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Worldwide spread of the little fire ant, *Wasmannia auropunctata* (Hymenoptera: Formicidae)

James K. Wetterer

Wilkes Honors College, Florida Atlantic University
5353 Parkside Drive, Jupiter, Florida 33458, USA
e-mail: wetterer@fau.edu
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Summary
Native to the Neotropics, *Wasmannia auropunctata* has spread to numerous other tropical and subtropical areas, where it is can reach extremely high densities and threaten the local biota. To evaluate the worldwide spread of *W. auropunctata*, I compiled published and unpublished specimen records from >1700 sites. I documented the earliest known *W. auropunctata* records for 53 geographic areas (countries, island groups, major West Indian islands, and US states), including many with no previously published records: Anguilla, Antigua, Barbuda, Caicos Islands, El Salvador, Guam, Montserrat, Nevis, St Kitts, St Martin, and Texas. In the New World, *W. auropunctata* has a seemingly continuous distribution from central Argentina to southernmost Texas, suggesting that it may be native throughout this expanse. *Wasmannia auropunctata* has also spread throughout the West Indies and to peninsular Florida, though it is unclear which West Indian islands may constitute part of its native range. The earliest Old World reports of *W. auropunctata*, in the 1890's, came from West Africa: Sierra Leone and Gabon. Although no additional records have come from Sierra Leone, *W. auropunctata* has spread broadly across Gabon and into neighboring countries, where it is a serious pest. In Oceania, the earliest records of *W. auropunctata* date to 1972 from New Caledonia and 1974 from the Solomon Islands. Pacific populations of *W. auropunctata* are actively spreading within these islands and to many other island groups. In the past decade, first records of *W. auropunctata* have been reported from several Old World areas, including the Central African Republic, Papua New Guinea, Australia, Guam, Italy, and Israel. *Wasmannia auropunctata* appears to still have much potential for future spread in the Old World.

Keywords
Biogeography; biological invasion; exotic species; invasive species

Introduction

More than 100 years ago, Forel (1911) listed 15 tramp ant species, spread by human commerce, which had achieved or were in the process of achieving broad cosmopolitan distributions. Eight of these are now major ecological, agricultural, and/or household

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pests: *Anoplolepis gracilipes* (Smith), *Linepithema humile* (Mayr), *Monomorium destructor* (Jerdon), *Monomorium pharaonis* (Linnaeus), *Paratrechina longicornis* (Latreille), *Pheidole megacephala* (Fabricius), *Solenopsis geminata* (Fabricius), and *Tapinoma melanocephalum* (Fabricius) (Wetterer, 2005, 2007, 2008, 2009a,b, 2010, 2011; Wetterer et al. 2009). Here, I examine the worldwide spread of a tramp ant not on Forel's (1911) list, *Wasmannia auropunctata* (Roger).

With great prescience, Emery (1893) wrote (in German) "some species, including *Prenolepis* [*Paratrechina*] *longicornis* Latr. and *Tapinoma melanocephalum* Fab., … have already become cosmopolitan in the tropics… Other species also certainly will become just as widespread in the future. One such cosmopolitan of the future, I expect will be the tiny South American *Tetramorium* [*Wasmannia*] *auropunctata* Rog., which is found everywhere in South America, and which I received from Sierra Leone." Concerning *W. auropunctata*, Emery (1894a) wrote (in Italian): "I have also received African samples from Gabon (the species is undoubtedly recently imported into that country)." Wetterer and Porter (2003) reviewed the distribution, impact, and control of *W. auropunctata*, but overlooked both of these references, the earliest published reports of *W. auropunctata* in the Old World. In addition, over the past decade, *W. auropunctata* has continued to spread and many reports have documented the discovery of new exotic populations of *W. auropunctata* in different parts of the world as well as the impact of this ant (e.g., Walsh et al., 2004; Ndoutoume-Ndong and Mikissa, 2007; Theron, 2007; Fasi, 2009; Loève, 2009; Vonshak et al., 2010). Also, the taxonomy of *Wasmannia* has been thoroughly revised (Longino and Fernández, 2007). Foucaud et al. (2010) recently used genetic analyses to examine the possible routes of introduction of *W. auropunctata* populations in different parts of the world. Here, I extend and update Wetterer and Porter's (2003) analysis of the worldwide distribution of *W. auropunctata*.

Taxonomy and identification

Roger (1863) described *Tetramorium auropunctatum* (= *W. auropunctata*) from Cuba. Junior synonyms include *Ochetomyrmex auropunctatus rugosus* Forel, *W. auropunctata australis* Emery, *W. auropunctata laevifrons* Emery, *W. auropunctata nigricans* Emery, *W. auropunctata obscura* Forel, *Xiphomyrmex atomum* Santschi, *Wasmannia glabra* Santschi, *W. auropunctata pulla* Santschi, and *Hercynia panamana* Enzmann (Longino and Fernández, 2007).

