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Eucalyptus gall wasp, *Leptocybe invasa* Fisher & La Salle (Insecta: Hymenoptera: Eulophidae), an emerging pest of eucalyptus in Florida

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INTRODUCTION AND DISTRIBUTION: Eucalyptus is used both as an ornamental and commercial tree. Its plantations are a major source of timber, firewood and mulch, and create areas for honeybee foraging. It is used in recreational areas, as shelterbelts from drifting sands, and as wind breaks surrounding cultivated and residential areas all over the world, including Florida. (Mendel et al. 2004; Wiley and Skelley 2008; Gaskill et al. 2009). In Florida, eucalyptus is the most commonly used tree for wind breaks in citrus groves, and is used extensively throughout the state's 500,000 acres of commercial citrus.

A new emerging pest of eucalyptus, *Leptocybe invasa* Fisher & La Salle, was first found in Italy, but mistakenly identified as *Aprostocetus* sp. (Viggiani et al. 2001). This was followed by another report of an infestation from Turkey in early 2000 (Aytar 2003). The first formal description of this insect came in 2004 from Australia as *L. invasa* (Fisher and Lasalle 2004) and is now considered likely native to Australia (Mendel et al. 2004).

Within the past decade it has become established in at least 38 countries from the Mediterranean Basin (France, Italy, Greece, Portugal, Spain, Turkey and Malta), Europe (U.K.), Middle East Asia (Israel, Iran, Iraq, Jordan and Syria) Sub Saharan Africa (Ethiopia, Kenya, Mozambique, Malawi, Tanzania and Uganda), northern Africa (Algeria, Egypt, Tunisia and Morocco), southern Africa (South Africa and Zimbabwe), eastern Asia (China), southern Asia (India and Sri Lanka), southeastern Asia (Laos, Taiwan, Thailand, Malaysia and Vietnam), Oceania (Australia), South America (Argentina, Brazil and Chile), and North America (USA) (Fig. 1). See Table 1. for references. In Florida, *L. invasa* was found for the first time in Broward County in 2008 (Wiley and Skelley 2008) and has since been reported from at least 11 counties with the distribution expanding northward (Fig. 2).

GENETIC ANALYSIS AND CRYPTIC SPECIES ISSUE: The recent global invasion of *L. invasa* had been attributed to a single thelytokous morphospecies due to the presence of only females in most of the reports. However, males were recorded in some countries, and the sex ratio was considered highly variable between different regions (Nugnes et al. 2015). Molecular analyses suggested that *L. invasa* is in fact a complex of two cryptic species involved in the rapid and efficient global spread of the wasp, the first recovered from the Mediterranean region and South America, the latter from China (Nugnes et al. 2015). The distance between Chinese and Western populations is at least 3.6% based on COI genes (Nugnes et al. 2015). In addition, genetic differences at the strain level of *Rickettsia* symbionts and sex ratio differences supports separation of the Chinese and Western populations, which can be therefore treated as putative species.

A genetic analysis was performed on samples collected from Homestead, Florida, using COI gene as described in (Nugnes et al. 2015), and confirmed that the population in southern Florida belongs to the Western species.

DESCRIPTION AND BIOLOGY: The descriptive morphology of *L. invasa* is mostly derived from the adult female life stage. The female adult wasp is 1.1 to 1.4 mm long (Fig. 3). The body is brownish in color with a blue to green metallic sheen. Fore coxae are yellow, mid and hind coxae are brown. The scape of the antennae is yellow, with the remaining segments being brown in color. Mean development time from oviposition to emergence is 132.6 days at room temperature (Mendel et al. 2004). In Israel, Iran and Turkey, the wasp produces two or three overlapping generations per year (Mendel et al. 2004). Mean survival time for wasps fed with honey and

water is 6.5 days (Mendel et al. 2004). The sex ratio is mostly female biased, (reproducing by parthenogenesis), except for a few records describing males from India, Turkey and Thailand (Nugnes et al. 2015).

Leptocybe invasa produces galls in the form of distinct swellings on leaf petioles, midribs and stems on new foliage of both young growth and mature trees (**Fig. 4**). Mean length of a gall containing a single wasp is 2.1 mm, and leaves of rapidly growing trees may contain greater than 50 galls per leaf (Mendel et al. 2004). The female wasps insert eggs into the upper side of the leaves and stems. As larvae develop, galls begin to form and the green color of the leaves containing the galls turns glossy pink. Subsequently, the leaf glossiness then diminishes and the galls turn from pink to red. Upon emergence of the wasps, the galls on the leaves turn light brown and the galls on the stems turn reddish-brown. The adults leave round exit holes after emergence (Fig. 3).

