctata* and *Iridomyrmex*

TABLE 2. Ant pests of South America, given in alphabetical order, with their origin and principle activity of economic importance.

	Origin	Principle activity of the pest status					
Ant Taxa	Native (N) or Introduced (I)	cut leaves or flowers	other plant damage	tending of Homoptera	aggres-sive?	public health importance	domestic pest	material damage
Acropyga spp.	N			x				
Acromyrmex spp.	N	x	x					
Atta spp.	N	x						x
Azteca spp.	N		x	x	x			
Camponotus spp.	N		x	x	x		x	x
Crematogaster spp.	N		x	x		?	x	
Iridomyrmex humilis	N/I			x		x	x	
Monomorium pharaonis	I					x	x	
Momomorium destructor	I					x	x	
Monomorium floricolis	I					?	x	
Paratrechina fulva	I/N			x		?	x	
Pheidole spp.	N					?	x	
Pheidole megacephala	I			x			x	?
Solenopsis spp.	N/I		x	x	x	?	x	x
Tapinoma melanocepalum	I			x		?	x	
Wasmannia auropunctata	N/I			x	x	?	x	?

humilis, these ants form polygynous colonies and fragment easily. Recent studies (Fowler unpublished) reveal that *M. pharaonis* is common in hospitals and health care centers, and is undoubtedly associated with hospital infections, as has been found in the rest of the world. Being restricted to structures, these *Monomorium* species are notorious household pests, difficult to control due to their colony organization. Colonies are often transported unknowingly from one local to another in boxes for the supermarket, etc., as occurs with *W. auropunctata* and *I. humilis* (see Eichler, this volume; Williams this volume).

PARATRECHINA FULVA

This ant, sometimes called *Nylanderia fulva*, has an interesting history. Even though it has long been considered a pest (Ihering 1933, Mello 1933, Monte 1933) of both households and agriculture, due to its propensity for protecting Homoptera, some of Brazil's popular literature during the 1930s and 1940s suggests that this ant was negatively associated with leaf-cutting ants of the genus *Atta*, and that it effectively controlled colonies of *Atta*. *Paratrechina fulva* was apparently taken into Colombia for *Atta* control, and while it did not produce any noticeable effects on *Atta* populations, it became a major coffee pest through its protection of mealy-bugs (Zenner de Polania and Ruiz Bolaños 1983). This species has probably been an under-estimated problem in many areas. See Zenner-Polania for details, this volume.

SOLENOPSIS spp.

Fire ants cause problems not only in North America, but occasionally in their homeland of South America. Some species are known to be detrimental because of their association with Homoptera (Nasca et al. 1982, Hays 1958), as well as their aggressiveness towards people (Monte 1941, Santos 1931). *Solenopsis* species can also damage vegetable gardens directly, crippling plants such as potato (Monte 1937, Mendes 1935, Ribeiro 1954, 1955a, 1955b, Anonymous 1940).

As in the United States, some *Solenopsis* species can damage structures - in particular, electrical installations (Galli and Fernandes 1988, MacKay and Vinson, this volume). Often, *Solenopsis* and *Wasmannia* are confused by even economic entomologists (Delabie 1988). *Solenopsis*, nevertheless, is at best a local and occasional problem, and never a problem on the scale encountered in the United States.

LEAF-CUTTING ANTS

The most problematic South American ants are undoubtedly leaf-cutting ants. Damages and control procedures will not be reviewed here, as these will be discussed elsewhere. However, some comment on their pest status and current management practices is necessary. Of the known leaf-cutting ant taxa, there is little hard evidence that the majority of the taxa are of significant economic importance. Furthermore, through the indiscriminate application of insecticides against all leaf-cutting colonies, human beings may have accelerated the extinction of some unique endemic species, such as *Atta robusta* (Table 3).

TABLE 3. The species of leaf-cutting ants, their distribution and their relative pest status, as assessed by citations

Leaf-cutting species (monocots m/ dicots-d)	Vegetation cut (amplitude)$	Distribution	Relative pest status§
Acromyrmex (Acromyrmex)			
ambiguus	d	pandemic	weak
aspersus	d	pandemic	dubious
coronatus	d	pandemic	weak
crassispinus	d	pandemic	moderate
diasi	d	endemic	dubious
disciger	d	pandemic	weak
*gallardoi**	d?	endemic	dubious
hispidus	d	pandemic	weak
hystrix	d	pandemic	weak
laticeps	d	pandemic	weak
lobicornis	d/m	pandemic	moderate
lundi	d	pandemic	weak
niger	d	pandemic?	weak
nobilis	d	endemic?	dubious
octospinosus	d	pandemic	moderate
rugosus	d	pandemic	dubious
subterraneus	d	pandemic	moderate
Acromyrmex (Moellerius)			
heyeri	m	pandemic	weak
*landolti***	m	pandemic	moderate
*mesopotamicus***	m?	endemic	dubious
pulvereus	m?	endemic	dubious
silvestrii	m	pandemic?	weak
striatus	m	pandemic	weak
versicolor	d/m?	endemic	dubious
Atta			
bispaerica	m	pandemic	moderate
capiguara	m	pandemic	strong
cephalotes	d	pandemic	moderate
colombica	d	pandemic	weak
*goiana****	m	endemic	dubious
*insularis****	d	endemic	weak
laevigata	d/m	pandemic	moderate
mexicana	d/m	pandemic	weak
*opaciceps****	d	endemic	weak
*robusta****	d	endemic	dubious
saltensis	d	pandemic	weak
*silvai****	d	endemic	dubious

