

EMILIO BADALAMENTI, DARIO CUSIMANO,
TOMMASO LA MANTIA & SALVATORE PASTA

THE RECENT SPREAD OF THE INVASIVE WOODY ALIEN PLANT
MELIA AZEDARACH L. (*Meliaceae*) IN SICILY

SUMMARY

This paper aims at reporting the ongoing process of naturalization of *Melia azedarach* L. in Sicily. In fact, over half a century after the first detection of spontaneous self-sown seedlings, an abrupt increase of naturalization cases has been recorded by the authors during the last twenty years. More in detail, *M. azedarach* successfully colonized many suburban lowland areas along the coasts of the island which are characterised by thermo-Mediterranean bioclimate. According to both field and literature data, a gradual spread of *M. azedarach* in the island can be expected, although it is not possible to predict the speed with which this will occur. Historical information on its introduction at global and local scales and on the traditional use of its seeds is provided, too.

Key-words: Alien flora, biological invasions, Mediterranean, introduction history

RIASSUNTO

La recente diffusione della specie legnosa invasiva Melia azedarach L. (Meliaceae) in Sicilia. Con questo contributo si intende descrivere il processo di naturalizzazione in corso di cui è protagonista *Melia azedarach* L. in Sicilia. Infatti, oltre mezzo secolo dopo la prima segnalazione di plantule nate da seme spontaneamente, gli autori hanno registrato un brusco incremento dei casi di naturalizzazione nel corso dell'ultimo ventennio. Più in dettaglio, *M. azedarach* ha colonizzato con successo molte aree suburbane di bassa quota lungo le coste dell'isola interessate da un bioclimate di tipo termo-mediterraneo. Sulla base dei dati di campo e delle informazioni tratte dalla letteratura consultata, ci si può aspettare una graduale diffusione di *M. azedarach* sull'isola, sebbene non sia possibile prevedere la rapidità con cui tale processo avrà luogo. Vengono inoltre fornite informazioni sulla sua introduzione su scala globale e locale e sull'uso tradizionale dei suoi semi.

Parole-chiave: Flora aliena, invasioni biologiche, Mediterraneo, storia dell'introduzione

FOREWORD

This paper aims at reporting and commenting the ongoing process of naturalization of *Melia azedarach* L. (Meliaceae) in Sicily, preferring urban and suburban coastal areas (e.g. roadsides, artificial water canals, dump places, abandoned quarries, disturbed screes), up to 200 m a.s.l., mostly subject to thermo-Mediterranean climatic conditions (Table 1).

ORIGIN AND ECOLOGY OF *MELIA AZEDARACH*

M. azedarach is considered to be native to S-SE Asia and N Australia (GISD, 2006; CELESTI-GRAPPOW *et al.*, 2009). In China it takes part to mixed broadleaved forest communities, but it also colonizes field edges and roadsides, from 500 m up to 2,100 m a.s.l. (HUA & MABBERLEY, 2008). Plenty of different vernacular names (e.g. Chinaberry tree, Bead tree, Persian lilac) testify the long history of introduction of this medium-sized deciduous tree; for instance, it has been held as sacred in all S Asia from Persia to Malaysia. After about two hundred years of being introduced in other continents, its present distribution range includes many countries with tropical, subtropical and warm-temperate climate of the entire American continent, from Florida to Argentina (LANGELAND & BURKS, 1998; TOURN *et al.*, 1999; ZALBA & VILLAMIL, 2002), Philippines, Hawaii and Cuba (COWEN, 1965) and several areas subject to Mediterranean climate, such as S Africa and some parts of Palestine and N Africa (VILÁ *et al.*, 1999; DANIN, 2000; HENDERSON, 2007). The species requires rather warm average annual temperatures (≥ 18 °C) and no less than 600 mm of yearly rainfall amount (RUSKIN, 1983).

INVASIVE BEHAVIOR AND ECONOMIC IMPACTS

Many are the biological traits of *M. azedarach* which explain its invasive success worldwide. First of all, its fast and effective seed dispersal strategy seems to have played a critical role in the spreading of Chinaberry tree outside its native area. In fact, sexual reproduction starts very early, just 2-3 years after birth, when plants still have a small shrub habit (DIRR, 1998).