DAMAGE: *Leptocybe invasa* is a serious pest in young plantations. Heavy galling prevents further development and causes leaf curling and stunted growth (Mendel et al. 2004). Infested growth causes substantial damage, seriously weakening old trees and killing young trees. All new growth is susceptible to damage when large concentrations of these wasps are found on leaves (Fig 3). The impact on adult trees is not known.

HOST PLANTS: There are at least 11 *Eucalyptus* species reported as favorable host plants of *L. invasa*, including *Eucalyptus botryoides, E. bridgesiana, E. camaldulensis*, *E. globulus*, *E. gunii, E. grandis*, *E. robusta*, *E. saligna*, *E. maidenii, E. tereticornis*, and *E. viminalis* (Cabi, 2016; Mendel et al. 2004).

MANAGEMENT: In the nine years since its first detection in 2008, *L. invasa* has expanded its range and is becoming an emerging pest in Florida (Wiley and Skelley 2008). Currently, few biological control measures are available against *L. invasa*, although research is being carried out to identify potential natural enemies in other parts of the world. Three parasitoid wasps are reported to parasitize *L. invasa*: *Selitrichodes neseri* Kelly & La Salle (Kelly et al. 2012), *Quadrastichus mendeli* Kim & La Salle, and *Selitrichodes kryceri* Kim & La Salle (Kim et al. 2008). None of these parasitoid wasps have been detected yet from Florida.

Chemical control may be available in nurseries, but would be difficult to accomplish in natural environments. Much data are lacking concerning taxonomy, current geographical distribution, biology and economic impact in Florida. Also, no data are available on the natural spread of this insect. Although adult *L. invasa* can fly or be carried by wind and spread over small distances, the primary mode of distribution is likely through the movement of eucalyptus plants and cut foliage. The trade of plants for planting and eucalyptus flower arrangements could potentially move this pest over long distances to other states in the U.S. where it has not been reported yet.

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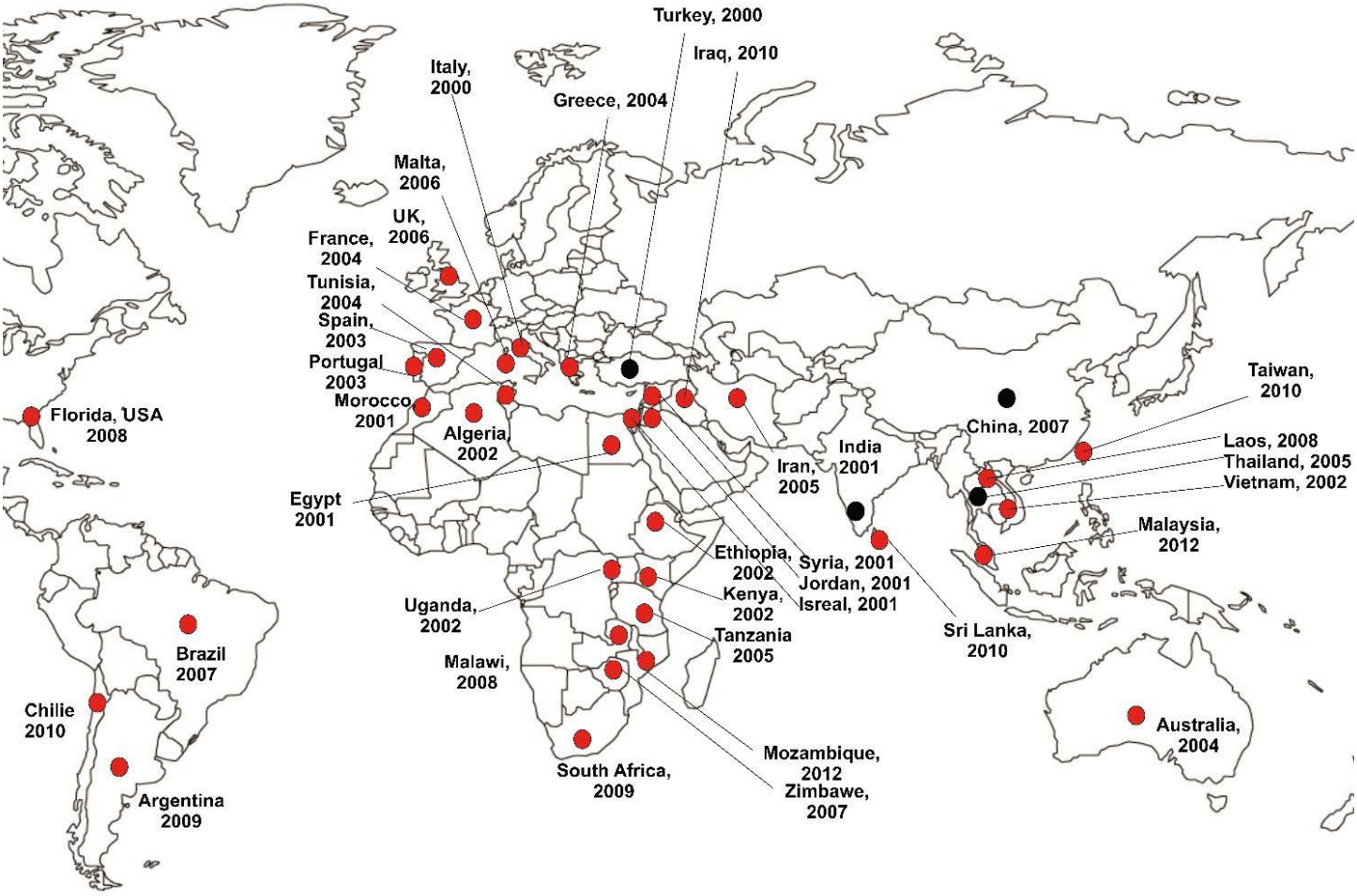