TABLE 3. Continued.

Leaf-cutting species (monocots m/ dicots-d)	Vegetation cut (amplitude)$	Distribution	Relative Pest status§
sp. nov.***	m	endemic	dubious
texana	d	pandemic	moderate
vollenweideri	m	pandemic	weak

$Based upon km of geographic distribution, or restriction to certain vegetation types. §Data derived from Cherrett (1986a); Fowler, et al. (1986) and Fowler & Robinson (1979); *Species of unknown taxonomic status. **Species under taxonomic changes in the near future (Fowler, 1988a). ***Species in danger of extinction.

Although these ants are generally considered damaging (Nasca et al. 1982, Rizo 1977, Bruner et al. 1945, Gallo et al. 1978), economic threshold data do not exist, especially for large, extensive pulp-wood plantations in Brazil. In these areas, given the ants' size, bait is generally spread at regular intervals throughout the area, often in polyethylene bags, which the ants cut open to get the bait. No studies relating to leaf-cutting ant damage to crop growth stage or to ant density were located and no evidence exists that extensive control program are warranted on a cost/benefit basis. Even those studies which have been cited to demonstrate the amount of damage caused by these ants are apparently flawed (see other chapters in this volume). Currently, research is directed toward identifying novel toxicants or more attractive baits, and no research is directed to the basic question of economic returns or of when, how much, or where to apply control strategies. These studies are of utmost importance to establish more rational control strategies for leaf-cutting ants (Table 1), that will also prove beneficial to solving other South American ant problems (Table 2).

REFERENCES CITED

ANONYMOUS, 1940. A debelacõa da formiga "ruiva" (*Solenopsis saevissima* Sm.). Campo, Rio de Janeiro, 11(124): 40.

ANONYMOUS, 1950. Combate às formigas doceiras, sara-sara (*Camponotus*). Chacaras e Quintais, São Paulo, 81(4): 467-477.

ANONYMOUS, 1953. Meios de Combate às formigas caseiras. Sel. Agric., Rio de Janeiro, 8(89): 72-74.

BANKS, W.A., C.S. LOFGREN and D.F. WILLIAMS. 1985. Development of toxic baits control of imported fire ants. In, Kaneko, T.M. and Spicer, L.D. (eds.), Pesticide Formulations and Application Systems. American Society for Testing and Materials, Philadelphia, pp. 133-143.

BONDAR, G. 1922. As lendas e a verdade sobre a formiga cacarema da Bahia e seu papel na lavoura. Chacaras e Quintais, São Paulo, 26(5): 369-371.

BONDAR, G. 1923. A formiga cacarema e o seu combate na lavoura. Correio Agric. Bahia, 1(1): 4.