Wasmannia auropunctata has tiny (~1.5 mm total length) monomorphic orange workers, which are quite slow moving. Workers have distinctive hatchet-shaped petioles, with the anterior and dorsal faces of the petiolar node meeting at a 90° angle (Figs 1-2, see Longino and Fernández, 2007).

Most researchers use the common name "little fire ant" for *W. auropunctata*, due to its tiny size and painful sting, despite the fact that "fire ant" generally refers to large species of the genus *Solenopsis*. In Oceania, some researchers refer to *W. auropunctata* as the "electric ant."

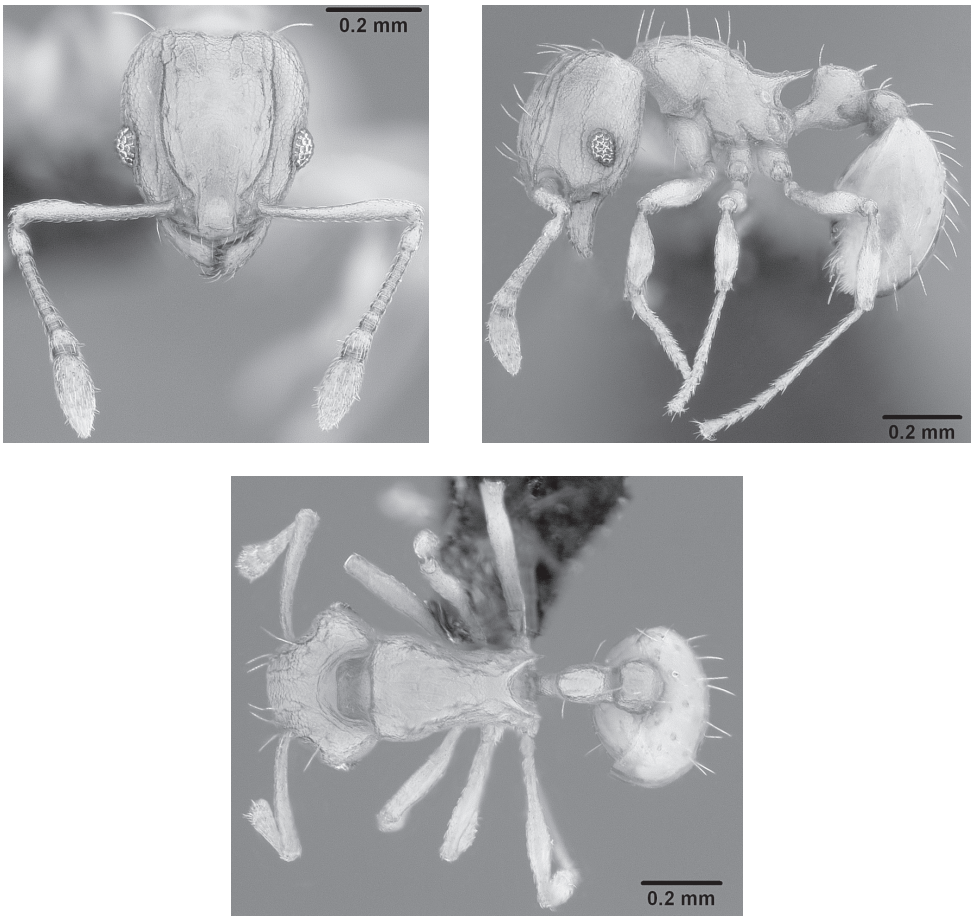

Figure 1. *Wasmannia auropunctata*. Worker from New Caledonia: (A) head, (B) lateral view, (C) dorsal view (photos by Eli Sarnat). This figure is published in color in the online version.

Methods

I compiled and mapped published and unpublished records of *W. auropunctata*. I obtained unpublished site records from museum specimens in the collections of Archbold Biological Station (identified by M. Deyrup), the British Museum (identified by B. Bolton), the Museum of Comparative Zoology (MCZ, identified by S. Cover), the Oxford University Natural History Museum (ONHM, identified by J. Wetterer), and the Smithsonian Institution (SI, identified by J. Wetterer). I also include unpublished records provided by A. Wild (Argentina), C. Vanderwoude (Papua New Guinea), A. Van Harten (Solomon Islands), and A. Mikheyev (Brazil, Dominica, and Guadeloupe). In addition, I used on-line databases with collection information on specimens by Antweb (www.antweb.org) and the Global Biodiversity Information Facility (www.gbif.org). I collected *W. auropunctata* in Florida, El Salvador, on West Indian islands, and in the Solomon Islands.