Fig. 1. The geographical distribution of *L. invasa*, including the year of its first report from the respective countries. Red represents the Western cryptic species with no record of males in sex ratio, and black represents the Chinese cryptic species with the record of males. Note: Cryptic species of Argentina, China, Italy, Tunisia, Turkey and U.S. were confirmed with genetic analysis in our study (Nugnes et al. 2015). Blank world map source: www.freeusandworldmaps.com and adapted by M.Z. Ahmed

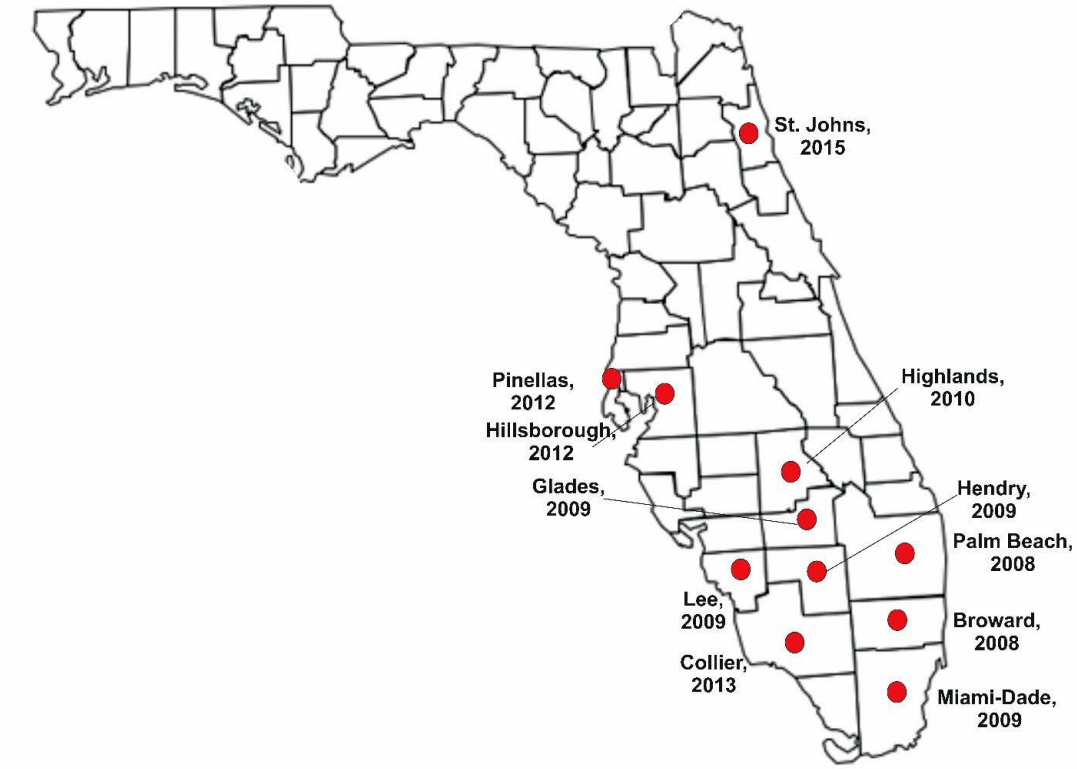

Fig. 2. The geographical distribution of *L. invasa* in Florida including the year of its first report from the respective county. Blank world map source: www.freeusandworldmaps.com and adapted by M.Z. Ahmed

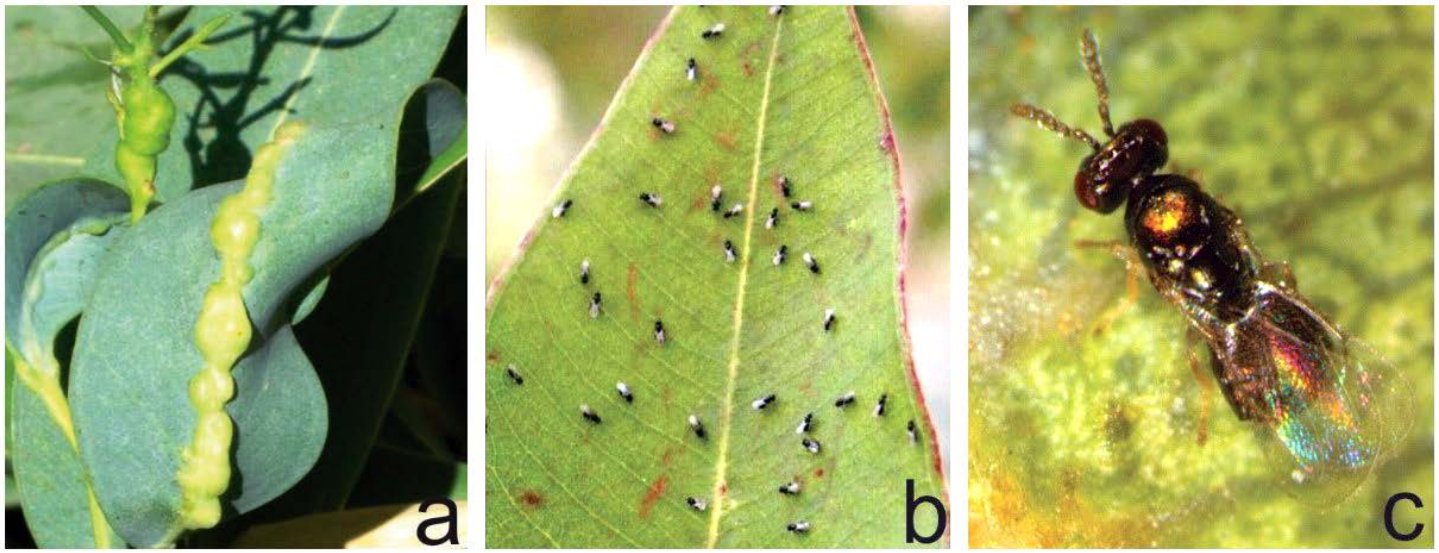

Fig. 3. Pest of eucalyptus, *L. invasa*: (a) larvae inside the gall, (b) pupae inside gall, and (c) freshly emerged adult wasp. Photo credit: NBAIR, India