BONDAR, G. 1930. A formiga de enxerto, praga dos cacaueiros na Bahia. Campo, Rio de Janeiro, 1(3): 50-52.
BONDAR, G. 1934a. A formiga cacarema nos cacauais e das matas da Bahia. Campo, Rio de Janeiro, 5(9): 36-37.
BONDAR, G. 1934b. A formiga do enxerto, a maior praga dos cacauais e das matas da Bahia. Campo, Rio de Janeiro, 5(5): 33-36.
BRUNER, S.C., L.C. SCARAMUZZA and A.R. OTERO. 1945. Catalogo de los insectos que atacam a las plantas economicas de Cuba. Bol. Est. Exp. Agron. Santiago de La Vega, 65: 1-246.
BUNZLI, G.H. 1935. Untersuchungen uber coccidophile Ameisen aus den Kaffee feldern von Surinam. Mitt. Schweiz. Entomol. Ges., 16: 453-593.
CAMPOS, L.A. de O. and H.C. de MORAIS. 1986. Transporte de homoptero por fêmeas de formigas do gênero *Acropyga* (Formicinae) em Vicosa, MG. Anais do VII Encontro de Mirmecologia do Estado de São Paulo. F. Caetano ed. UNESP - FAPESP - CNPq. 52-53.
CHANG, V.C.S., A.K. OTA, and D. SANDERS. 1980. Parallel ridge barrier to control ant damage to orifices of drip irrigation tubes. J. Econ. Entomol., 73: 403-406.
CHERRETT, J.C.M. 1986. The economic importance and control of leaf-cutting ants. In, Vinson, S.B. (ed.), Economic Impact and Control of Social Insects. Praeger, New York, pp. 165-192.
CLARK, D.P., C. GUYASAMIN, O. PAZMINO, C. DONOSO and Y. PAEZ de VILLACIS. 1982. The tramp ant, *Wasmannia auropunctata*: autoecology and effects on ant diversity and distribution on Santa Cruz Island, Galapagos. Biotropica, 14: 196-207.
COSTA LIMA, A.M. da. 1931. A propósito de *Acropyga pickeli* Borgm., 1927. Bol. Biol., 21: 65-69.
COSTA, R.G. 1937. Ainda as formigas acucareiras. Chacaras e Quintais São Paulo, 55(3): 296.
CROWELL, K.L. 1968. Rates of competitive exclusion by the Argentine ant in Bermuda. Ecology, 49: 551-555.
DADE, W.E. 1974. Hormigas en viviendas y jardines de Lima metropolitana. *Iridomyrmex humilis* (Mayr) *Monomorium minimun* (L.) Rev. Peru. Entomol., 17: 126-127.
DELABIE, J.H.C. 1988. Ocorrência de *Wasmannia auropunctata* (Hymenoptera, Formicidae, Myrmicinae) em cacauais na Bahia. Rev. Theobroma, (in press).
DELABIE, J.H.C. and J.E. MANTOVANI. 1988. Observacões sobre a biologia de *Acropyga* spp. (Formicidae, Plagiolepidini) associdas a rizosfera do cacaueiro. Res. IX Encontro de Mirmecologia, Vicosa, MG (in press).
EBERHARD, W.G. 1978. Mating swams of a South American *Acropyga* (Hymenoptera: Formicidae) Ent. News 89: 14-16.
EMELEN, A.V. 1924. Formigas nocivas as abelhas. Chacaras Quintais, São Paulo, 30(2): 153-155.
ERICKSON, J.M. 1971. The displacement of native ant species by the introduced Argentine ant, *Iridomyrmex humilis* Mayr. Psyche, 78: 257-266.
FONSECA, J.P. da. 1936. Combate às formigas caseiras. O Biol., 2: 68-69.
FONSECA, J.P. da. 1953. Meios de combate às formigas caseiras. Sitios Fazendas, São Paulo, 19(7): 54.

FOWLER, H.G. 1981. Control of noxious ants with locally produced baits. Turrialba, 31: 161-162.
FOWLER, H.G. 1988a. Taxa of the Neotropical grass-cutting ants, (*Acromyrmex*) *Moellerius* (Hymenoptera: Formicidae: Attini). Cientifica (São Paulo) (in press).
FOWLER, H.G. 1988b. Eradication of the native ant fauna by the introduction of an exotic ant in Itapirica, Bahia, Brazil, during hydroelectric dam construction. Environ. Conserv. (in press).
FOWLER, H.G. and S.W. ROBINSON. 1979. Field identification and relative pest status of Paraguayan leaf-cutting ants. Turrialba, 29: 11-16.
FOWLER, H.G., L.C. FORTI, V. PEREIRA-da-SILVA and N.B. SAES. 1986. Economics of grass-cutting ants. In, Lofgren, C.S. and Vander Meer, R.K. (eds.), Fire Ants and Leaf-Cutting Ants: Biology and Management. Westview Press, Boulder, pp. 18-35.
GALLI, J.C. and O.A. FERNANDES. 1988. Dano causado por formigas do gênero *Solenopsis* (Hymenoptera, Formicidae) à fios electricos em Jaboticabal-SP. An. Soc. Entomol. Bras., 17: 225-226.
GALLO, D., O. NAKANO, S. SILVEIRA-NETO, R.P.L. CARVALHO, G.C. de BATISTA, E. BERTI-FILHO, J.R.P. PARRA, R.A. ZUCCHI and S.B. ALVES. 1978. Manual de Entomologia Agricola. Editora Ceres, São Paulo, 531 p.
HASKINS, C.P., and E.F. HASKINS. 1965. *Pheidole megacephala* and *Iridomyrmex humilis* in Bermuda - equilibrium or slow displacement? Ecology, 46: 736-740.
HAYS, K.L. 1958. The present status of the imported fire ant in Argentina. J. Econ. Entomol., 51: 111-112.
IHERING, R. von. A formiga cuibana, um flagello. Campo, Rio de Janeiro, 4(1): 31-32.
IPINZA, I. REGLA, G. FIGUEROA and J. OSORIO. 1981. *Iridomyrmex humilis*, "hormiga argentina," como vector de infecciones intra-hospitilares. I. Estudios bacteriologicos. Folia Entomol. Mex., 50: 81-96.
KEMPF, W.W. 1972. Catalogo abreviado das formigas da Região Neotropical (Hymenoptera: Formicidae). Studia Entomol., 15: 3-344.
LUBIN, Y.D. 1984. Changes in the native fauna of the Galapagos Islands following invasion by the little red fire ant, *Wasmannia auropunctata*. Bol. J. Linn. Soc., 21: 229-242.
MELLO, P. de. 1933. A formiga cuyabana em Pernambuco. Rel. Soc. Ind. Viacao, Recife, 2: 67-69.
MENDES, D. 1935. A debeliacão da formiga ruiva, *Solenopsis saevissima* Sm. Chacaras Quintais, São Paulo, 51(5): 630.
MONTE, O. 1931. Formigas doceiras. Bol. Agric. Zootech. Vet., Minas Gerais, 4: 95.
MONTE, O. 1937 Formiguinhas no batatal. Chacaras Quintais, São Paulo, 56(1): 103.
MONTE, O. 1941. Combate à formiga lavapes. Chacaras Quintais, São Paulo, 63(5): 606.
MONTE, O. 1946. Combate à cuiabana. Chacaras Quintais, São Paulo, 73(3): 334.
MOREIRA, C. 1918. Vida da sara sará e como combate-a. Chacaras Quintais, São Paulo, 17(6): 62-463.