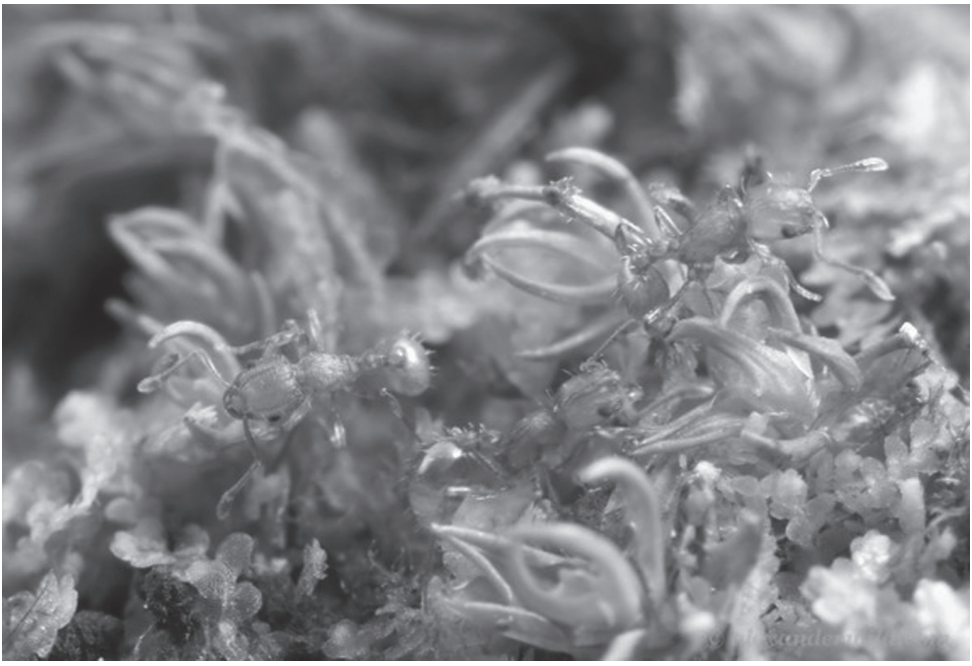

Figure 2. *Wasmannia auropunctata* workers in Panama (photo by A. Wild). This figure is published in color in the online version.

Geographic coordinates for collection sites came from published references, specimen labels, maps, or geography web sites (e.g., earth.google.com, www.tageo.com, and www.fallingrain.com). If a site record listed a geographic region rather than a "point locale," and I had no other record for this region, I used the coordinates of the largest town within the region or, in the case of small islands and natural areas, the center of the region. In some cases where I found many records within a small area (e.g., from antweb.org), I did not plot every record.

Results

I collected *W. auropunctata* at many sites in Florida and on 31 West Indian islands: Anguilla, Antigua, Barbados, Barbuda, Culebra, Curaçao, Dominica, Grand Bahama, Grenada, Guadeloupe, Jamaica, Marie Galante, Margarita, Martinique, Mona, Montserrat, Nevis, New Providence, Providenciales, Puerto Rico, St Croix, St John, St Kitts, St Lucia, St Martin, St Thomas, St Vincent, Tobago, Tortola, Trinidad, and Vieques. Of the 34 West Indian islands I surveyed, I did not find *W. auropunctata* only on three: Aruba, Bonaire, and Grand Cayman. In El Salvador, I found *W. auropunctata* in two botanical gardens in San Salvador. In the Solomon Islands, I collected *W. auropunctata* on both islands I visited: Guadalcanal and Savo.

I compiled and mapped specimen records from >1700 sites (Tabels 1-5, Fig. 3), compared with <500 site records used by Wetterer and Porter's (2003) analysis.

Table 1. Earliest known records for *Wasmannia auropunctata* from South America, Central America, Mexico, Texas, and neighboring islands. Unpublished records include collector, museum source, and site. + = no previously published records. MCZ = Museum of Comparative Zoology.

Locality	Earliest Record
Guatemala	≤ 1886 (Forel, 1886 as *Ochetomyrmex auropunctata rugosa*)
Costa Rica	1889 (Emery, 1894b as *Tetramorium auropunctatum*)
Bolivia	≤ 1894 (Emery, 1894a as *W. auropunctata laevifrons*)
Brazil	≤ 1894 (Emery, 1894a as *W. auropunctata australis*)
Paraguay	≤ 1894 (Emery, 1894a as *W. auropunctata rugosa*)
Cocos Island	1899 (Wheeler, 1919)
Mexico	1899 (Forel, 1899 as *W. auropunctata rugosa*)
Peru	≤ 1908 (N. Holmgren, MCZ): Chaquimayo
Argentina	≤ 1909 (Forel, 1909 as *W. auropunctata australis*)
Guyana	1911 (Wheeler, 1916)
Colombia	≤ 1912 (Forel, 1912)
Nicaragua	1916 (C.K. Noble, MCZ): Tuli Creek
Honduras	1920 (Mann, 1922)
Panama	1924 (W.M. Wheeler, MCZ): Barro Colorado Island
French Guiana	≤ 1931 (Santschi, 1931 as *W. glabra*)
Surinam	1932 (Bünzli, 1935)
Galapagos Islands	1935 (Wetterer and Porter, 2003)
Venezuela	1935 (N.A. Weber; MCZ): multiple sites
Belize	1972 (S. and J. Peck, MCZ): Hummingbird Gap
Ecuador	1976 (S. and J. Peck; MCZ): multiple sites
Uruguay	≤ 1985 (Zolessi et al., 1985)
+ Texas	2010 (N. Collins, bugguide.net): Resaca de La Palma
+ El Salvador	2012 (J.K. Wetterer, MCZ): San Salvador

I documented the earliest known *W. auropunctata* records for 53 geographic areas (countries, island groups, major islands, and US states), including many areas for which I found no previously published records: Anguilla, Antigua, Barbuda, Caicos Islands, El Salvador, Guam, Montserrat, Nevis, St Kitts, St Martin, and Texas.

