BioOne COMPLETE

Dispersal and Establishment of New Populations of the Biological Control Agent Floracarus perrepae (Acariformes: Eriophyidae) on Old World Climbing Fern, Lygodium microphyllum (Polypodiales: Lygodiaceae)

Authors: Lake, Ellen C., Smith, Melissa C., Pratt, Paul D., Boughton, Anthony J., and Pemberton, Robert W.

Source: Florida Entomologist, 97(2) : 827-829

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/024.097.0271

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

DISPERSAL AND ESTABLISHMENT OF NEW POPULATIONS OF THE BIOLOGICAL CONTROL AGENT *FLORACARUS PERREPAE* (ACARIFORMES: ERIOPHYIDAE) ON OLD WORLD CLIMBING FERN, *LYGODIUM MICROPHYLLUM* (POLYPODIALES: LYGODIACEAE)

ELLEN C. LAKE[1,*], MELISSA C. SMITH[1], PAUL D. PRATT[1], ANTHONY J. BOUGHTON[2] AND ROBERT W. PEMBERTON[3]
[1]USDA-ARS Invasive Plant Research Laboratory, 3225 College Avenue, Fort Lauderdale, FL 33314, USA

[2]University of Florida, Tropical Research & Education Center, Homestead, FL 33031, USA

[3]Research Associate, Florida Museum of Natural History; USDA-Agricultural Research Service (retired)

*Corresponding author; E-mail: Ellen.Lake@ars.usda.gov

Lygodium microphyllum (Cav.) R. Br (Polypodiales: Lygodiaceae), Old World climbing fern, is native to wet tropical and subtropical areas of the Old World. It was initially cultivated as an ornamental plant and was first reported as naturalized in Florida in 1965 (Beckner 1968; Pemberton & Ferriter 1998). *Lygodium microphyllum* has invaded multiple habitat types and important conservation areas in Florida including Everglades National Park and Arthur R. Marshall Loxahatchee National Wildlife Refuge (Ferriter & Pernas 2006). The fern outcompetes native vegetation by growing over and smothering native plant species primarily in wetland systems (Pemberton et al. 2002). *Lygodium microphyllum* can alter fire ecology by carrying fire into areas that usually do not burn, including cypress sloughs and tree canopies, and may rapidly colonize areas disturbed by fire (Pemberton & Ferriter 1998; Volin et al. 2004 and references therein). Vigorous vegetative growth from persistent rhizomes and prolific spore production make *L. microphyllum* difficult to manage using conventional methods (Pemberton & Ferriter 1998).

Floracarus perrepae Knihinicki & Boczek (Acariformes: Eriophyidae) is the most widely distributed herbivore on *L. microphyllum* in its native range (Goolsby et al. 2003). Females colonize and feed on the subleaflets of *L. microphyllum*, which causes the leaflet margins to roll. These galls are critical for the survival and reproduction of the mite and are diagnostic of mite presence in the field. Although one gall may contain multiple adults, a single gravid female is capable of inducing gall formation (Freeman et al. 2005). Galling by the mite reduced aboveground biomass by 49% and belowground biomass by 35% compared to controls during pre-release testing in the native range (Goolsby et al. 2004).

Floracarus perrepae can form full or partial leaf roll galls on sporelings of several *Lygodium* species but when mature plants of the same species were tested *F. perrepae* only completed development on *L. microphyllum* (Gooolsby et al. 2005). Based on these results, the United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA-APHIS) issued a permit for the field release of *Floracarus perrepae* in 2006 (Boughton & Pemberton 2011). The mite was subsequently released at 6 sites in south Florida during 2008 and at a seventh site in 2010 (Boughton & Pemberton 2011). Low levels of galling, fewer than 140 galls per site, were observed at 4 of these release sites in the months following releases, but after 14 mo, mite populations persisted at only 2 sites (Boughton & Pemberton 2011; Table 1). Sites were not regularly monitored after June 2011.

The limited establishment and population growth of *F. perrepae* led to the assumption that mite populations remained at very low levels or had been extirpated. To test this assumption, release sites were resurveyed between 29 Jan and 13 Feb 2013. Two observers searched *L. microphyllum* foliage for approximately 25 min at each site. Two of the 7 sites had been treated with herbicide and there was no access to a third (Table 1). Of the 4 remaining sites, there was no mite activity at the site in Loxahatchee National Wildlife Refuge, but the other three, all located within Jonathan Dickinson State Park, had very low levels of galling, i.e., only a few galls were found (Table 1). This result indicates that *F. perrepae* has persisted in the release area for more than 5 yr following release and is established within the park.

