УДК 582

DO WETLAND VASCULAR PLANTS INTRODUCED IN MOROCCO ALSO BECOME INVASIVE?

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Received August 5, 2023; Revised January 20, 2024; Accepted February 25, 2024

The propagation of exotic species is a complex process influenced by taxa-specific factors, in addition to climate and anthropozoogenic activities. However, the introduction of plants outside their native range does not always lead to their naturalization and/or the invasion of native ecosystems. Once non-native species have become established, they become extremely difficult to eradicate or control. Moroccan wetlands are crucial to the conservation of biodiversity, but they are susceptible to invasive hygrophilous plants. The invasive potential of introduced hygrophytes in Morocco was assessed through an extensive documentation review on their distribution, biology, ecology, uses, considering both their updated scientific names and their synonymy. Three groups of hygrophytes with varying invasive potential have been identified, based on their bioclimatic distribution, intrinsic propagation ability and use. The high invasiveness group (species with high invasiveness in other countries) includes *Populus nigra* L., *P. alba* L., *Cotula coronopifolia* L., *Gomphocarpus fruticosus* (L.) W.T. Aiton, and *Arundo donax* L. With the exception of *Cotula coronopifolia*, which is naturalized in Morocco, none of other highly invasive in other countries species has reached naturalized and/or invasive status. The status of these introduced hygrophytes in Morocco, as well as those with moderate (*Heliotropium curassavicum* L., *Cotula anthemoides* L., *Pistia stratiotes* L., *Cyperus eragrostis* Lam., and *Paspalum distichum* L.) or low invasive potential [*Azolla filiculoides* Lam., *Modiola caroliniana* (L.) G. Don, *Salix babylonica* L., *Asclepias curassavica* L., *Eclipta prostrata* (L.) L., *Triglochin striata* Ruiz & Pav., and *Eichhornia crassipes* (Mart.) Solms], is compared with that of other regions of the world. Although *Pistia stratiotes* has invaded wetlands in several regions, its invasion is currently limited in Morocco due to environmental and management factors. As a result, more botanical studies of Moroccan wetlands are needed, as many introduced species are currently poorly known and their status may change, while new introduced hygrophytes may also be encountered. Assessing the invasive potential of introduced hygrophytes will enable in part the implementation of proactive measures to better protect local wetlands against invasive species.

Keywords: Hygrophytes, Invasive potential, Plant distribution, Plant use
DOI:10.35885/1996-1499-17-1-151-154

Full text of the paper is published in Russian Journal of Biological Invasions. DOI: 10.31857/S207511172104XXXYYY/

References

Al-Snafi, A.E., The constituents and biological effects of *Arundo donax* – A review, Int. J. Phytopharm. Res., 2015, vol. 6, no. 1, pp. 34-40.

APB, African Plant Database (version 3. 4. 0), Conservatoire et Jardin botaniques de la Ville de Genève and South African National Biodiversity Institute, Pretoria. http://www.ville-ge. ch/musinfo/bd/cjb/africa/. Accessed on July 2022.

Barbosa, G.C., Silva, M.F.S., Oliveira, F.C.E., Oliveira, M.C.P., Mayo, S.J., and Andrade, I.M., Germination and seedling development in *Pistia stratiotes* L., Int. J. Aquat. Biol., 2019, vol. 7, no. 6, pp. 322–331. https://doi.org/10.22034/ijab.v7i6.713

Bellard, C., Cassey, P., and Blackburn, T.M., Alien species as a driver of recent extinctions, Biol. Lett., 2016, vol. 12, no.2, pp. 20150623. http://doi.org/10.1098/rsbl.2015.0623

Bellard, C., Thuiller, W., Leroy, B., Genovesi, P., Bakkenes, M., and Courchamp, F., Will climate change promote future invasions?,Glob. Chang. Biol., 2013, vol. 19, no. 12, pp. 3740–3748. https://doi.org/10.1111/gcb.12344