Wasmannia auropunctata is now known from every South and Central American country except Chile (Table 1) and virtually every major Caribbean island (Table 2). Nancy Collins (pers. comm.) posted a photo on bugguide.net of *W. auropunctata* tending Hemiptera in the far south of Texas (Table 1; identified by J. Trager).

Wasmannia auropunctata has been recorded from several sites in temperate North America and Europe (Table 3), but all appear to be indoor records.

Discussion

In the New World, *W. auropunctata* has a seemingly continuous range from central Argentina and Uruguay, through eastern Mexico, to southernmost Texas (Fig. 3),

Table 2. Earliest known records for *Wasmannia auropunctata* from the West Indies, Florida, and Bermuda. ONHM = Oxford University Natural History Museum. SI = Smithsonian Institute. Abbreviations as in Table 1.

Locality	Earliest Record
Cuba	≤ 1863 (Roger, 1863 as *Tetramorium auropunctatum*)
Bahamas	1886 (T. Pergande, SI): Abaco
St Vincent	≤ 1893 (Forel, 1893)
+ Antigua	≤ 1895 (C.A. Barber, SI): site unknown
Grenada	≤ 1897 (Forel, 1897)
Puerto Rico	1899 (A. Busck, SI): Culebra
Jamaica	1909 (Wheeler, 1911)
Dominica	1911 (Wheeler, 1913)
Guadeloupe	≤ 1912 (Forel, 1912)
Barbados	≤ 1912 (Forel, 1912)
Martinique	≤ 1912 (Forel, 1912)
St Lucia	≤ 1912 (Forel, 1912)
Trinidad	≤ 1912 (Forel, 1912)
Haiti	1912-1913 (Wheeler and Mann, 1914)
Dominican Republic	1915 (cu, MCZ): Villa Rivas
Tobago	1916 (C.B. Williams, ONHM): Charlotteville
Florida	1924 (Deyrup et al., 2000)
US Virgin Islands	≤ 1925 (C. Emery, SI): St Thomas
Bermuda	1925 (Wetterer and Wetterer, 2004)
+ Nevis	1934 (N.A. Weber, MCZ): site unknown
+ Montserrat	1935 (N.A. Weber, MCZ): site unknown
Curaçao	1936 (Weber, 1948)
Margarita	1936 (Weber, 1948)
Dutch Caribbean	1937 (Weber, 1948): Saba and Statia
British Virgin Islands	2005 (J.K. Wetterer, MCZ): Sage Mountain Road
+ Anguilla	2006 (J.K. Wetterer, MCZ): Windward Point
+ Barbuda	2007 (J.K. Wetterer, MCZ): Codrington
+ St Kitts	2007 (J.K. Wetterer, MCZ): Turtle Beach
+ St Martin	2007 (J.K. Wetterer, MCZ): Pic Paradis
+ Caicos Islands	2010 (J.K. Wetterer, MCZ): 1 km W East End, Providenciales

Table 3. Earliest known records for *Wasmannia auropunctata* from temperate Europe and North America.

Locality	Earliest Record
England	1907 (Donisthorpe, 1908)
California	≤ 1937 (Keifer, 1937)
Manitoba	1977 (Ayre, 1977)
Ontario	1978 (Anonymous, 1979)
British Columbia	1994 (Naumann, 1994)
Quebec	1999 (Wetterer and Porter, 2003)
Italy	2006 (Jucker et al., 2008)

Table 4. Earliest known records for *Wasmannia auropunctata* from Africa and the Middle East.

Locality	Earliest Record
Sierra Leone	≤ 1893 (Emery, 1893)
Gabon	≤ 1894 (Emery, 1894a)
Cameroon	1959 (Bruneau de Miré, 1969)
Central African Rep.	≤ 2004 (Walsh et al., 2004)
Israel	2005 (Vonshak et al., 2010)

Table 5. Earliest known records for *Wasmannia auropunctata* from Australia and Oceania.