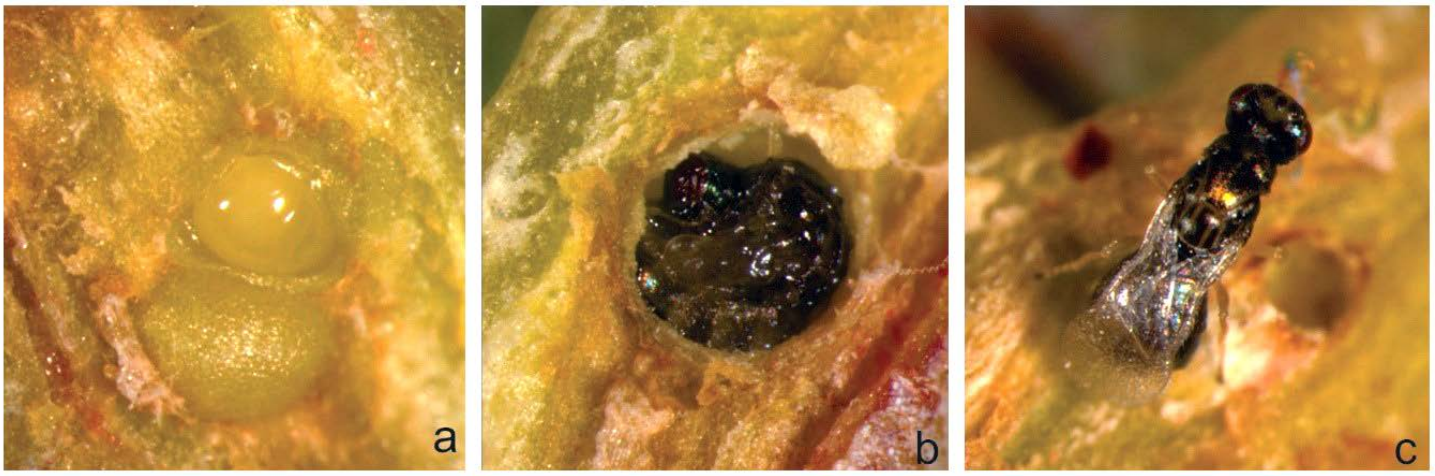

Fig. 4. Pest of eucalyptus, *L. invasa*: (a) wasp induced galls on leaves twigs and stems, (b) adult wasps on ecalyptus leaf, and (c) adult wasp. Photo credit: Agrolink, Italy (a,b) and NBAIR, India (c).

Table 1. The reports of *L. invasa* in the world including their references.

COUNTRY	YEAR	REFERENCE
Italy	2000	(Viggiani et al. 2001)
Turkey	2000	(Aytar 2003)
Egypt	2001	(Wylie and Speight 2012)
Jordan	2001	(Wylie and Speight 2012)
Syria	2001	(Wylie and Speight 2012)
Israel	2001	(Mendel et al. 2004)
Morocco	2001	(Mendel et al. 2004) (Kim et al. 2008)
Algeria	2002	(Mendel et al. 2004)
Ethiopia	2002	(Giliomee 2011)
Kenya	2002	(Mutitu 2003)
Uganda	2002	(Nyeko et al. 2009)
Vietnam	2002	(Thu 2002)
Portugal	2003	(Branco et al. 2006)
Spain	2003	(Sánchez 2003)
Australia	2004	(Fisher and Lasalle 2004)
France	2004	(Wylie and Speight 2012) (EPPO 2006)
Greece	2004	(Wylie and Speight 2012)
Thailand	2004	(Lawson et al. 2012)
Tunisia	2004	(Dhahri and Jamaa 2010)
Iran	2005	(Hesami et al. 2005)
Tanzania	2005	(Roux 2005)
Malta	2006	(Mifsud 2012)
U.K.	2006	(Wylie and Speight 2012)
Brazil	2007	(Costa et al. 2008)
China	2007	(Wu et al. 2009)
India	2007	(Kumar et al. 2007) (Kumari 2010)
South Africa	2007	(Dittrich-Schroder et al. 2014)
Zimbabwe	2007	(MENRM 2010)
Laos	2008	(Thu et al. 2009)
Malawi	2008	(FRIM 2010)
USA	2008	(Wiley and Skelley 2008)
Argentina	2009	(Aquino et al. 2011)

COUNTRY	YEAR	REFERENCE
Chile	2010	(Wylie and Speight 2012)
Iraq	2010	(Hassan 2012)
Sri Lanka	2010	(Karunaratne et al. 2010)
Taiwan	2010	(Sangtongpraow et al. 2011)
Malaysia	2012	(Lawson et al. 2012)
Mozambique	2012	(IPPC 2012)

LITERATURE CITED

Aquino, D., E. Botto, M. Loiacono, and P. Pathauer. 2011. Avispa de la agalla del eucalipto, *Leptocybe invasa* Fischer & La Salle (Hymenoptera: Eulophidae: Tetrastichinae), en Argentina. RIA / Trabajos en prensa, 1-6.

