

Rapid Communication

Alien *Limnobium laevigatum* (Humb. & Bonpl. ex Willd.) Heine (Hydrocharitaceae) becoming prevalent in Zimbabwe and Zambia

Geoffrey W. Howard^{1,*}, Mark A. Hyde² and Mike G. Bingham³

¹31 Esplanade, Port Willunga, 5173 Australia

²29 Harry Pichanick Drive, Alexandra Park, Harare, Zimbabwe

³Private Bag 31, Woodlands, Zambia

E-mail addresses: geoffreyhoward44@gmail.com (GH), mahyde@gmail.com (MH), mgbinghamzambia@gmail.com (MB)

*Corresponding author

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Abstract

Limnobium laevigatum (Hydrocharitaceae) is a freshwater plant indigenous to Central and South America, which has become naturalized and invasive in parts of North America, Asia and Australia and has been detected in Southern Africa. Populations have been found in Zimbabwe and Zambia over the last eleven years and we warn of its likely spread to other parts of Africa and the likelihood of it becoming invasive in tropical Africa.

Key words: floating freshwater plants, invasive aquatic plants, river and lake-edge floating plants, Zambezi River catchment

Introduction

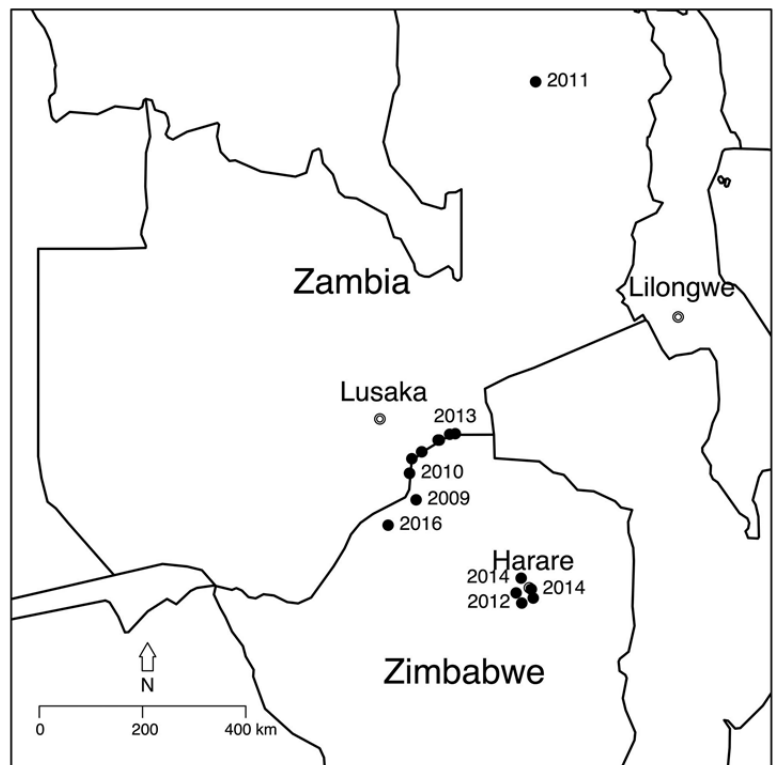
Limnobium laevigatum (Humb. & Bonpl. ex Willd.) Heine (South American Spongeplant or Amazon Frogbit) is a fleshy New World freshwater herb in the family Hydrocharitaceae that floats on the water surface and also grows submerged or partly submerged or emergent. It is native to mainly tropical areas of Central and South America and is reported to range from central areas of Mexico to northern parts of Argentina (Cook and Urmi-Konig 1983). It is thought to have a distinct and non-overlapping natural distribution with *Limnobium spongia* (Bosc) Rich ex Steud., which is a native of the USA, especially in the southern subtropical areas, but also further north in some temperate locations (Cook and Urmi-Konig 1983). In 1992, *L. laevigatum* was described as a subspecies of *L. spongia*: *Limnobium spongia* (Bosc) Steud., subsp. *laevigatum* (Humb. & Bonpl. ex Willd.) Lowden (Lowden 1992), but in more recent texts (such as Cook 1996; DiTomaso and Healy 2003; The Plant List 2013) it is referred to as a full species. The two species of *Limnobium* do not overlap in their natural distributions, but *L. laevigatum* has become established in several places

in the southern USA, where it has become invasive in some circumstances. In California, it has been described as “with potential to be as bad an aquatic pest as water hyacinth (or possibly worse)” (Tidwell and O’Donnell 2010).