Locality	Earliest Record
New Caledonia	1972 (Fabres and Brown, 1978)
Solomon Islands	1974 (Ikin, 1984)
Society Islands	1977 (Meyer and Jourdan, 2005)
Wallis and Futuna	≤ 1981 (Gutierrez, 1981 in Jourdan, 1997)
Santa Cruz Islands	1995 (A. Van Harten, pers. comm.): Nendo Island
Tuvalu	≤ 1997 (Waterhouse, 1997)
Vanuatu	1998 (Rapp, 1999)
Hawaii	1999 (Conant and Hirayama, 2000)
Australia	2002 (Foucaud et al., 2010)
Papua New Guinea	2005 (Vanderwoude, 2008)
+ Guam	2011 (Ridgell, 2011)

suggesting that it may be native throughout this expanse. *Wasmannia auropunctata* has also spread throughout the West Indies and peninsular Florida (Fig. 3). Because its known distribution from South America through the Lesser and Greater Antilles to Florida shows no large gaps, it is not possible to discern where in the West Indies *W. auropunctata* is native and where it is exotic, and it seems likely that many islands have a mix of native and exotic populations. Indoor records of *W. auropunctata* from temperate North America are certainly exotic. Genetic analyses of New World populations of *W. auropunctata* are needed to establish the native range of this species.

The earliest Old World reports of *W. auropunctata* date to the 1890's (Emery 1893, 1894a) from Gabon and Sierra Leone. Since that time, *W. auropunctata* populations have been documented in widespread areas in and around Gabon and the neighboring countries of Cameroon and the Central Africa Republic (Fig. 3), but no additional records have been reported from Sierra Leone. It may be that Emery (1893) reported *W. auropunctata* from Sierra Leone in error, which would explain why Emery (1894a) did not mention this record. Alternatively, *W. auropunctata* populations may have never expanded or even disappeared in Sierra Leone. Finally, it may be that *W. auropunctata* populations are thriving in Sierra Leone, but due to exceptionally poor sampling, these populations and their impact have remained unrecognized. Additional fieldwork in Sierra Leone would be valuable.

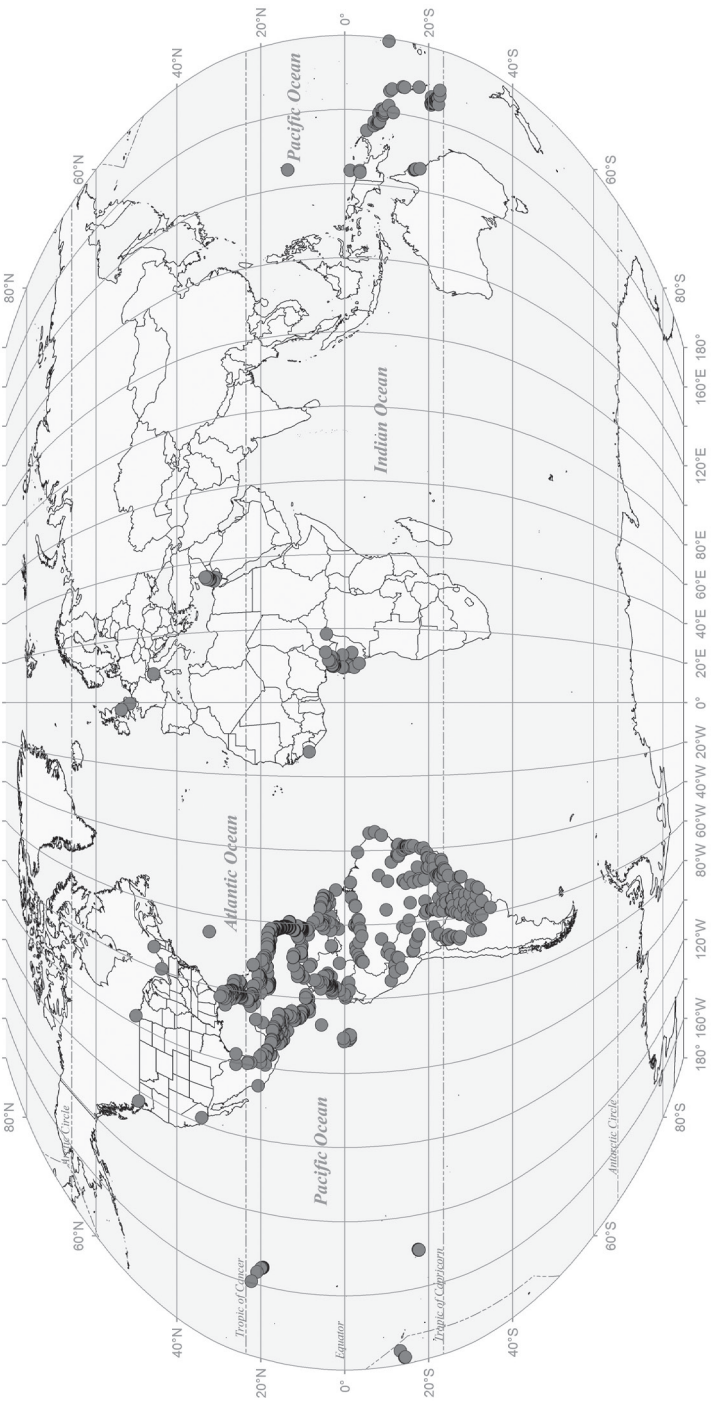

Figure 3. Worldwide distribution records of *Wasmannia auropunctata*. This figure is published in color in the online version.