Blackburn, T.M., Pyšek, P., Bacher, S., Carlton, J.T., Duncan, R.P., Jarošík, V., Wilson, J.R.U., and Richardson, D.M., A proposed unified framework for biological invasions, TrendsEcolEvol., 2011, vol.26,no.7, pp.333–339. https://doi.org/10.1016/j.tree.2011.03.023

Bradley, B.A., Wilcove, D.S., and Oppenheimer, M., Climate change increases risk of plant invasion in the Eastern United States, Biol. Invasions, 2010, vol. 12, no. 16, pp. 1855–1872. https://doi.org/10.1007/s10530-009-9597-y

Byun, C., Blois, S., and Brisson, J., Management of invasive plants through ecological resistance, Biol. Invasions, 2018, vol. 20, no. 1, pp. 13–27. https://doi.org/10.1007/s10530-017-1529-7

CABI, Centre for Applied Bioscience International-Compendium. https://www.cabidigitallibrary.org. Accessed on July 2022.

Carr, C., Plant Fact Sheet for Knotgrass (*Paspalum distichum*), USDA-Natural Resources Conservation Service, James E. "Bud" Smith Plant Materials Center, Knox City, 2010, TX 79529

Catford, J.A., Hydrological impacts of biological invasions, in Impact of biological invasions on ecosystem services, Vilà, M. and Hulme, P., Eds., Cham: Springer, 2017, pp. 63-80. http://dx.doi.org/10.1007/978-3-319-45121-3_5

Caudullo, G. and de Rigo, D., Populus alba in Europe: distribution, habitat, usage and threats, in European atlas of forest tree species, San-Miguel-Ayanz, J., de Rigo, D., Caudullo, G., Houston Durrant, T., and Mauri, A., Eds., Luxembourg: Publ. Off. EU, 2016, pp. e010368+

Chadli, C., Libiad, M., Khabbach, A., Bouslamti, R., and Ennabili, A., Functional aspects of *Pistiastratiotes*, an invasive plant of Al Jawahir (Fez) wadi lentic habitats, Bot. Complut., 2022, vol. 46, pp. e80494. https://doi.org/10.5209/bocm.80494

Chadli, C., Mardi, L., Boualam, O., Bouslamti, R., and Ennabili, A., Experimental control tests of *Pistiastratiotes*L., an invasive aquatic plant of lentic habitats (Fez, Morocco), Sci. Afr., 2023, vol. 21, pp. e01775. https://doi.org/10.1016/j.sciaf.2023.e01775

Dickmann, D.I. and Kuzovkina, J., Poplars and willows of the world, with emphasis on silviculturally important species, in Poplars and willows: Trees for society and the environment, UK: CABI, Wallingford, 2014, pp. 8–91. https://doi.org/10.1079/9781780641089.0008

Ennabili A, Nabil L, Ater M., Importance socio-économique des hygrophytes au Nord-ouest du Maroc. Al Biruniya, Rev. Maroc. Pharmacogn. Etudes Ethnoméd. Bot. Appl., 1996, vol. 12, no. 2, pp. 95-120. https://doi.org/10.6084/m9.figshare.12941951.v1

Ennabili, A. and Radoux, M., Nitrogen and phosphorus uptake and biomass production in four riparian plants grown in subsurface flow constructed wetlands for urban wastewater treatment, J. Environ. Manage., 2021, vol. 280, pp. 111806. https://doi.org/10.1016/j.jenvman.2020.111806

Ennabili, A., Libiad, M., and Khabbach., A., Importance of wetlands in maintaining the richness of Morocco's vascular flora, Wetl., 2021, vol. 41, no. 121, pp. 1–10. https://doi.org/10.1007/s13157-021-01517-3

Ennabili, A., Végétation hygrophile du Maroc Méditerranéen: écologie, socio-économie et rôle potentiel dans l'épuration des eaux usées, Dissertation, University of Liège, 1999. https://doi.org/10.13140/RG.2.2.15553.79209

