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Larra bicolor Fabricius (Hymenoptera: Crabronidae): its distribution throughout Florida

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Abstract. We document the presence of *Larra bicolor* Fabricius (Hymenoptera: Crabronidae) in 46 of Florida's 67 counties. The species is represented by two stocks. The first (released in 1981) originated in Pará, Brazil, but was obtained from Puerto Rico, and became established in Broward County in southern Florida. The second (released in 1988) originated in Santa Cruz de la Sierra, Bolivia, and became established in Alachua County in northern Florida. The Bolivian stock, aided by additional satellite releases from Alachua County, is now widely distributed. The species probably occupies all counties in central and northern Florida, but may yet be absent from some southern counties. Introduction was made for classical biological control of invasive mole crickets.

Introduction

Larra spp. have traditionally been called wasps although they are bee-relatives (Hymenoptera: Apoidea). As explained in Portman et al. (2009) we follow the taxonomic lead of W. J. Pulawski (unpublished) in transferring *Larra* from Sphecidae to Crabronidae. All are parasitoids of mole crickets (Orthoptera: Gryllotalpidae) (Menke 1992).

Larra bicolor F. is a widely-distributed South American species using various *Scapteriscus* spp. mole crickets as hosts (Menke 1992). Stock from Amazonian Brazil (via Puerto Rico) was introduced in 1981 into southern Florida, and stock from Bolivia was introduced in 1988 into northern Florida (Frank et al. 1995, Frank and Sourakov 2002). By 2005, the Brazilian stock still seemed confined to a small area (Frank and Walker 2006); no releases have been made of it since the early 1980s.

At evidence of establishment of the Bolivian stock in 1993, one question was: will this stock spread from Gainesville throughout Florida, and how long will such spread take? We could not envisage enlisting a network of dedicated observers representing every county for the duration of such a project. But, evidence of dispersal accumulated from the efforts of volunteer observers until by mid-2005 the stock had been reported from 25 counties (Frank and Walker 2006). Then for 12 months we received funding to try to document its establishment in the remaining 42 counties.

The wasp was introduced as one of three biological control agents to suppress invasive mole crickets (Frank and Walker 2006). Although earmarked funding for the biological control program ended in 1991, there still was pressure from the ranching and turf industries to achieve suppression throughout Florida. This pressure prompted satellite releases of stock from the Gainesville area. Releases were made only on a small scale for lack of financial support, but they hinder interpretation of the natural spread of the Bolivian stock. This paper documents the spread of *L. bicolor*.

Materials and Methods

Releases of the Bolivian stock. Initial releases in Alachua Co. (Gainesville area) were made in 1988 and 1989 (Frank et al. 1995). No more were made until 1998, and these are listed below under names of counties (in bold). All releases in Florida were made at plants of *Spermacoce verticillata* F. (Rubiaceae), almost all planted deliberately, which serves as a nectar source (Arévalo and Frank 2005). Releases were generally of 30 adult wasps, mainly female, at or after sundown. **Orange**: Orlando, Winter Pines Golf

Club, October 1998 and May 1999; **Martin**: Stuart, Willoughby Golf Club, October 1998 and June 1999; **Palm Beach**: Palm Beach Gardens, Frenchman's Creek Country Club, November 1998 and June 1999; Lake Worth, The Falls Country Club, November 1998 and June 1999; **Lee**: Ft. Myers, City of Ft. Myers County Club, October 1998 and June 1999; **Hillsborough**: Valrico, River Hills Country Club, November 1998 and May 1999; **Brevard**: Cocoa, Sam's Executive Golf Course, by Lowell Loadholtz, fall 2001; **Gadsden**: Quincy, Russ Mizell, fall 2002; **Manatee**: Palmetto, in collaboration with Peggy Dessaint, November 2002; **Charlotte**: Punta Gorda, St. Andrews South Golf Club, June 2003; **St. Lucie**: Bluefield Road, south of hwy 70, close to western boundary of county, October 2004, in collaboration with Ken Hibbard, FDACS-DPI; **Bay**: Panama City, in collaboration with Ken Rudisill, November 2004; **Indian River**: Vero Beach, delivered to Christine Kelly-Begazzo for release, October 2006; **St. Lucie**: Ft. Pierce, in collaboration with Ed Skvarch, October 2006; **Martin**: Stuart, delivered to John Alleyne for release, November 2006.