In the Indo-Pacific, the earliest records of *W. auropunctata* date to 1972 from New Caledonia and 1974 from the Solomon Islands. Indo-Pacific populations of *W. auropunctata* appear to be actively spreading, with recent first records from Papua New Guinea and Guam. Within the Solomon Islands, *W. auropunctata* has spread to at least 15 islands (Wetterer and Porter, 2003; Fasi, 2009). The exotic populations of *W. auropunctata* in New Caledonia and Hawaii were each apparently established by a single fertilized queen (Foucaud et al., 2006; Mikheyev et al., 2009).

In Israel, *W. auropunctata* was first found in 2005, and this species is now widespread. It seems likely that *W. auropunctata* will soon be found in neighboring countries.

Although *W. auropunctata* occurs in a wide range of habitats, it appears to be most common in tropical moist forest and in irrigated fields and gardens, and is rare in arid and semi-arid habitats. For example, on the semi-arid islands of Anguilla and St Martin, I found high densities of *W. auropunctata* only in one region on each island, the sole remnants of intact closed-canopy forest, in Katouche Valley on Anguilla and on the south flank of Mount Fortune on St Martin. Its rarity in drier habitats may help explain the lack of records from the semi-arid Caribbean islands of Aruba, Bonaire, and Grand Cayman, and also the scarcity of records from northern Mexico and southern Texas. Vonshak et al. (2010) found *W. auropunctata* widespread in arid Israel, but always associated with human activity.

The first records of *W. auropunctata* from El Salvador and many West Indian islands are very recent (Tables 1 and 2), probably due to poor sampling in the past rather than recent invasions. The new record in southernmost Texas (25.9°N; Table 1), however, might represent a recent range extension. Similarly, the southernmost record of this species, from a park in downtown Buenos Aires, Argentina (34.6°S; A. Wild, pers. comm.), may also represent a recent range extension.

In the Old World, *W. auropunctata* populations are spreading on many fronts (Tabels 4 and 5). When exotic populations of *W. auropunctata* attain very high densities, this species can become a very serious pest (Wetterer and Porter, 2003). In the Solomon Islands, Fasi (2009) reported that *W. auropunctata* made up 97% of all ants in subsistence gardens. In Israel where *W. auropunctata* was first found in 2005, Vonshak et al. (2010) found that high densities of *W. auropunctata* displace almost all the local ant fauna. Walker (2006) found a similar impact on the native ants of Gabon. Walsh et al. (2004) reported that *W. auropunctata* is rapidly spreading in West Africa (also see Tindo et al., 2011), where its stings appear to be responsible for eye damage in many domestic and wild animals, including elephants and leopards. On Tahiti, *W. auropunctata* has spread to many parts of the island and is believed to be responsible for eye damage to numerous cats and dogs (Theron, 2007; Loève, 2009). In fact, reports of eye damage to domestic animals led to the discovery of three new populations of *W. auropunctata* in Israel (Vonshak et al., 2010).

Whereas *W. auropunctata* has already invaded suitable habitats throughout the New World, in the Old World, *W. auropunctata* populations are still spreading and have much potential for future spread. Although *W. auropunctata* is tiny, its ecological and economic impact can be great. Continued efforts are needed to document and limit the spread and impact of this invasive ant.

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References

Anonymous. 1979. Solving problems in the Toronto Zoo. Pest Control Technology 7 (10):14–15.

Ayre, G.L. 1977. Exotic ants in Winnipeg. Manitoba Entomologist 11:41–44.

Bruneau de Miré, P. 1969. Une formi utilisée au Cameroun dans la lutte contre les mirides du cacaoyer: *Wasmannia auropunctata* Roger. Café Cacao Thé 13:209–212.

Bünzli, G.H. 1935. Untersuchungen über coccidophile Ameisen aus den Kaffeefeldern von Surinam. Mitteilungen der Schweizerischen Entomologischen Gessellschaft 16:453–593.

Conant, P. and C. Hirayama. 2000. *Wasmannia auropunctata* (Hymenoptera: Formicidae): established on the Island of Hawai'i. Bishop Museum Occasional Papers 64:21–22.

Deyrup, M., L. Davis, and S. Cover. 2000. Exotic ants in Florida. Transactions of the American Entomological Society 126:293–326.

Donisthorpe, H. 1908. Additions to the wild fauna and flora of the Royal Botanic Gardens, Kew: VII. Hymenoptera. Formicidae (ants). Bulletin of Miscellaneous Information, Royal Botanic Gardens, Kew 1908:121–122.

Emery, C. 1893. Über die Herkunft der Pharao-Ameise. Biologisches Centralblatt 13:435–436.

Emery, C. 1894a. Studi sulle formiche della fauna Neotropica. Bollettino della Societa Entomologica Italiana 26:137–241.

Emery, C. 1894b. Estudios sobre las hormigas de Costa Rica. Anales del Museo Nacional de Costa Rica 1888-1889:45–64.

Fabres, G. and W.L. Brown Jr. 1978. The recent introduction of the pest ant *Wasmannia auropunctata* into New Caledonia. Journal of the Australian Entomological Society 17:139–142.