Seed production is extremely abundant and mature fruits are released from trees up to 12 months after ripening, thus improving the dissemination performance exploiting the most suitable climatic conditions for germination. Moreover, the seeds maintain viability for more than two years, even under severe dehydration (HONG & ELLIS, 1998). However, the speed and effec-

tiveness of the invasive process achieved by *M. azedarach* is strongly influenced by the abundance and the variety of disseminators which feed on its fleshy drupes, i.e. small mammals for short distances, or birds and bats for longer distances (BATCHER, 2000; VOIGT *et al.*, 2011). Thank to its ability to re-sprout both from damaged stumps and roots, *M. azedarach* is able to form dense and extensive clonal stands in very short times, thus preventing the entry of native woody species (LANGELAND & BURKS, 1998; TOURN *et al.*, 1999), and making difficult its mechanical control (BATCHER, 2000). Due to its invasive behavior, *M. azedarach* has been included in the Global Invasive Species Database (GISD, 2006), managed by the group of specialists working within the Species Survival Commission (SSC) of the International Union for Conservation of Nature (IUCN). In its secondary distribution range, *M. azedarach* has successfully invaded both open natural habitats like S African savannahs, the Pampas of Argentina and disturbed environments, such as roadsides, but also riparian and forest ecosystems subject to anthropogenic disturbance (LANGELAND & BURKS, 1998; HOOD & NAIMAN, 2000; VAN WILGEN *et al.*, 2001; GHERSA *et al.*, 2002; HENDERSON, 2007). Especially in S Africa, the widespread occurrence of this Asian tree has reached particularly worrying dimensions, so that huge costs will have to be incurred in order to contain its rising spread and the negative ecological impacts (MARAIS *et al.*, 2004; HENDERSON, 2007). In U.S.A., *M. azedarach* has been recently listed among the 14 non-native target species for which the development of focused programs of biological control exploiting the numerous phytophagous enemies which live in its native range is regarded as a priority (DING *et al.*, 2006).

MELIA AZEDARACH IN EUROPE AND IN ITALY

Naturalized in France and former Yugoslavia since half a century (TUTIN, 1968), more recently *M. azedarach* also spread in Iberian Peninsula (NAVARRO ARANDA & MUÑOZ GARMENDIA, 2008), on Canarian islands and Croatia as well as in other Mediterranean countries such as Balearic islands, Cyprus, Israel, Jordan and Malta, while its status is doubtful in Anatolia (Turkey) and Crete (JURY, 2009).

After boiling the fruits, the seeds of Persian lilac, which bear a natural perforation through the centre, were used to make rosaries. Although this popular use is disappearing, in Italy *M. azedarach* is still called “albero dei rosari” or “albero dei paternostri”. Despite being included since long time in the category of naturalized plants (BÉGUINOT & MAZZA, 1916; VIEGI *et al.*, 1974), PIGNATTI (1982) treated it only as a casual. Moreover, CELESTI-GRAPPOW *et al.* (2010) report it as fully naturalized for Sicily only and as a ca-

sual alien in central and southern Italy (Marche, Latium, Campania and Sardinia). Finally, in a botany forum *M. azedarach* recently figures as naturalized (http://www.actaplantarum.org/ipfi/floraz_comp_map_dist.php?s=8591&m=20) also in Basilicata and Tuscany.

MELIA AZEDARACH IN SICILY: PAST INTRODUCTION, RECENT SPREAD AND INVASION FORECASTS

As concerns *M. azedarach* in Sicily, PITRÈ (1889) calls it “*Pacenza, arvu-lu di pacenza*” and writes “Simbolo dell’infedeltà coniugale femminile. Un marito becco volontario è chiamato *pacinziusu*” (= Patience, tree of patience, ... Symbol of womanly infidelity. A man who accepts to have been betrayed by his wife is also called *patient*...”). Apart from these picturesque details, the origin of the vernacular name still remains a mystery, also considering that Sicilians still use it referring to many other exotic or ruderal plants such as *Chenopodium botrys* L., *Rumex* spp., *Salix* spp., *Ailanthus altissima* (Mill.) Swingle, etc. (TROPEA, 1990). Due to its fast growth rate and the good quality of its wood, during XX century *M. azedarach* was considered one of the most promising trees to be cultivated in Sicily in order to improve national cellulose production (PALAZZO, 1956). At Favignana (Egadi Islands, W Sicily) it was planted in order to use its wood as raw material for ship construction.