Limnobium laevigatum has become a favourite freshwater aquarium plant, which may explain the recent spread of this South American species to parts of North America (Gaimari and O’Donnell 2009), Japan (Perryman 2013), Eastern Australia (The Atlas of Living Australia 2015), and now Africa. The link between the spread of this species and the freshwater aquarium trade, as a likely pathway for invasion, was noted after *L. laevigatum* was discovered in an urban waste water drain, in 2003, in a suburb of Perth, Western Australia (SERCUL 2013).

The present report describes the first records of naturalised *L. laevigatum* on the African continent that are available to us to date. The first recorded appearance of this plant in Africa was in 2005, when it was recognized as a new species of water plant in Zimbabwe by Professor Brian Marshall. It was found in Lake Chivero, a water supply impoundment close to Harare, and was finally identified as *Limnobium laevigatum* in 2009 (Hyde 2010a, b).

Figure 1. Map of part of Southern Africa, focusing on Zambia and Zimbabwe, and showing the main collection sites (and dates) of *Limnobium laevigatum*. Open circles are towns and cities, closed (black) circles are collection sites (the open circle for the capital of Zimbabwe, Harare, is amongst the closed circles around Harare). For details see Supplementary material Table S1.



Methods

Following the discovery of the Amazon Frogbit growing on the edge of water bodies near Harare, Zimbabwe, and in Charara Bay, on the southern edge of Lake Kariba (also in Zimbabwe), several further records were collected and recorded in the Flora of Zimbabwe (Hyde et al. 2015) and the Flora of Zambia (Bingham et al. 2015). The present report has gathered and collated this data in order to prepare an initial map of the present known distribution of this alien South American plant in central-southern Africa.

In order to assess more detailed aspects of the distribution, habitat, life-form and extent of this plant in the Zambezi Valley, a field trip was performed in October 2013, to the Zambezi River, Eastern Zambia. Physical collections and examinations, on-site photography and noted descriptions of the localities were done. Further, relative density of the plants was registered, especially in relation to water hyacinth (*Eichhornia crassipes* (Mart.) Solms), a long-term alien resident of the middle Zambezi River. Searches for any different life stages of *L. laevigatum*, to determine whether it has flowered in this part of its new habitat, were also done.

Results

Records to date

Published and unpublished records of *L. laevigatum* in Africa have so far been limited, despite extensive literature and personal contact searches, and all of these are within Zambia and Zimbabwe (Figure 1, Supplementary material Table S1). We found no records of this species outside these two countries, although there is one record from northern Zambia (Kennedy et al. 2016; Figure 1), which could indicate its likely presence in neighboring countries such as Tanzania or the Democratic Republic of Congo.

To date, no flowers have been found on any of the specimens seen or collected in Africa. The plant's specific identity was deduced from the general morphology of the available specimens and the initial identification was verified by Prof. J.J. Symoens. There is no doubt that this is a species of *Limnobium* (as characterized by the "spongy" undersurface of the younger leaves), so the uncertainty was between the two known species. This verification was followed by detailed examination of illustrated structures, especially the leaf shapes, spongiform undersides, and vegetative reproduction. The identification was

corroborated by the “Aquarium and Pond Plants of the World”, by USDA Animal and Plant Health Inspection Service’s 2015 Identification Technology, Edition 2.1 (USDA Animal and Plant Health Inspection Service 2015), which has numerous images of the various aspects and parts of the two *Limnobium* species, prepared for non-experts interested in wetland and aquarium plants.

L. laevigatum looks superficially like water hyacinth and has been found in several locations together with (or very near) water hyacinth—including the premises of a Government Department in Harare, Zimbabwe, where the two species were noted growing together in a research culture (GH pers. obs., 2011). In addition, several situations were observed along the Zambian shores of the middle Zambezi River where the young plants of the two species were growing in relatively close proximity, but both freely-floating and subject to movements by wind and water currents.