Fasi, J. 2009. Quantifying the dominance of little fire ant (*Wasmannia auropunctata*) and its effect on crops in the Solomon Islands. Master's thesis. University of the South Pacific, Suva. 101 pp.

Forel, A. 1886. Espèces nouvelles de fourmis américaines. Annales de la Société Entomologique de Belgique 30:xxxviii-xlix.

Forel, A. 1893. Formicides de l'Antille St. Vincent, récoltées par Mons. H. H. Smith. Transactions of the Entomological Society of London 1893:333–418.

Forel, A. 1897. Quelques Formicides de l'Antille de Grenada récoltés par M. H. H. Smith. Transactions of the Entomological Society of London 1897:297–300.

Forel, A. 1899. Biologia Centrali-Americana; or, contributions to the knowledge of the fauna and flora of Mexico and Central America. Insecta. Hymenoptera. 3. Formicidae. R.H. Porter, London, 160 pp.

Forel, A. 1909. Ameisen aus Guatemala usw., Paraguay und Argentinien (Hym.). Deutsche Entomologische Zeitschrift 1909:239–269.

Forel, A. 1911. Aperçu sur la distribution géographique et la phylogénie des fourmis. Memoires Ier Congres International d'Entomologie 2:81–10.

Forel, A. 1912. Formicides Néotropiques. Part IV. 3me sous-famille Myrmicinae Lep. Mémoires de la Société Entomologique de Belgique 20:1–32.

Foucaud, J., Jourdan, H., Le Breto, J., Loiseau, A., and Konghouleux, D. 2006. Rare sexual reproduction events in the clonal reproduction system of introduced populations of the little fire ant. Evolution 60:1646–1657.

Foucaud, J., J. Orivel, A. Loiseau, J.H.C. Delabie, H. Jourdan, D. Konghouleux, M. Vonshak, M. Tindo, J. Mercier, D. Fresneau, J. Mikissa, T. McGlynn, A.S. Mikheyev, J. Oettler, and A. Estoup, 2010. Worldwide invasion by the little fire ant: routes of introduction and eco-evolutionary pathways. Evolutionary Applications 3:363–374.

Ikin, R. 1984. Solomon Islands cocoa tree-ant. Quarterly Newsletter of FAO Asia Pacific Plant Protection Commission 27:8.

Jourdan, H. 1997. Threats on Pacific islands: the spread of the tramp ant *Wasmannia auropunctata* (Hymenoptera: Formicidae). Pacific Conservation Biology 3:61–64.

Jucker, C., F. Rigato, and R. Regalin. 2008. Exotic ant records from Italy (Hymenoptera, Formicidae). Bollettino di Zoologia agraria e di Bachicoltura 40:99–107.

Keifer, H.H. 1937. Systematic entomology. California Department of Agriculture Bulletin 26:433–435.

Loève, É. 2009. The little fire ant (LFA) on Tahiti, *Wasmannia auropunctata* (Roger, 1863): the solved issue of some colonies explosions. Fenua Animalia, Motu Uta, Tahiti, 11pp.

Longino, J. T. and F. Fernández. 2007. Taxonomic review of the genus *Wasmannia*. Memoirs of the American Entomological Institute 80:271–289.

Mann, W.M. 1922. Ants from Honduras and Guatemala. Proceedings of the United States National Museum 61:1–54.

Meyer, J. and H. Jourdan. 2005. Little fire ant in Tahiti and *Miconia* in New Caledonia: French connection to tackle "new" invasions in South Pacific islands. Aliens 21:1.

Mikheyev, A.S., S. Bresson, and P. Conant. 2009. Single-queen introductions characterize regional and local invasions by the facultatively clonal little fire ant *Wasmannia auropunctata*. Molecular Ecology 18:2937–2944.

Naumann, K. 1994. An occurrence of two exotic ant (Formicidae) species in British Columbia. Journal of the Entomological Society of British Columbia 91:69–70.

Ndoutoume-Ndong, A. and B. Mikissa. 2007. Influence de la présence de la fourmi *Wasmannia auropunctata* (Roger 1863) (Hymenoptera: Formicidae) sur les autres espèces de fourmis dans la réserve de la Lopé (centre du Gabon). Annales de la Société Entomologique de France 43:155–158.

Rapp, G. 1999. Introduction of the fire ant *Wasmannia auropunctata* into Vanuatu. Ag Alert 18:1.

Ridgell, C. 2011. Invasive "little fire ants" pose huge problem for Guam. Pacific News Center 11 November 2011 <http://www.pacificnewscenter.com/index.php?option=com_content&view=article&id=18549:video-invasive-little-fire-ants-pose-huge-problem-for-guam&catid=45:guam-news&Itemid=156>, retrieved on 22 October 2012.

Roger, J. 1863. Die neu aufgeführten Gattungen und Arten meines Formiciden-Verzeichnisses nebst Ergänzung einiger früher gegebenen Beschreibungen. Berliner Entomologische Zeitschrift 7:131–214.