Despite its introduction in Palermo Botanical Garden dates back at least to the second half of XVIII century (UCRIA, 1789), the first signs of naturalization of the species in Sicily were recorded only around 1959, when DI MARTINO & PERRONE (1962) listed it among the epiphytes growing in the city of Palermo. Subsequently, the species was considered as naturalized at regional level, even if confined to urban and suburban habitats (CELESTI-GRAPOW *et al.*, 2010). Although *M. azedarach* is widely used as an ornamental species along the roadsides, the public parks and the private gardens of the cities and the towns of the main island, like San Vito Lo Capo (BERNHARDT & NAUMER, 1987), Palermo (PINTAGRO, 1999), and almost all the circum-Sicilian islands, so far it proved to be naturalized only at Pantelleria (DOMINA & MAZZOLA, 2008). On the other hand, up to now we prevalently observed few self-sown young individuals growing near the parent plants. Such a trend suggests that, at least so far, the main strategy of seed dispersal has been barochory instead of zoochory.

However, the recent colonization of semi-natural open environments suggests the invasive potentialities of the species (Tab. 1). For instance, a regeneration nucleus of about 20 young individuals located at Carini per-

Table 1

Current distribution of *M. azedarach* in Sicily. DM & P = DI MARTINO & PERRONE (1962); D & M = DOMINA & MAZZOLA (2008); SP = S. Pasta; EB = E. Badalamenti; DC = D. Cusimano; TLM = T. La Mantia; i = isolated individuals; n = nuclei; n.a.i. = no additional information.

Prov.	Year	Municipality (locality)	Habitat	Data source	Demography
Catania	2013	Adrano	Roadsides	TLM	i
Palermo	1959	Palermo (Policlinico)	Growing as an epiphyte on urban trees	DM & P	i
	1990	Palermo (Boccadifalco and Poggio Ridente)	Abandoned quarries	SP	i
	1991	Palermo (Arenella and Acquasanta)	Dump places and abandoned quarries	SP	n
	1992	Palermo (Cardillo)	Roadsides	SP	i
	1998	Palermo (Villa Tasca and Mezzomonreale)	Roadsides	SP	i
	1999	Palermo (Pizzo Sella)	Abandoned quarries	SP	i
	2008	Palermo (Fondo Micciulla)	Orchards and roadsides	TLM	i
	2010	Palermo (Barcarello, R.N.O. Capo Gallo)	Semi-natural grassland	EB	i
	2013	Palermo (Ciaculli, Partanna Mondello e Olio di Lino)	Roadsides	TLM & SP	i
	2008	Capaci	Suburban areas	EB	n
	2009	Carini	Suburban areas	EB	n
	2011	Cinisi	Public garden	EB	n
	2011	Monreale	Artificial water canal	EB	i
	2012	Terrasini (SS 113, Km. 301)	Abandoned olive groves	EB	n
	2012	Trappeto (Fosso Carrozza)	Roadsides	DC	i
	2013	Borgetto (SS 186, Km. 21)	Roadsides	EB	i
	2013	Partinico (SS 113, Km. 306)	Roadsides	EB	i
Trapani	2006	Pantelleria Is. (near Cala Cinque denti)	Dump places and abandoned quarries	SP	n
	2008	Pantelleria Is.	n.a.i.	D & M	–
	2013	Pantelleria Is. (main town, Khamma, Rekhale, airport)	Suburban areas, roadsides	TLM	i + n

See next page

Table 1: *see previous page*

	2010	Màcari	Roadsides	EB & DC	i
	2010	San Vito Lo Capo (Contrada Timpe Bianche)	Roadsides	EB	n
	2012	Favignana Is.	Orchards	TLM	i

formed abundant fruiting just 4 years after birth; its regular monitoring since January 2011 revealed a very fast growth in terms of biomass and height. The emergence and the establishment of the seedlings of *M. azedarach* is strongly biased by the local co-occurrence of *Pennisetum setaceum* (Forssk.) Chiov. (Fig. 1), whose competitive ability has long been recognized (PASTA *et al.*, 2010).