MOREIRA, C. 1919. A sara-sará de pernas ruivas. Lavoura, Rio de Janeiro, 22: 45-51.
NASCA, A.J., A.L. TERÁN, R.V. FERNANDEZ and A.J. PASQUALINI. 1982. Animales perjudiciales e beneficos a los citros en el noroeste argentina. CIPRON, Tucuman, 361 p.
RIBEIRO, J.H.C. 1954. Sobre a formiga ruiva e seu combate. Agron. E. Rio, 13: 227-231.
RIBEIRO, J.H.C. 1955a. Sobre a formiga ruiva e seu combate. Chacaras Quintais, São Paulo, 91(1): 51-53.
RIBEIRO, J.H.C. 1955b. Sobre a formiga ruiva e seu combate. Agric. Pecuar., Abr (398), 44, 46, 48.
RIZO, H.F. 1977. Catalogo de insectos perjudicales en cultivos de la republica argentina. Ed. Hemisfero Sul, Buenos Aires, 65 p.
SANTOS, E. 1931. A praga das pequenas formigas. Campo, Rio de Janeiro, 2(7): 42.
SCARPELLINI, J.R., O. NAKANO and C.S. MOREIRA. 1986. Ocorrêcia e inconveniência de *Camponotus* (*Myrmobrachys*) *brasilensis* Mayr, 1862 (Hymenoptera-Formicidae) em citrus. Rev. Agric., 61: 175-176.
SILVA, P. 1945. A formiga de enxerto. Bol. Divulg. Inst. Cacau, 1: 1-21.
SILVA, P. 1955. A formiga cacarema e o cacaueiro. Junta Exec. Com. Pragas Cacau. Bahia, 2: 1-13.
SILVA, P. and M.da R. BARBOSA. 1948a. Formiga cacarema x formiga de enxerto. Bahia Rural, 16(9): 16-17.
SILVA, P. and M.da R. BARBOSA. 1948b. O Instituto do Cacau e o combate à formiga de enxerto. Bahia Rural, 16(7): 23-26.
SMITH, M.R. 1936. The ants of Puerto Rico. Puerto Rico J. Agric., 20: 819-875.
STRICKLAND, A.H. 1945. A survey of the arthropod soil and litter fauna of some forest reserves and cacao estates in Trinidad, British West Indies. J. Anim. Ecol. 14(1): 1-11.
TRUJILLO PELUFFO, A. 1942. Insectos y otras parasitas de la agricultura y sus produto en la Uruguay. Fac. Agron. Montevideo. 323 p.
WEBER, N.A. 1944. The Neotropical coccid-tending ants of the genus *Acropyga* Roger. Annals Entomol. Soc. Am. 37: 89-122.
WILLIAMS, D.F. 1986. Chemical baits: specificity and effects on other ant species. In, Lofgren, C.S. and Vander Meer, R.K. (eds.), Fire Ants and Leaf-cutting Ants: Biology and Management. Westview Press, Boulder, pp. 378-386.
VELLO, F. and W.S. MAGALHÃES. 1971. Estudos sobre a participacão da formiga cacarema *Azteca chartifex spiritii* Forel na polinizacão do cacaueiro na Bahia. Rev. Theobroma 1(4): 29-44.
ZENNER DE POLANIA, I. and N. RUIZ BOLAÑOS. 1983. Control quimico de la hormiga loca, *Nylanderia fulva* (Mayr). Rev. ICI, 18: 241-250.