Two releases, not listed above, were made in spite of earlier presence in the county (St. Johns 2001, Sarasota 2003). One hundred and eighty adult *L. bicolor* were supplied from Gainesville to the University of Georgia Agricultural Extension Service in 2001, and allowed establishment of populations at three sites in and near Tifton, Georgia. Adults were supplied to the Louisiana Agricultural Extension Service in September 2002 for release at a patch of *Chamaecrista fasciculata* (Michx.) Greene (Fabaceae), partridge pea, near Baton Rouge, but are not known to have established.

Detection. Until 2005, attempts to detect the presence of *L. bicolor* in each county followed no statewide strategy. They were mainly responses to requests from collaborators in counties distant from Gainesville, and these collaborators were interested in improved control of pest mole crickets. Responses generally took the form of supply to the collaborator of *S. verticillata* plants with request that the plants be installed in a suitable habitat, maintained, and examined occasionally for the presence of adult wasps (examples are Baker, Bradford, Flagler, and Santa Rosa counties). Or, someone had reported to Howard Frank the presence of the wasp in some distant county (examples are Levy, Liberty, Putnam, and Sarasota counties). By mid-2005, all forms of detection had shown the presence of the Bolivian stock in 25 counties (Fig. 4 in Frank and Walker 2006).

In Spring 2005, a plan was devised (and funded) to seek collaborators in the remaining 42 counties, to provide each of them with at least 15 *S. verticillata* plants, and to encourage them to maintain the plants and collect or photograph wasps as evidence. The plants were grown, distributed, and were in place in most of those counties by Spring or Summer 2006. Most of these collaborators were county-based Extension Service employees, and were typically horticulturists or livestock agents. Some of them, in turn, encouraged participation by Master Gardeners. One was an FDACS-DPI employee. Meanwhile, reports continued to Howard Frank of sightings by people uninvolved in the project, who were curious about the possible presence of *L. bicolor* in their county. Outstanding examples are Collier and Escambia counties, among the most distant from Gainesville, both of them occupied by Spring 2006.

All reports by non-entomologists were confirmed by examination of specimens or photographs, or by a soon-subsequent confirmed record from a nearby place.

Results

Brazilian stock. A population of the Brazilian stock, from the original release in 1981, still exists at Davie, Broward County. A specimen of it was collected in Palm Beach County: West Palm Beach, Possum Pass, November 2004, by Alejandro Arévalo. The voucher specimen is now in the Florida State Collection of Arthropods. Wasps of the Bolivian stock can be distinguished from those of the Brazilian by microsculpture of the head (Menke 1992, Frank et al. 1995).

First reported sightings of *L. bicolor* in the 44 counties now believed to be occupied by the Bolivian stock. Alachua: Gainesville, attacking a mole cricket, October 1993 – Judy Gillmore (Entomology and Nematology Dept, UF); **Baker**: Macclenny, November 2003 – Mike Sweat (Baker Co. Extension); **Bay**: Panama City, at *S. verticillata* flower, August 2006 – Ken Rudisill (Bay Co. Extension); **Bradford**: Starke, trapped in the window of a pickup truck, June 2004 – Paulette Tomlinson (Bradford Co. Extension); **Brevard**: Cocoa, at *S. verticillata* flower on a golf course, 2002 – Lowell Loadholtz (Brevard Co. Extension, retired)