The recovery of *F. perrepae* in Jonathan Dickinson State Park prompted a broader survey of *L. microphyllum* in the area surrounding the park between 29 Jan and 26 Apr 2013. Roadside patches of *L. microphyllum* radiating away from the established population at Jonathan Dickinson State Park were searched for galls by 2 observers for approximately 20 min per site. Distances between searches in any given direction were predicated on *L. microphyllum* presence but intervals were generally 1-5 km. Searches along a given direction were terminated after several

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

TABLE 1. LOCATION AND STATUS OF *FLORACARUS PERREPAE* RELEASES. VERY LOW DENSITY INDICATES ONLY A FEW GALLS WERE FOUND AFTER INTENSIVE SEARCHING.

Location	Site	Release Date(s)	Status from Boughton & Pemberton (2011)	2013 Survey	2013 Mite Status
Jonathan Dickinson State Park	JD1(JD45)	1-VII to 23-X-2008	galls present after 12-14 mo	31-I-2013	Very low density
Jonathan Dickinson State Park	JD2(JD46)	19-VI to 23 X-2008; 15-VII-2009; 17-XI-2010	galls present after 12-14 mo	29-I-2013	Very low density
Jonathan Dickinson State Park	JD25	17-XI-2010	N/A	29-I-2013	Very low density
Private Land (Martin County)	PL1	8-V-2008	0 galls after 1-4 wk	No access to site	Unknown
Grassy Waters Preserve	GWP1	24VI to 28-VIII-2008	13 galls after 1-4 wk	31-I-2013	*L. microphyllum* treated with herbicide
Grassy Waters Preserve	GWP3	5-XII-2008; 22-VII-2009	0 galls after 1-4 mo	31-I-2013	*L. microphyllum* treated with herbicide
Loxahatchee National Wildlife Refuge	LNWR	15-VI to 5-XII-2008	28 galls after 1-4 mo	13-II-2013	No mite activity

searches yielded negative results. Mite activity was found between 2.8 and 18.5 km from the nearest release; the mean dispersal distance was 10.5 ± 1.8 km. Presuming these mite populations originated from the closest release site (JD25) and had recently colonized the sites we surveyed, we conservatively estimate a dispersal rate of 3.5 ± 0.6 km/yr. No galls were found in *L. microphyllum* populations located to the south or due west of the park, but multiple patches to the north and northwest contained galls, some of which had abundant mite populations with the majority of subleaflets galled on some plants. Like all Eriophyidae, *F. perrepae* are wind dispersed and their distribution to the north and west of Jonathan Dickinson State Park is consistent with the direction of the prevailing winds for this area, which are from the east and southeast except in March (McCollum & Cruz 1981).

Additional *L. microphyllum* research is underway at several other locations across the fern's distribution in Florida and *F. perrepae* has not been detected at these sites (E.C.L and M.C.S personal observation). Thus, dispersal was presumed to be limited to the area north and west of Jonathan Dickinson State Park. Recently, however, galls were observed on *L. microphyllum* in the Cape Sable region of Everglades National Park in May 2013. Galls were inspected using a microscope and mites discovered within were confirmed to be *F. perrepae*.

Gall densities were abundant, numerous subleaflets galled on many rachises, within the *L. microphyllum* vegetation at several colonized sites, including Cape Sable. Here, damage was observed along a ca. 50 m transect but dense sawgrass, *Cladium jamaicense* Crantz (Poales: Cyperaceae), and time limitations prevented a full survey of the site. The source population for the Cape Sable mites remains unclear. The mites may have dispersed from the only known *F. perrepae* populations in Florida, ca. 220 km northeast or from a rearing site ca. 120 km northeast. It is also possible the source may be a yet undiscovered *F. perrepae* population that exists in southern Florida. These data clearly indicate, however, that *F. perrepae* is more widely distributed than previously thought. Additional research is needed to systematically map the distribution of *F. perrepae*, evaluate its effectiveness as a biological control agent of *L. microphyllum*, and determine the best time to make releases to maximize establishment.