At the moment it is difficult to predict with sufficient reliability the rate of the naturalization process of *M. azedarach* in Sicily. Nonetheless, the increasing number of regeneration nuclei observed during the last decades in the whole regional territory may be the prelude of its rapid spread, like it has already happened to many other invasive species (RICHARDSON *et al.*, 2000). Three main factors will probably rule the near future of *M. azedarach* in Sici-



Fig. 1 — Young individuals of *Melia azedarach* gradually spreading in a suburban area of Carini (Palermo province) together with *Pennisetum setaceum*.

ly, i.e. i) the introduction frequency, ii) the climatic trend, and iii) the interaction with potential disseminators. As concerns the first driving factor, the Persian lilac is still planted for shading and ornamental purposes in many urban and sub-urban areas. Moreover, we believe that *M. azedarach* will be neither limited by natural enemies, as it is well protected by numerous chemical compounds with strong insecticidal (BREUER & DEVKOTA, 1990; CHEN *et al.*, 1996) and nematicidal (NTALLI *et al.*, 2010) properties, nor by climatic constraints, especially if the warming trend recorded on a regional basis over the last 30 years (D'ASARO *et al.*, 2007) will be confirmed.

The invasive behavior of *M. azedarach* may be enhanced if it widens its spectrum of potential dispersers. This may occur, as Sicily hosts many species belonging to the same groups of birds (Passeriformes, Piciformes) and bats (Chiroptera) which disperse *Melia's* fruits in South Africa (VOIGT *et al.*, 2011); besides, Wood pigeons (*Columba palumbus*, Linnaeus 1758) feeding on *Melia* have already been observed in the territory of Trabia (Palermo province, Rosa E.B. Carvalho, *pers. comm.*).

Acknowledgements — Part of the data here reported have been carried out by the first author during field investigations within his doctoral thesis in “Sistemi Arborei Agrari e Forestali” (XXIV cycle), Department of Agricultural and Forest Sciences (SAF), University of Palermo. The authors are grateful to the anonymous referee whose suggestions allowed to improve the text.

REFERENCES

- BATCHER M.S., 2000. Element stewardship abstract for *Melia azedarach*. The Natural Conservancy, Arlington, Virginia, 7 pp. <http://www.invasive.org/gist/esadocs/documnts/meli-aze.pdf> (last access: 30/05/2013).
- BÉGUINOT A. & MAZZA O., 1916. Le avventizie esotiche della flora italiana e le leggi che ne regolano l'introduzione e la naturalizzazione. *N. Giorn. bot. ital.*, 23: 403-465, 495-540.
- BERNHARDT K.-G. & NAUMER E., 1987. Die floristische Zusammensetzung von Alleen und Gehölzreihen in Sizilien. *Baubinia*, 8(4): 195-207.
- BREUER M. & DEVKOTA B., 1990. Control of *Thaumatococcus panyocampa* (Den. & Schiff.) by extracts of *Melia azedarach* L. (Meliaceae). *J. appl. Entomol.*, 110 (2): 128-135.
- CELESTI-GRAPOW L., ALESSANDRINI A., ARRIGONI P.V., ASSINI S., BANFI E., BARNI E., BOVIO M., BRUNDU G., CAGIOTTI M., CAMARDA I., CARLI E., CONTI F., DEL GUACCHIO E., DOMINA G., FASCETTI S., GALASSO G., GUBELLINI L., LUCCHESI F., MEDAGLI P., PASSESALACQUA N., PECCENINI S., POLDINI L., PRETTO F., PROSSER F., VIDALI M., VIEGI L., VILLANI M.C., WILHALM T. & BLASI C., 2009. Inventory of the non-native flora of Italy. *Plant Biosystems*, 143 (2): 386-430.
- CELESTI-GRAPOW L., PRETTO F., CARLI E. & BLASI C. (eds.), 2010. Flora vascolare alloctona e invasiva delle regioni d'Italia. *Casa Editrice Università La Sapienza*, Roma, 208 pp.
- CHEN C.C., CHANG S.J., CHENG L.L. & HOU R.F., 1996. Deterrent effect of the chinaberry extract on oviposition of the diamondback moth, *Plutella xylostella* (L.) (Lep., Yponomeutiidae). *J. appl. Entomol.*, 120 (3): 165-169.