Aytar, F. 2003. Natural biology, distribution and control method of *Leptocybe invasa* Fisher & La Salle (Hymenoptera Eulophidae), eucalyptus gall wasps in Turkey. Journal of DOA 8**:** 47-66.

Branco, M., J. Franco, C. Valente, and Z. Mendel. 2006. Survey of eucalyptus gall wasps (Hymenoptera: Eulophidae) in Portugal. Boletín de sanidad vegetal Plagas 32**:** 199-202.

Cabi. 2016. Leptocybe invasa. Invasive Species Compendium**.** [Accessed 4 October 2017]

Costa, V., F.E. Berti, C. Wilcken, and J. Stape. 2008. Eucalyptus gall wasp, *Leptocybe invasa* Fisher & La Salle (Hymenoptera: Eulophidae) in Brazil: New forest pest reaches the New World. Revista de Agricultura (Piracicaba) 83**:** 136-139.

Dhahri, S., and M. Jamaa. 2010. First Record of *Leptocybe invasa* and *Ophelimus maskelli*, eucalyptus gall wasps in Tunisia. Tunisian Journal of Plant Protection 5**:** 229-234.

Dittrich-Schroder, G., M. Harney, S. Neser, T. Joffe, S. Bush, B.P. Hurley, M.J. Wingfield, and B. Slippers. 2014. Biology and host preference of *Selitrichodes neseri*: A potential biological control agent of the eucalyptus gall wasp, *Leptocybe invasa*. Biological Control 78**:** 33-41.

EPPO, 2006. First report of two new eucalyptus pests in the South of France. NPPO of France, 2006-05. [Accessed 4 October 2017]

Fisher, N., and J. Lasalle. 2004. In: Mendel et al. 2004. The taxonomy and natural history of *Leptocybe invasa* (Hymenoptera: Eulophidae) gen. & sp. nov., an invasive gall inducer on eucalyptus. Australian Journal of Entomology 43**:** 101-113.

FRIM, 2010. Biodiversity in Malawi. Convention on Biological Diversity. [Accessed 4 October 2017]

Gaskill, D. A., S. E. Hung, and T. R. Smith. 2009. 2009 Florida CAPS blue gum chalcid survey report. Florida Cooperative Agricultural Pest Survey, Program Report No. 2009-03-BGCW-01. (Accessed 22 December 2017)

Giliomee, J.H. 2011. Recent establishment of many alien insects in South Africa – a cause for concern. African Entomology 19**:** 151-155.

Hassan, F.R. 2012. First record of the eucalyptus gall wasp, *Leptocybe invasa* Fisher and La Salle (Hymenoptera: Eulophidae), in Iraq. Acta Agrobotanica 65**:** 93-98.

Hesami, S., H. Alemansoor, and S. Seyedebrahimi. 2005. Report of *Leptocybe invasa* (Hym.: Eulophidae), gall wasp of *Eucalyptus camaldulensis* with notes on biology in Shiraz Vicinity. Journal of Entomological Society of Iran 24**:** 99-108.

IPPC. 2012. Occurrence of eucalyptus gall wasp *Leptocybe invasa* in Mozambique. Report No. MOZ-02/2. [Accessed 4 October 2017]

Karunaratne, W., J. Edirisinghe, and K. Ranawana. 2010. Rapid survey of damage due to gall wasp infestation in a coppiced *Eucalyptus camaldulensis* plantation in Maragamuwa, Naula in the Matale District of Sri Lanka. Ceylon Journal of Science (Biological Sciences) 39**:** 157-161.

Kumari, N.K. 2010. Bioecology and management of eucalyptus gall wasp, *Leptocybe invasa* Fisher & La salle (Hymenoptera: Eulophidae). Master's Thesis, University of Agricultural Sciences, Bangalore, India. [Accessed 4 October 2017]

Kelly, J., J. La Salle, M. Harney, G. Dittrich-Schroder, and B. Hurley. 2012. *Selitrichodes neseri* n. sp., a new parasitoid of the eucalyptus gall wasp *Leptocybe invasa* Fisher & La Salle (Hymenoptera: Eulophidae: Tetrastichinae). Zootaxa 50-57.

Kim, I.K., Z. Mendel, A. Protasov, D. Blumberg, and J. La Salle. 2008. Taxonomy, biology, and efficacy of two Australian parasitoids of the eucalyptus gall wasp, *Leptocybe invasa* Fisher & La Salle (Hymenoptera: Eulophidae: Tetrastichinae). Zootaxa 1-20.