EPPO, European and Mediterranean Plant Protection Organization. Data sheets on pests recommended for regulation: *Pistiastratiotes* L., EPPO Bull., 2017, vol. 47, no. 3, pp. 537–543. https://doi.org/10.1111/epp.12429

Fennane, M., Ibn Tattou, M., Mathez, J., Ouyahya, A., El Oualidi, J., Flore pratique du Maroc-Manuel de détermination des plantes vasculaires, Trav. Inst. Sci. Univ. Mohammed V, Sér. Bot., 1999, vol. 1, no. 36.

Fernández-Zamudio, R., García-Murillo, P., and Cirujano, S., Germination characteristics and sporeling success of *Azollafiliculoides* Lamarck, an aquatic invasive fern, in a Mediterranean temporary wetland, Aquat. Bot., 2010, vol. 93, no. 2, pp. 89–92. http://dx.doi.org/10.1016/j.aquabot.2010.03.011

Gallardo, B. and Aldridge, D.C., The "dirty dozen": socio-economic factors amplify the invasion potential of 12 high-risk aquatic invasive species in Great Britain and Ireland, J. Appl. Ecol., 2013, vol. 50, no. 3, pp. 757–766. https://doi.org/10.1111/1365-2664.12079

Gilman, E.F., Klein, R.W., and Hansen, G., *Asclepiascurassavica* butterfly weed, milkweed, silkweed, Environmental Horticulture Department, UF/IFAS Extension, 2018, FPS-491. https://doi.org/10.32473/edis-fp049-1999

Gioria, M. and Osborne, B.A., Resource competition in plant invasions: emerging patterns and research needs, Front. Plant Sci., 2014, vol. 5, no. 501, pp. 1–21. https://doi.org/10.3389/fpls.2014.00501

GISD, Global Invasive Species Database, Species profile: *Arundodonax*. http://www.iucngisd.org/gisd/species.php?sc=112 on 04-08-2023. Accessed on April 13, 2023.

Goodwin, B.J., McAllister, A.J., and Fahrig, L., Predicting invasiveness of plant species based on biological information, Conserv. Biol., 1999, vol. 13, no. 2, pp. 422–426. https://doi.org/10.1046/j.1523-1739.1999.013002422.x

Gopika, G., Kumar, V.A., and Prabhu, G.N., Extraction of natural dye from the flowers of *Eichhorniacrassipes*, Indian J. Sci. Res., 2018, vol. 20, no. 1, pp. 63–67.

Haddadchi, A., Gross, C.L., and Fatemi, M., The expansion of sterile *Arundodonax* (Poaceae) in southeastern Australia is accompanied by genotypic variation, Aquat. Bot., 2013, vol. 104, pp. 153–161. http://dx.doi.org/10.1016/j.aquabot.2012.07.006

Hegazy, A., Mussa, S., and Farrag, H., Invasive plant communities in the Nile Delta coast, Glob. J. Environ. Res., 2008, vol. 2, no. 1, pp. 53–61.

Hegazy, A.K., Trade-off between sexual and vegetative reproduction of the weedy *Heliotropiumcurassavicum*, J. Arid Environ., 1994, vol. 27, no. 3, pp. 209–220.

Hellmann, J.J., Byers, J.E., Bierwagen, B.G., and Dukes, J.S., Five potential consequences of climate change for invasive species, Conserv. Biol., 2008, vol. 22, no. 3, pp. 534–543. https://doi.org/10.1111/j.1523-1739.2008.00951.x

Hill, M.P. and Cilliers CJ, A review of the arthropod natural enemies, and factors that in-fluence their efficacy, in the biological control of the water hyacinth, *Eichhorniacrassipes* (Mart.) Solms-Laubach (Pontederiaceae) in South Africa, in Biological control of weeds in South Africa (1990–1998), Olckers, T. and Hill, M.P., Eds., Pretoria: The Entomological Society of South Africa, 1999, pp. 103–112.