following a satellite release there in fall 2001; **Charlotte**: Punta Gorda, at *S. verticillata* flower, November 2003 – Dave Knesky (St Andrews South Golf Club), following a satellite release there in June 2003; **Citrus**: Hernando, feeding at wildflower nectar in a waterway on a golf course, May 2002 – David Hoggard (Citrus Hills Golf Course); **Clay**: Gold Head Branch State Park, May 1997 – Charles Porter and Lionel Stange (Florida State Collection of Arthropods); **Collier**: east of Naples, Golden Gate Estates, trapped in a screened porch, May 2006 – Brian Womble (Naples, see his blog (http://tamingoftheband-aid.blogspot.com/2006/05/let-me-tell-yall-story.html); **Escambia**: Pensacola, attacking a mole cricket in a private garden, June 2006 – Melita Hoffman (Pensacola); **Flagler**: Bunnell, at *S. verticillata* flower, November 2003 – Chuck Lippi (Flagler Co. Extension); **Gadsden**: Quincy, at *S. verticillata* flower, June 2004 – Russ Mizell (North Florida Research and Education Center); **Gilchrist**: Trenton, at *S. verticillata* flower, August 2006 – Marvin Weaver (Gilchrist Co. Extension); **Gulf**: Port St. Joe Elementary School, at *S. verticillata* flower, June 2006 – Roy Carter (Gulf Co. Extension); **Hamilton:** Stephen Foster State Folk Culture Center, on wildflowers, July 2001 – Andrei Sourakov (then of USDA-ARS-CMAVE); **Hernando**: Brooksville, Tom Varn Park, at *Solidago* (Asteraceae) flower, October 2004 – Howard Frank with Guangye Hu (Hernando Co. Mosquito Control); **Highlands**: near Lake Placid, at flowers of *Serenoa repens* (Bartram) Small (Arecaceae), *Ampelopsis arborea* (L.) Koehe (Vitaceae), *Baccharis halimifolia* L. (Asteraceae), and *Garberia heterophylla* (Bartram) Merr. and F. Harper (Asteraceae), first seen in 2005, Mark Deyrup (Archbold Biological Station); **Hillsborough**: Seffner, by Extension office, at *S. verticillata* flower, September 2005 – Sydney Park-Brown (Hillsborough Co. Extension); **Holmes**: Bonifay, at *S. verticillata* flower, June 2006 – Hope Burton (Holmes Co, Extension); **Jackson**: Marianna, at *S. verticillata* flower, August 2006 – Mack Glass (rancher collaborating with Jackson Co. Extension); **Lake**: Tavares, county agricultural center, September 2007 – Charles Fedunak (Lake Co. Extension); **Lee**: I-75 exit at Palm Beach Boulevard, road margin, at *S. verticillata* flower, May 2007 – Howard Frank; **Leon**: Tallahassee, at *S. verticillata* flower, June 2006, Debbie Dalton (Leon Co. Extension); **Levy**: southern Levy Co., in pheromone-baited trap, May 1999 – Rob Meagher (USDA-ARS-CMAVE); **Liberty**: near Bristol, ABRP Sweetwater Tract, on *Agalinis* (Scrophulariaceae), October 2002 – Charles Porter and Lionel Stange (Florida State Collection of Arthropods); **Madison**: Lee, at *S. verticillata* flower, June 2006 – Kevin Campbell (Madison Co. Extension); **Manatee**: Palmetto, at *S. verticillata* flower, November 2004 – Peggy Dessaint (Manatee Co. Extension); **Marion**: Citra, at *S. verticillata* flower, September 2001 – Alejandro Arévalo (Entomology and Nematology Dept., UF); **Nassau**: Yulee, trapped in a screened porch, June 2006 – Rebecca Jordi (Nassau Co. Extension); **Okaloosa**: Crestview, at *S. verticillata* flower, October 2007 – Larry Williams (Okaloosa Co. Extension); **Okeechobee**: a ranch in northwestern part of the county, at *S. verticillata* flower, July 2007 – Pat Hogue and Pat Miller (Okeechobee Co. Extension); **Orange**: Orlando, county extension office, at *S. verticillata* flower, August 2007 – Ed Thralls (Orange Co. Extension); **Osceola**: about midway between St. Cloud and Kenansville, at *S. verticillata* flower, December 2007 – Randy Bateman (Osceola Co. Extension); **Pasco**: at *S. verticillata* flower, August 2005 – Ed Jennings (Pasco Co. Extension); **Pinellas**: Clearwater, in sweep-net sample, May 2004 - Jason Sharp (FDACS-DPI); **Polk**: a few miles east of Bartow, at *S. verticillata* flower, November 2003 – Howard Frank with David Shibles (Polk Co. Extension); **Putnam**: Katharine Ordway Preserve, in a Malaise trap, May 1999 – Randy Lundgren (Gainesville); **St Johns**: St. Augustine, at *S. verticillata* flower on a sod farm, June 2001 – Andrei Sourakov (then of USDA-ARS-CMAVE); **Santa Rosa**: Milton, by extension office, at *S. verticillata* flower, June 2005 – Theresa Friday (Santa Rosa Co. Extension); **Sarasota**: Sarasota, a larva attached to a pitfall-trapped mole cricket, August 2002 – Fred Santana (Sarasota Co. Extension), the traps being run on behalf of Katie Barbara (Entomology and Nematology, UF) who noticed and identified the larva; **Seminole**: Oviedo, at *S. verticillata* flower, June 2008 – Rosemarie Bashore, Master Gardener, reported by Al Ferrer (Seminole Co. Extension); **Sumter**: Bushnell, Youth Center, at extrafloral nectaries of an ornamental bush, June 2004 – Howard Frank with Wendel Martinkovic (Sumter Co. Extension); **Volusia**: Deland, a larva attached to a *Scapteriscus* mole cricket, November 1999 – Stacey Simmons, reported by Lionel Stange (Florida State Collection of Arthropods); **Wakulla**: Crawfordville, at *S. verticillata* flower, July 2006 – Bill Petty (Wakulla Co. Extension).