Life forms detected

All of the specimens of *L. laevigatum* recorded in this study were in a vegetative condition. These ranged from single new small plants with two initial leaves (Figure 2), to large multiple plants with lateral growths (ramets) producing new plants (Figure 3) that eventually separate. They have also been observed in very large masses, especially in quiet bays and interstices of the banks of streams and water bodies (Figure 4). Other accumulations have formed classical “floating islands” entirely of this species, or together with other common water plants such as water hyacinth and the native water grass *Vossia cuspidata* (Roxb.) Griff., both of which regularly form floating islands in lakes and rivers in Africa. An example of such a “floating island” of *L. laevigatum* and *V. cuspidata*, found on the Zambian side of the middle Zambezi, is illustrated in Figure 5. This phenomenon has been noted for water hyacinth and the other species of *Limnobium* (*L. spongia*), which form joint floating islands in Florida (Mallison et al. 2001).

Discussion

There is no doubt that *L. laevigatum* is well-established in the Zambezi River, downstream from Lake Kariba and on the edge of the lake, as well as in at least two peri-urban water bodies in Harare, Zimbabwe. The absence of a larger number of records in the area is surprising, as both Lake Kariba and the Zambezi River straddle an international border and are utilized extensively by fishermen, so are likely to be infested far beyond the few records registered here.



Figure 2. A new small plant of *Limnobium laevigatum*, with two almost-circular initial leaves, showing the spongiform texture on the underside of the larger leaf and the start of the next pair of shoots, with the submerged roots with root hairs clearly visible. Photo GH.



Figure 3. Young *Limnobium laevigatum* plant (LHS) with a younger plant produced from a ramet (RHS). Scale: pen length 12.5 cm. Photo GH.

Figure 4. A dense mat of *L. laevigatum* on the edge of a backwater of the Zambezi River, in Lower Zambezi National Park, Zambia. Photo GH.



Figure 5. A “floating island” of *L. laevigatum*, and the grass *Vossia cuspidata*, in the mainstream of the Zambezi River, Zambia. Photo GH.



This may be because both water hyacinth and *L. laevigatum* are superficially similar in their juvenile stages. Both species, when in high density and growing close together, change their form from lateral petioles and leaf laminas to vertical petioles and leaf laminas (Gopal 1987; Cunha et al. 2012). It is likely that *L. laevigatum* has already spread further, but has not been recognized as a distinct and new addition to the water plants of tropical Africa.

While *L. laevigatum* has been shown to be only slightly “aggressive” in competition with other floating water plants in its native South America (Milne et al. 2007), it has the potential to be invasive in freshwaters outside its natural range. These include southern USA (Akers 2010; Perryman 2013), Western Australia (SERCUL 2013), Eastern Australia (Hawkesbury River County Council 2014) and Japan (Kadono 2004). The USA infestation in California is regarded as serious, as the plant has dominated all other floating vegetation in some areas, resulting in

the preparation of a Weed Risk Assessment that details significant invasion and defines the species as a noxious weed (USDA Animal and Plant Health Inspection Service 2013).

It is likely that original introductions of *L. laevigatum* have occurred through aquariums, as there is a well-developed trade and use of this species as an attractive and useful plant (e.g. aquarium plant websites). It is also likely that, in the future, downstream flow in the Zambezi River may carry this species beyond the Cahora Bassa dam in Mozambique and assist its spread into riverine and lake systems beyond Zambia and Zimbabwe. Additionally, it is possible that *L. laevigatum* could travel upstream in the tributaries of the Zambezi facilitated by movements of water birds or fishermen and their fishing gear and boats, in much the same way as water hyacinth did from the Zambezi Valley to the Shire River (in Malawi) and then into Lake Malawi over a period of 27 years (Terry 1996). In this way,

L. laevigatum may move to other water bodies and streams in the catchment of the Zambezi River and so to nearby wetlands and lakes with high diversity and unique freshwater species, such as Lake Malawi and Lake Tanganyika. We therefore believe that there is an urgent need to detect and map the present range of *L. laevigatum* in the tropical and sub-tropical freshwaters of central and southern Africa, to prepare for possible serious invasions and to find ways to both prevent its spread and manage any established invasions. We are not aware of any means of biological control of this species under such conditions, nor of any kind of recommendations for other forms of control in African environments: this needs to be addressed as soon as possible.

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Supplementary material

The following supplementary material is available for this article:

Table S1. Localities of collections of *Limnobiium laevigatum*.

This material is available as part of online article from:

http://www.reabic.net/journals/bir/2016/Supplements/BIR_2016_Howard_et_al_Supplement.xls