Hill, M.P., The potential for the biological control of the floating aquatic fern *Azollafiliculoides* Lamarck (red water fern/rooivaring) in South Africa. Report to the Water Research Commission by the Plant Protection Research Institute Agricultural Research Council, WRC Report No. KV 100/97, 1997.

Hong, S.H., Lee, Y.H., Lee, G., Lee, D.H., and Adhikari, P., Predicting impacts of climate change on Northward range expansion of invasive weeds in South Korea, *Plants*, 2021, vol. 10, no. 8, pp. 1604. https://doi.org/10.3390/plants10081604

Howard, G.W. and Matindi, S.W., Alien invasive species in Africa's wetlands: some threats and solutions, Gland (Switzerland): IUCN, 2003.

Hulme, P.E. Trade, transport and trouble: managing invasive species pathways in an era of globalization, J. Appl. Ecol., 2009, vol. 46, no. 1, 2009, pp. 10–18. https://doi.org/10.1111/j.1365-2664.2008.01600.x

IUCN, International Union for Conservation of Nature, Red List of Threatened Species. Version 2022-2. http://www.iucnredlist.org. Accessed on July 2022.

Janes, R., Growth and survival of *Azollafiliculoides* in Britain I. Vegetative production, New. Phytol., 1998, vol. 138, no. 2, pp. 367–375. https://doi.org/10.1046/j.1469-8137.1998.00114.x

Jeričević, M. and Jeričević, N. *Ecliptaprostrata* (L.)L. a new alien species in Croatian flora, Nat. Croat., 2017, vol. 26, no. 1, pp. 105–108. https://doi.org/10.20302/NC.2017.26.8

Karmiris, I., Platis, P., Kazantzidis, S., and Papachristou, T.G., Habitat use by free grazing water buffaloes at the Kerkini Lake, in Ecosystem services and socio-economic benefits of Mediterranean grasslands, Kyriazopoulos, A.P., López-Francos, A., Porqueddu, C., and Sklavou P., Eds., Zaragoza (Spain): CIHEAM, Options Méditerranéennes : Série A. SéminairesMéditerranéens; n. 114, 2016, pp. 151-154.

Keller, H.A., Delucchi, G., Agnolin, A.M., Agnolin, F.L., and Hurrell, J.A., The genus *Gomphocarpus*(Apocynaceae: Asclepiadoideae) in Argentina, Bonplandia, 2021, vol. 30, no. 2, pp. 161–168. http://dx.doi.org/10.30972/bon.3024941

Khabbach, A., Libiad, M., and Ennabili, A., An updated checklist of the wetland vascular flora from Morocco, Moroc. J. Biol., 2020, vol. 17, pp. 1–35. https://doi.org/10.6084/m9.figshare.12937823.v3

Khabbach, A., Libiad, M., and Ennabili,A., Invasion increasing risk of Al JawahirWadi lentic habitats by *Pistiastratiotes* L. (North-Central Morocco), Bot. Complut., 2019, vol. 43, pp.97–107. htttps://dx.doi.org/10.5209/bocm.64280.

Khabir, Z.H., Sadeghi, S.E., Hanifeh, S., and Eivazi, A., Investigation on effect of *Populus alba* stands distance on density of pests and their natural enemies population under poplar/alfalfa agroforestry system, Pak. J. Biol. Sci., 2009, vol. 12, no. 2, pp. 192–194. https://doi.org/10.3923/pjbs.2009.192.194

Klein, H., Common brassbuttons, *Cotulacoronopifolia* L., Alaska Natural Heritage Program, University of Alaska Anchorage, 2011. Accessed on July 19, 2022.