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Conclusion and Discussion

Collaborators in 11 northwestern counties who did not detect *L. bicolor* in 2006 made no reports since then. However, the scattered (rather then clumped) distribution of detection in the counties northwest of Gainesville suggests that the wasp is present in all of them. Detection in Hamilton County in 2001 and

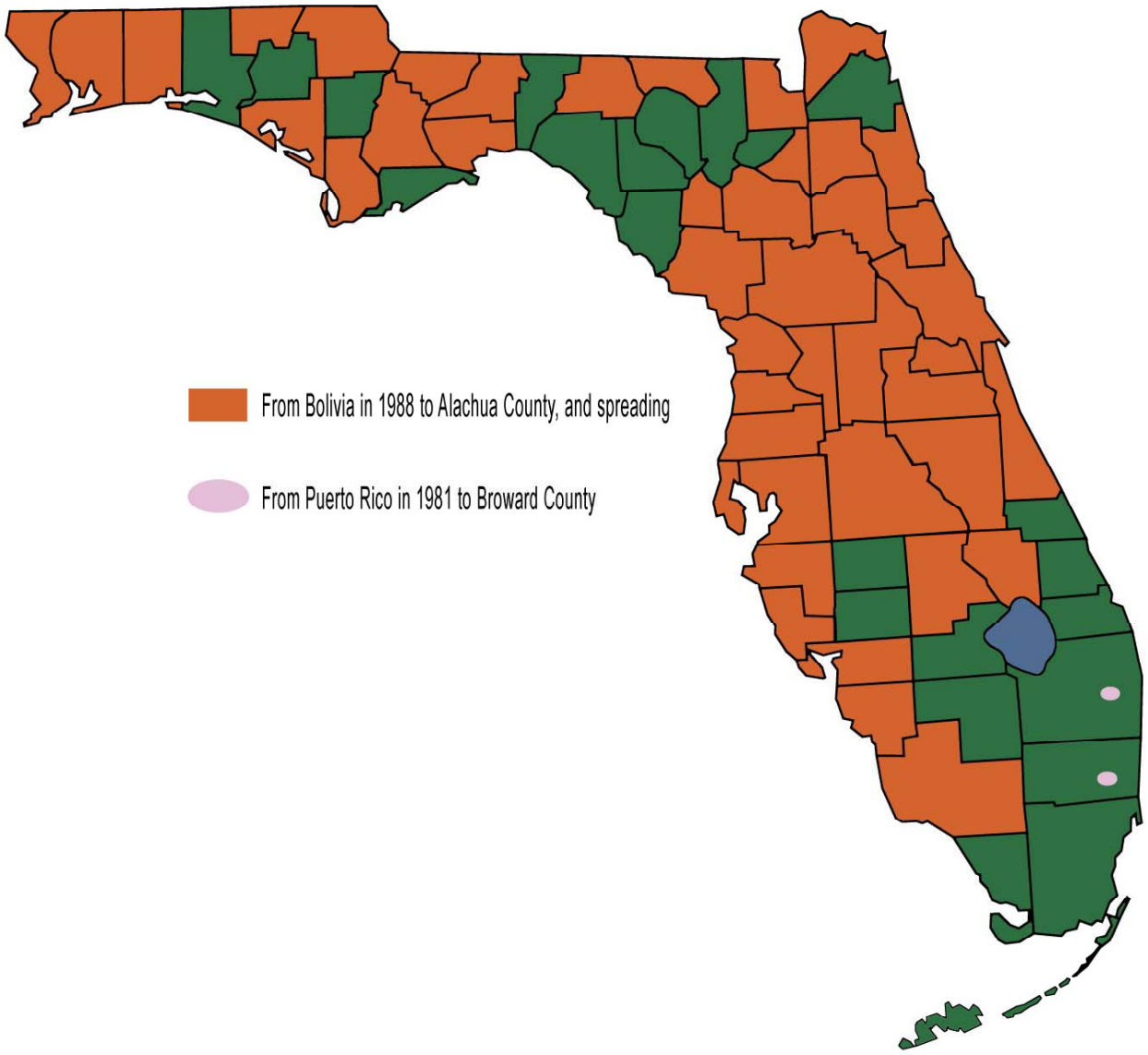

Figure 1. Map showing confirmed distribution of *L. bicolor* among Florida counties. Green (dark gray) indicates counties without records, orange (medium gray) counties where the Bolivian stock has been recorded, and pale magenta (very pale gray) ovals the localities where the Brazilian stock has been detected in southeastern counties. As of October 2008.

Liberty County in 2002, before releases had been made north of Gainesville, imply a natural spread from Alachua County, suggesting that all the intervening counties should be occupied. Some of the collaborators in eastern and southern counties who did not detect *L. bicolor* in 2006 persevered with the task and reported it in 2007 or 2008.

Larra bicolor uses nectar from several plants, but *S. verticillata* is outstanding among them (Arévalo and Frank 2005). In northern Florida, plantings of *S. verticillata* are attractive to wasps, and make detection of *L. bicolor* easy. In southern Florida, *S. verticillata* grows in disturbed areas from the Florida Keys north to Indian River Co. on the east coast, north to Sarasota Co. on the west coast, and north to Highlands and Okeechobee counties in the center. The widespread presence of this plant in the south may conceivably make plantings of *S. verticillata* less useful as attractors in southern counties. This may perhaps be the explanation of why *L. bicolor* has seemingly been harder to detect in seven counties north from the Florida Keys to Indian River Co. on the east coast (and perhaps also in other southern counties).

The wasp may be present in all those counties (although we do not know whether it is represented by the Brazilian or Bolivian stock).