ACKNOWLEDGMENTS

We thank the South Florida Water Management District for funding this research, the field sites for allowing us to work on their properties, and Hillary Cooley for facilitating travel within Everglades National Park. Gloria Witkus provided technical assistance in the field.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

SUMMARY

The mite *Floracarus perrepae* Knihinicki & Boczek (Acariformes: Eriophyidae), a biological control agent of *Lygodium microphyllum* (Cav.) R. Br (Polypodiales: Lygodiaceae), Old World climbing fern, was released in south Florida from 2008 to 2010 but did not readily establish in the field. The original release sites were resurveyed in 2013 and the mite has established within Jonathan Dickinson State Park and has dispersed to *L. microphyllum* patches outside the park at a rate of 3.5 ± 0.6 km/yr. The mite has also dispersed to the Cape Sable region of Everglades National Park.

Key Words: eriophyid mite, gall, weed biological control, wind dispersal

RESUMEN

El ácaro *Floracarus perrepae* Knihinicki y Boczek (Acariformes: Eriophyidae), un agente de control biológico de *Lygodium microphyllum* (Cav.) R. Br. (Polypodiales: Lygodiaceae), un helecho trepador del Mundo Antiguo, fue liberado en el sur de la Florida del 2008 hasta el 2010, pero no se estableció fácilmente en el campo. Se realizó un sondeo de nuevo en el 2013 de los sitios originales donde fueron liberadas y el ácaro se ha establecido dentro del Parque Estatal de Jonathan Dickinson y se ha dispersado a parches de *L. microphyllum* fuera del parque a una velocidad de 3.5 ± 0.6 km/año. El ácaro se ha dispersado a la región del Cabo Sable del Parque Nacional Everglades.

Palabras Clave: ácaro, agalla, control biológico de malezas, dispersión por el viento

REFERENCES CITED

BECKNER, J. 1968. *Lygodium microphyllum*, another fern escaped in Florida. American Fern J. 55: 93-94.

BOUGHTON, A. J., AND PEMBERTON, R. W. 2011. Limited field establishment of a weed biocontrol agent, *Floracarus perrepae* (Acariformes: Eriophyidae), against Old World climbing fern in Florida-a possible role of mite resistant plant genotypes. Environ. Entomol. 40: 1448-1457.

FERRITER, A., AND PERNAS, T. 2006. An explosion in slow motion: tracking the spread of *Lygodium microphyllum* in Florida. Wildland Weeds 9: 7-9.

FREEMAN, T. P., GOOLSBY, J. A., OZMAN, S. K., AND NELSON, D. R. 2005. An ultrastructural study of the relationship between the mite *Floracarus perrepae* Knihinicki & Boczek (Acariformes: Eriophyidae) and the fern *Lygodium microphyllum* (Lygodiaceae). Australian J. Entomol. 44: 57-61.

GOOLSBY, J. A., WRIGHT, A. D., AND PEMBERTON, R. W. 2003. Exploratory surveys in Australia and Asia for natural enemies of Old World climbing fern, *Lygodium microphyllum*: Lygodiaceae. Biol. Control 28: 33-46.

GOOLSBY, J. A., ZONNEVELD, R., AND BOURNE, A. 2004. Prerelease assessment of impact on biomass production of an invasive weed, *Lygodium microphyllum* (Lygodiaceae: Pteridophyta), by a potential biological control agent, *Floracarus perrepae* (Acariformes: Eriophyidae). Environ. Entomol. 33: 997-1002.

GOOLSBY, J. A., ZONNEVELD, R., MAKINSON, J. R., AND PEMBERTON, R. W. 2005. Host-range and cold temperature tolerance of *Floracarus perrepae* Knihinicki & Boczek (Acari: Eriophyidae), a potential biological-control agent of *Lygodium microphyllum* (Pteridophyta: Lygodiaceae). Australian J. Entomol. 44: 321-330.

MCCOLLUM, S. H., AND CRUZ, SR., O. E. 1981. Soil survey of Martin County area, Florida. USDA, Soil Conservation Service.

PEMBERTON, R. W., AND FERRITER, A. P. 1998. Old World climbing fern (*Lygodium microphyllum*), a dangerous invasive weed in Florida. American Fern J. 88: 165-175.

PEMBERTON, R. W., GOOLSBY, J. A., AND WRIGHT, T. 2002. Old World climbing fern, pp. 139-147 *In* R. Van Driesche, S. Lyon, B. Blossey, M. Hoddle and R. Reardon [eds.], Biological control of invasive plants in the eastern United States (Publication FHTET-2002-04) - Forest Health Technology Enterprise Team. U.S. Dept. Agric. Forest Service.

VOLIN, J. C., LOTT, M. S., MUSS, J. D., AND OWEN, D. 2004. Predicting rapid invasion of the Florida Everglades by Old World Climbing Fern (*Lygodium microphyllum*). Diversity Distrib. 10: 439-446.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use