Kolar, C.S. and Lodge, D.M., Progress in invasion biology: predicting invaders, Trends Ecol. Evol., 2001, vol. 16, no. 4, pp. 199–204. https://doi.org/10.1016/S0169-5347(01)02101-2

Kösesakal, T. and Yıldız, M., Growth performance and biochemical profile of *Azollapinnata* and *Azollacaroliniana* grown under greenhouse conditions, Arch. Biol. Sci., 2019, vol. 71, no. 3, pp. 475–485. http://dx.doi.org/10.2298/ABS190131030K

Kriticos, D.J. and Brunel, S., Assessing and managing the current and future pest risk from water hyacinth*, (Eichhorniacrassipes)*, an invasive aquatic plant threatening the environment and water security. PLoS One, 2016, vol. 11, no. 8, pp. e0120054. https://doi.org/10.1371/journal.pone.0120054

Mandi, L., Darley, J., Barbe, J. and Baleux, B., Essais d'épuration des eaux usées de Marrakech par la jacinthe d'eau (Charges organique, bactérienne et parasitologique). Rev. Sci. Eau, 1992, vol. 5, no. 3, pp.313–333. https://doi.org/10.7202/705134ar

Mariani, C., Cabrini, R., Danin, A., Piffanelli, P., Fricano, A., Gomarasca, S., Dicandilo, M., Grassi, F., and Soave, C., Origin, diffusion and reproduction of the giant reed (*Arundodonax* L.): A promising weedy energy crop. Ann. Appl. Biol., 2010, vol. 157, no. 2, pp. 191–202. https://doi.org/10.1111/j.1744-7348.2010.00419.x

Meyerson, L.A. and Mooney, H.A., Invasive alien species in an era of globalization, Front. Ecol. Environ., 2007, vol. 5, no. 4, pp. 199–208. https://doi.org/10.1890/1540-9295(2007)5[199:IASIAE]2.0.CO;2

Minogue, P., and Wright, S., Biology, control and invasive potential of giant reed (*Arundodonax* L.) in Florida, Environmental Horticulture Department, UF/IFAS Extension, 2022, FOR328. https://edis.ifas.ufl.edu/publication/FR396. Accessed on July 19, 2022.

Mitchell, C.E., Agrawal, A.A., Bever, J.D., Gilbert, G.S., Hufbauer, R.A., Klironomos, J.N., Maron, J.L., Morris, W.F., Parker, I.M., Power, A.G., Seabloom, E.W., Torchin, M.E., and Vázquez, D.P, Biotic interactions and plant invasions. Ecol. Lett., 2006, vol. 9, no. 6, pp.726–740. https://doi.org/10.1111/j.1461-0248.2006.00908.x

Mokhtari, N., Mrabet, R., Lebailly, P., and Bock, L., Spatialisation des bioclimats, de l'aridité et des étages de végétation du Maroc, Rev. Maroc. Sci. Agron. Vét., 2013, vol. 2, no. 1, pp. 50–66.

Moll, E.J.A Further report on the distribution of introduced plants on Santa Cruz Island, Galapagos.Occasional paper, School of Natural and Rural Systems Management, 1998, vol. 5, no. 1.

MTE2D, Ministère de la Transition Energétique et du Développement Durable, 4ème Communication Nationale du Maroc à la Convention Cadre des Nations Unies sur les Changements Climatiques, 2020. https://unfccc.int. Accessed on July 2023.

Murren, C.J., Auld, J.R., Callahan, H., Ghalambor, C.K., Handelsman, C.A., Heskel, M.A., Kingsolver, J.G., Maclean, H.J., Masel, J., Maughan, H., Pfennig, D.W., Relyea, R.A., Seiter, S., Snell-Rood, E., Steiner, U.K., and Schlichting, C.D., Constraints on the evolution of phenotypic plasticity: Limits and costs of phenotype and plasticity, Hered., 2015, vol. 115, no. 4, pp. 293–301. https://doi.org/10.1038/hdy.2015.8

Naidoo, G., Growth, water and ion relationships in the coastal halophytes *Triglochinbulbosa* and *T. striata,* Environ. Exp. Bot., 1994, vol. 34, no. 4, pp. 419–42. https://doi.org/10.1016/0098-8472(94)90024-8

NCBI, National Center for Biotechnology Information, U.S. National Library of Medicine. https://www.ncbi.nlm.nih.gov. Accessed on July 2022.