- COWEN D.V., 1965. Flowering trees and shrubs in India. 4th revised and enlarged edition. *Thacker*, Bombay, xviii + 159 pp.
- DANIN A., 2000. The inclusion of adventive plants in the second edition of Flora Palaestina. *Willdenowia*, 30: 305-314.
- DI MARTINO A. & PERRONE C., 1962. Nuovo contributo alla flora arborea di Palermo. *Lav. Ist. bot. Giard. colon. Palermo*, 18: 112-202.
- D'ASARO F., AGNESE C., COSTA G. & LAZZARA P., 2007. Analisi regionale delle variazioni a lungo termine di grandezze climatiche in Sicilia. *Convegno AILA*, 4 pp.
- DING J., REARDON R., WU Y., ZHENG H. & FU W., 2006. Biological control of invasive plants through collaboration between China and the United States of America: A perspective. *Biol. Invasions*, 8 (7): 1439-1450, doi:10.1007/s10530-005-5833-2.
- DIRR M.A., 1998. Manual of woody landscape plants: their identification, ornamental characteristics, culture, propagation and uses (5th ed). *Stipes Publishing*, Champaign, 1187 pp.
- DOMINA G. & MAZZOLA P., 2008. Flora ornamentale delle isole circumsiciliane. *Quad. Bot. ambientale appl.*, 19: 107-119.
- GHERSA C.M., DE LA FUENTE E., SUAREZ S. & LEON R.J.C., 2002. Woody species invasion in the Rolling Pampa grasslands, Argentina. *Agr. Ecosyst. & Environ.*, 88 (3): 271-278.
- GISD (= Global Invasive Species Database), 2006. *Melia azedarach*. <http://www.issg.org/database/species/ecology.asp?si=636&fr=1&sts=sss&lang=EN> (last access 30/05/2013).
- HENDERSON L., 2007. Invasive, naturalized and casual alien plants in southern Africa: a summary based on the Southern African Plant Invaders Atlas (SAPIA). *Bothalia*, 37 (2): 215-248.
- HONG T. & ELLIS R., 1998. Contrasting seed storage behaviour among different species of Meliaceae. *Seed Sci. Technol.*, 26: 77-95.
- HOOD W.G. & NAIMAN R.J., 2000. Vulnerability of riparian zones to invasion by exotic vascular plants. *Plant Ecol.*, 148 (1): 105-114.
- HUA P. & MABBERLEY D.J., 2008. *Melia* L. Pp. 130-131 in: Wu Z.Y. & Raven P.H. (eds.), Flora of China, Vol. 11 (Oxalidaceae through Aceraceae). *Science Press*, Beijing, and Missouri Botanical Garden Press, St. Louis. <http://flora.huh.harvard.edu/china/PDF/PDF11/Melia.pdf> (last access 15/04/2013).
- JURY S., 2009. Meliaceae. In: Euro+Med Plantbase - the information resource for Euro-Mediterranean plant diversity. <http://ww2.bgbm.org/EuroPlusMed/PTaxonDetail.asp?NameId=25962&PTR-effk=7500000> (last access: 30/05/2013).
- LANGELAND K.A. & BURKS K.C. (eds.), 1998. Identification and biology of non-native plants in Florida's natural areas. *University of Florida*, Gainesville: 96-97. http://www.flep-pc.org/ID_book/melia%20azedarach.pdf (last access: 15/04/2013).
- MARAIS C., VAN WILGEN B.W. & STEVENS D., 2004. The clearing of invasive alien plants in South Africa: a preliminary assessment of costs and progress. *S. Afr. J. Sci.*, 100: 97-103.
- NAVARRO ARANDA C. & MUÑOZ GARMENDIA F. (eds.), 2008. Meliaceae. *Flora iberica*, 9 (1): 1-4. (http://www.floraiberica.es/floraiberica/texto/borradores/vol_IX/09_119_00_Meliaceae.pdf).
- NTALLI N.G., COTTIGLIA F., BUENO C.A., ALCHÉ L.E., LEONTI M., VARGIU S., BIFULCO E., URANIA MENKISSOGLU-SPIROUDI U. & CABONI P., 2010. Cytotoxic tirucallane triterpenoids from *Melia azedarach* fruits. *Molecules*, 15: 5866-5877, doi:10.3390/molecules15095866.
- PALAZZO F.C., 1956. Quaderno n. 2. Centro sperimentale E. Paternò per l'Industria della cellulosa della carta e delle fibre tessili. *Tip. S. Pezzino e F.*, Palermo, 126 pp.
- PASTA S., BADALAMENTI E. & LA MANTIA T., 2010. Tempi e modi di un'invasione incontrastata: *Penisetum setaceum* (Forssk.) Chiov. (Poaceae) in Sicilia. *Naturalista sicil.*, 34: 487-525.