Santschi, F. 1931. Fourmis de Cuba et de Panama. Revista de Entomologia (Rio de Janeiro) 1:265–282.

Theron, L. 2007. Wasmannia auropunctata linked keratopathy (WALK) hypothesis the Polynesian case. PhD dissertation. Université de Liège, Liège. 38 pp.

Tindo, M., P.S. Mbenoun Masse, M. Kenne, R. Mony, J. Orivel, A. Doumtsop Fotio, A. Fotso Kuate, C. Djiéto-Lordon, A. Fomena, A. Estoup, A. Dejean, and J. Foucaud. 2011. Current distribution and population dynamics of the little fire ant supercolony in Cameroon. Insectes Sociaux 59:175–182.

Vanderwoude, C. 2008. Operational plan for management of *Wasmannia auropunctata* (little fire ant) in East Sepik Province, Papua New Guinea. VCL New Zealand, 21 pp.

Vonshak, M., T. Dayan, A. Ionescu-Hirsh, A. Freidberg, and A. Hefetz. 2010. The little fire ant *Wasmannia auropunctata*: a new invasive species in the Middle East and its impact on the local arthropod fauna. Biological Invasions 12:1825–1837.

Walker, K.L. 2006. Impact of the little fire ant, *Wasmannia auropunctata*, on native forest ants in Gabon. Biotropica 38:666–673.

Walsh, P.D., P. Henschel, K.A. Abernethy, C.E.G. Tutin, P. Telfer, and S.A. Lahm. 2004. Logging speeds little red fire ant invasion of Africa. Biotropica 36:637–641.

Waterhouse, D.F. 1997. The major invertebrate pests and weeds of agriculture and plantation forestry in the southern and western Pacific. Australian Centre for International Agricultural Research, Canberra, Australia, 93 pp.

Weber, N.A. 1948. Studies on the fauna of Curaçao, Aruba, Bonaire and the Venezuelan islands 14: Ants from the Leeward group and some other Caribbean localities. Natuurwetenschappelijke Studiekring voor Suriname en Curacao 5:78–86.

Wetterer, J.K. 2005. Worldwide distribution and potential spread of the long-legged ant, *Anoplolepis gracilipe*s. Sociobiology 45:77–97.

Wetterer, J.K. 2007. Biology and impacts of Pacific islands invasive species. 3. The African big-headed ant, *Pheidole megacephala* (Hymenoptera: Formicidae). Pacific Science 61:437–456.

Wetterer, J.K. 2008. Worldwide spread of the longhorn crazy ant, *Paratrechina longicornis* (Hymenoptera: Formicidae). Myrmecological News 11:137–149.

Wetterer, J.K. 2009a. Worldwide spread of the ghost ant, *Tapinoma melanocephalum* (Hymenoptera: Formicidae). Myrmecological News 12:23–33.

Wetterer, J.K. 2009b. Worldwide spread of the destroyer ant, *Monomorium destructor* (Hymenoptera: Formicidae). Myrmecological News 12:97–108.

Wetterer, J.K. 2010. Worldwide spread of the pharaoh ant, *Monomorium pharaonis* (Hymenoptera: Formicidae). Myrmecological News 13:115–129.

Wetterer, J.K. 2011. Worldwide spread of the tropical fire ant, *Solenopsis geminata* (Hymenoptera: Formicidae). Myrmecological News 14:21–35.

Wetterer, J.K. and Porter, S.D. 2003. The little fire ant, *Wasmannia auropunctata*: distribution, impact, and control. Sociobiology 42:1–41.

Wetterer, J.K. and A. L. Wetterer. 2004. Ants (Hymenoptera: Formicidae) of Bermuda. Florida Entomologist 87:212–221.

Wetterer, J.K., A.L. Wild, A.V. Suarez, N. Roura-Pascual, and X. Espadaler. 2009. Worldwide spread of the Argentine ant, *Linepithema humile* (Hymenoptera: Formicidae). Myrmecological News 12:187–194.

Wheeler, W.M. and W.M. Mann. 1914. The ants of Haiti. Bulletin of the American Museum of Natural History 33:1–61.

Wheeler, W.M. 1911. Additions to the Ant-fauna of Jamaica. Bulletin of the American Museum of Natural History 30:21–29.

Wheeler, W.M. 1913. Ants collected in the West Indies. Bulletin of the American Museum of Natural History 32:239–244.

Wheeler, W.M. 1916. Ants collected in Trinidad by Professor Roland Thaxter, Mr. F.W. Urich, and others. Bulletin of the Museum of Comparative Zoology 60:323–330.

Wheeler, W.M. 1919. The ants of Tobago Island. Psyche 26: 113.

Zolessi, L.C. de, Y.P. de Abenante, and M.E. Phillippi. 1985. Insetos del Uruguay (Hymenoptera: Formicidae). Lista ilustrada de los formicidos del Uruguay (2da. Parte). Actas de las Jornadas de Zoologia del Uruguay 1985:19–20