Kumar, S., S. Kant, and T. Emmanuel. 2007. Emergence of gall inducing insect *Leptocybe invasa* (Hymenoptera: Eulophidae) in Eucalyptus plantations in Gujarat, India. Indian Forester 133**:** 1566-1568.

Lawson, S., M. Griffiths, H. Nahrung, A. Noack, M.C.W. Wingfield, B. Slippers, N. Lo, P. Thu, S. Lee, N. Lelana, S. Ketphanh, X. Zhou, and S. Eungwijarnpanya. 2012. Biological control of eucalypt pests overseas and in Australia. Report Australian Centre for International Agricultural Research (ACIAR), ISBN 9781922137173. [Accessed 4 October 2017]

Mendel, Z., A. Protasov, N. Fisher, and J. La Salle. 2004. Taxonomy and biology of *Leptocybe invasa* gen. & sp n. (Hymenoptera: Eulophidae), an invasive gall inducer on eucalyptus. Australian Journal of Entomology 43**:** 101-113.

MENRM. 2010. Ministry of Environment & Natural Resources Management, Zimbabwe's fourth national report to the convention on biological diversity. MENRM, Harare, Zimbabwe. [Accessed 4 October 2017]

Mifsud, D. 2012. *Leptocybe invasa* Fisher & La Salle, 2004 and *Ophelimus maskelli* Haliday, 1844-two new records of gall forming Eulophidae from Malta (Hymenoptera, Chalcidoidea). Bulletin of Entomological Society of Malta 5**:** 189–193.

Mutitu, K. E., L. Mwangi, B. Otieno, and M. Minjire. 2003. Pests and Diseases Associated with Eucalyptus in Kenya. Kenya Forest Research Institute, Research Note No. 7, ISSN 2070-2450. [Accessed 4 October 2017]

Nugnes, F., M. Gebiola, M.M. Monti, L. Gualtieri, M. Giorgini, J.G. Wang, and U. Bernardo. 2015. Genetic Diversity of the Invasive Gall Wasp *Leptocybe invasa* (Hymenoptera: Eulophidae) and of its *Rickettsia* Endosymbiont, and Associated Sex-Ratio Differences. PloS one 10**:** 19.

Nyeko, P., E.K. Mutitu, and R.K. Day. 2009. Eucalyptus infestation by *Leptocybe invasa* in Uganda. African Journal of Ecology 47**:** 299-307.

Roux, J. 2005. Pest alert – Blue gum chalcid. Tree Protection News. [Accessed 4 October 2017]

Sánchez, I. 2003. Descubiertas dos nuevas plagas del eucalipto en España. Quercus 214**:** 32-33.

Sangtongpraow, B., K. Charernsom, and S. Siripatanadilok. 2011. Longevity, fecundity and development time of eucalyptus gall wasp, *Leptocybe invasa* Fisher and La Salle (Hymenoptera: Eulophidae) in Kanchanaburi Province, Thailand. Thai Journal of Agricultural Science 44**:** 155-163.

Thu, P. 2002. The first record of gall forming wasp associated with eucalypt plantations in Vietnam. Journal of Agriculture and Rural Development in the Tropics and Subtropics 11**:** 1598-1599.

Thu, P., B. Dell, and T. Burgess. 2009. Susceptibility of 18 eucalypt species to the gall wasp *Leptocybe invasa* in the nursery and young plantations in Vietnam. Science Asia 35**:** 113-117.

Viggiani, G., S. Laudonia, and U. Bernardo. 2001. The increase of insect pests in eucalyptus. Informatore-Agrario. 58**:** 86-87.

Wiley, J., and P. Skelley. 2008. A eucalyptus pest, *Leptocybe invasa* Fisher and LaSalle (Hymenoptera: Eulophidae), Genus and Species New to Florida and North America. Pest Alert DPI-FDACS. [Accessed 4 October 2017]

Wu, Y., X. Jiang,, D. Li, J. Luo, G. Zhou, M. Chang, and Z. Yang. 2009. *Leptocybe invasa*, a new invasive forest pest making galls on twigs and leaves of eucalyptus trees in China. Scientia Silvae Sinicae 45**:** 161-163.

Wylie, F., and M. Speight. 2012. Insect pests in tropical forestry. Cabi. 2nd ed., CPI group Ltd, Croydon, UK