- PINTAGRO M., 1999. Arborea. La storia di Palermo in cento alberi illustri. *Helix Media Editore*, 160 pp.
- PITRÈ G., 1889. Usi e costumi credenze e pregiudizi del popolo siciliano. Vol. 3. Ristampa (1978). *Casa Editrice il Vespro*, 520 pp.
- RICHARDSON D.M., PYŠEK P., REJMÁNEK M., BARBOUR M.G., PANETTA F.D. & WEST C.J., 2000. Naturalization and invasion of alien plants: concepts and definitions. *Diversity Distrib.*, 6: 93-107.
- RUSKIN F.R., 1983. Firewood crops. Shrub and tree species for energy production. Vol. 2. BOSTID Report No. 40. *National Academy Press*, Washington DC, USA, vii + 92 pp., 36 pl., http://pdf.usaid.gov/pdf_docs/PNAAP479.pdf.
- TOURN G.M., MENVIELLE M.F., SCOPEL A.L. & PIDAL B., 1999. Clonal strategies of a woody weed: *Melia azedarach*. *Plant and Soil*, 217: 111-117.
- TROPEA G. (a cura di), 1990. Vocabolario siciliano. Vol. III (N-Q). *Centro di Studi Filologici e Linguistici siciliani Opera del Vocabolario Siciliano*, Palermo-Catania, xxvii + 4 tavv. f.-t. +1063 pp.
- TUTIN T.G., 1968. *Melia*. P. 231 in: Tutin T.G., Heywood V.H., Burges N.A., Moore D.M., Valentine D.H., Walters S.M. & Webb D.A. (eds.), *Flora Europaea*, vol. 2. *Cambridge University Press*, Cambridge.
- UCRIA (DA) B., 1789. Hortus Regius Panormitanus aere vulgaris anno MDCCLXXX noviter extructus septoque ex indigenis, exoticisque plerisque complectens plantas, etc. *Typis Regiis*, Panormi, 498 pp.
- VAN WILGEN B.W., RICHARDSON D.M., LE MAITRE D.C., MARAIS C. & MAGADLELA D., 2001. The economic consequences of alien plant invasions: example of impacts and approaches to sustainable management in South Africa. *Environment, Development and Sustainability*, 3: 145-168.
- VIEGI L., CELA RENZONI G. & GARBARI F., 1974. Flora esotica d'Italia. *Lav. Soc. ital. Biogeogr.*, 4 (1973): 125-220.
- VILÀ M., MEGGARO Y. & WEBER E., 1999. Preliminary analysis of the naturalized flora of northern Africa. *Orsis*, 14: 9-20.
- VOIGT F.A., FARWIG N. & JOHNSON S.D., 2011. Interactions between the invasive tree *Melia azedarach* (Meliaceae) and native frugivores in South Africa. *J. trop. Ecol.*, 27: 355-363, doi:10.1017/S0266467410000702.
- ZALBA S.M. & VILLAMIL C.B., 2002. Woody plant invasion in relictual grasslands. *Biol. Invasions*, 4: 55-72.

Authors' addresses — E. BADALAMENTI, D. CUSIMANO, T. LA MANTIA, Dipartimento SAF, Viale delle Scienze Ed. 4, Ingr. H - 90128 Palermo (I); email: emilio.badalamenti@unipa.it; dario.cusimano@unipa.it, tommaso.lamantia@unipa.it; S. PASTA, Consiglio Nazionale delle Ricerche, Istituto di Genetica Vegetale, Corso Calatafimi 414 - 90129 Palermo (I); email: salvatore.pasta@igv.cnr.it