The approach of the widespread Bolivian stock to the restricted Brazilian stock in Broward and Palm Beach counties offers an opportunity for a study in population genetics. It would be useful to confirm the continued genetic differentiation between the two stocks, and to learn whether they interbreed freely. We believe that *L. bicolor* populations now occupy all regions of Florida even if not yet all counties.

Endnotes

County extension faculty (named above) in Baker, Bay, Bradford, Brevard, Flagler, Gilchrist, Gulf, Hillsborough, Holmes, Jackson, Lake, Leon, Madison, Manatee, Nassau, Okaloosa, Okeechobee, Orange, Osceola, Pasco, Polk, Santa Rosa, Sarasota, Seminole and Wakulla counties were the backbone of this effort. FDACS-DPI personnel stationed in or visiting Clay, Liberty, Pinellas, and Volusia counties played an important role, as did Lionel Stange and Jim Wiley in providing taxonomic help. Alejandro Arévalo, Katie Barbara, Mark Deyrup, Judy Gillmore, Melita Hoffman, David Hoggard, Dave Knesky, Randy Lundgren, Rob Meagher, Andrei Sourakov, and Brian Womble, provided information for other counties. Several people deserve special mention. Retired Extension Director Lowell Loadholtz in Brevard County, took *S. verticillata* plants from Gainesville to a golf course in his county and then, once they were established, took *L. bicolor* there, and succeeded in establishing a population. Fred Santana (Sarasota County) launched a program to publicize use of *L. bicolor* and give away *S. verticillata* plants to residents of his county. Audrey Durr, Florida Yards and Neighborhoods Agent, Citrus County, promoted use of nectar sources (*S. verticillata* and a native plant, partridge pea, to encourage populations of the wasp. Lance Osborne (Mid-Florida Research and Education Center) became interested in the potential of *S. verticillata* as a banker plant for various beneficial insects. *Spermacoce verticillata* plants in 4-L (1-gal.) pots are now available from a commercial grower. This contribution is dedicated to the late Reece Sailer who, 30 years ago, had the vision that *L. bicolor* would solve Florida's pest mole cricket problems, and to Fred Bennett who, in 1988, imported the appropriate (Bolivian) stock of that species.

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