Ndhlovu, P.T., Omotayo, A.O., Otang-mbeng, W., and Aremu, A.O., Commercialization potential of six selected medicinal plants commonly used for childhood diseases in south africa: A review, Sustain., 2022, vol.14, no. 1, pp. 17. https://doi.org/10.3390/su14010177

Pilu, R., Bucci, A., Badone, F.C., and Landoni, M., Giant reed (*Arundodonax* L.): A weed plant or a promising energy crop, Afr. J. Biotechnol., 2012, vol. 11, no. 38, pp. 9163–9174. https://doi.org/10.5897/AJB11.4182

Radosevich, S.R., Stubbs, M.M., and Ghersa, C.M., Plant invasions process and patterns, Weed. Sci., 2003, vol. 51, no. 2, pp. 254–259. https://doi.org/10.1614/0043-1745(2003)051[0254:PIPAP]2.0.CO;2

Rakotoarisoa, T.F., Use of water hyacinth (Eichhorniacrassipes) in poor and remote regions-a case study from Lake Alaotra, Madagascar, Dissertation, University of Hildesheim, 2017.

Rezooqi, A.M., Mouhamad, R.S., and Jasim, K.A., The potential of *Azollafiliculoides* for in vitro phytoremediation of wastewater, J. Phys. Conf. Ser., 2021, vol. 1853, pp. 012014. http://dx.doi.org/10.1088/1742-6596/1853/1/012014

Richardson, D.M., Allsopp, N., D'Antonio, C.M., Milton, S.J., and Rejmánek, M., Plant invasions the role of mutualisms, Biol. Rev. Camb. Philos. Soc., 2000a, vol. 75, no. 1, pp. 65–93. https://doi.org/10.1017/S0006323199005435

Richardson, D.M., Pysek, P., Rejmanek, M., Barbour, M.G., Panetta, F.D., and West, C.J., Naturalization and invasion of alien plants: Concepts and definitions, Divers. Distrib., 2000b, vol. 6, no. 2, pp. 93–107. https://doi.org/10.1046/j.1472-4642.2000.00083.x

Sadeghi, R., Zarkami, R., and van Damme, P., Modelling habitat preference of an alien aquatic fern, *Azollafiliculoides* (Lam.), in Anzali wetland (Iran) using data-driven methods. Ecol. Modell., 2014, vol. 284, pp. 1–9. https://doi.org/10.1016/j.ecolmodel.2014.04.003

Şapci, H. and Vural, C., Two new naturalized species of the genus *Cyperus* (Cyperaceae) from Turkey, J. Artvin-Coruh Univ. Facult. For., 2018, vol. 19, no. 1, pp. 35–38. http://dx.doi.org/10.17474/artvinofd.333093

Sax, D.F., Latitudinal gradients and geographic ranges of exotic species: implications for biogeography. *J. Biogeogr*., 2001, vol. 28, no. 1, pp. 139–150.

Sbay, H. and Taroq, M., The culture of the poplar in Morocco Realities and perspectives, International Conference on the Future of Poplar Culture, Rome, November 13-15, 2003.

Simberloff, D., Martin, J.L., Genovesi, P., Maris, V., Wardle, D.A., Aronson, J., Courchamp, F., Galil, B., García-Berthou, E., Pascal, M., Pyšek, P., Sousa, R., Tabacchi, E., and Vilà, M., Impacts of biological invasions: what's what and the way forward. Trends Ecol. Evol., 2013, vol. 28, no. 1, pp. 58–66. https://doi.org/10.1016/j.tree.2012.07.013

Starodubtseva E.A., Morozova, O.V., and Grigorjevskaja, A.J., Materials for the Black Book of Voronezh Oblast. Russ. J. Biol. Invasions, 2014, vol. 5, no. 3, pp. 206–216. https://doi.org/10.1134/S2075111714030114

Thiébaut, G., Non-indigenous aquatic and semiaquatic plant species in France, in Biological invaders in inland waters: Profiles, distribution, and threats, Gherardi, F., Ed., Dordrecht (Netherlands): Springer, 2007, pp. 209–229. https://doi.org/10.1007/978-1-4020-6029-8_11

Thiégba, K.K., sangne, Y.C., Groga, N., and Yatty, K., Comparative growth of *Azollacaroliniana* and *Azollafiliculoides* under the influence of a fertilizing biologique: Filtrate of the chicken droppings (Daloa, Côte d'Ivoire). Int. J. Innov. Sci. R*es*., 2020, vol. 49, no. 1, pp. 188–196.

Thompson, S., Range expansion by alien weeds in the coastal farmlands of Guyana, J. Biogeogr., 1988, vol. 15, pp. 109–118.

Toorn, J., On the ecology of *Cotulacoronopifolia* L. and *Ranunculus sceleratus* L. I. Geographic distribution, habitat, and field observations, Acta Bot. Neerl.,1980, vol. 29, no. 5/6, pp. 385–396. https://doi.org/10.1111/J.1438-8677.1980.TB01244.X

Verloove, F. and Reynders, M., Studies in the genus *Paspalum* (paniceae, poaceae) in Europe — 1. *Paspalumdistichum* subsp. Paucispicatum, an overlooked taxon in France, Willdenowia, 2007, vol. 37, no. 1, pp. 199. http://dx.doi.org/10.3372/wi.37.37109

Weber, E. and Gut, D., Assessing the risk of potentially invasive plant species in central Europe, *J. Nat. Conserv*., 2004, vol. 12, no. 3, pp. 171–179. https://doi.org/10.1016/j.jnc.2004.04.002

WeedUS, Database of Plants Invading Natural Areas in the United States. http://www.invasive.org/weedus/. Accessed on July 2022.

Wibowo, Y.G., Tyaz Nugraha, A., and Rohman, A., Phytoremediation of several wastewater sources using *Pistiastratiotes* and *Eichhorniacrassipes* in Indonesia. Environ. Nanotechnol. Monit. Manag., 2023, vol. 20, pp. 100781. https://doi.org/10.1016/j.enmm.2023.100781

Yao, Y.X., Shang, X.P., Yang, J., Lin, R.Z., Huai, W.X., and Zhao, W.X., Genetic variation may have promoted the successful colonization of the invasive gall midge, *Obolodiplosis robiniae*, in China. Front. Genet., 2020, vol. 11, art. 387. https://doi.org/10.3389/fgene.2020.00387

Yigermal, H., Nakachew, K., and Assefa, F., Distribution, threats and management options for water hyacinth (*Eichhorniacrassipes*) in Ethiopia: A review, J. Res. Weed Sci., 2020, vol. 3, pp. 9–23. https://doi.org/10.26655/JRWEEDSCI.2020.1.2

Young, S.L., Kimball, S., and Novak, S.J., Invasion of Plant Communities, in Global Plant Invasions, Clements, D.R., Upadhyaya, M.K., Joshi, S., and Shrestha, A., Eds., Cham: Springer, 2022, pp. 29–51. https://doi.org/10.1007/978-3-030-89684-3_2

Zedler, J.B. and Kercher, S., Causes and consequences of invasive plants in wetlands: opportunities, opportunists, and outcomes. Crit. Rev. Plant Sci., 2004, vol. 23, no. 5, pp. 431–452, http://dx.doi.org/10.1080/07352680490514673