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Urban Landscape Evolution as a Consequence of an Invasive Pest: The Case of a Small Sicilian Town

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Abstract

The Red Palm Weevil (RPW), after its accidental introduction in Italy in 2005, determined a progressive disruption of Canary palms mostly in the central and southern regions. As it is difficult to undertake the management of this pest, the possibility of substituting the killed/symptomatic palms with other ornamental trees has been recently discussed. In this context, understanding the citizens' needs about green areas can improve the management of public parks and urban greening. Involving citizens on the natural resource management using public participation processes is crucial. The case study of a small town of Sicily (Italy) was treated and the spread of this pest was monitored. Moreover, the possibility of substituting the killed palms with other ornamentals was discussed by involving a sample of the population through a direct survey aimed at detecting the preferences in respect to certain tree species (as potential substitutes of the killed palms) listed in a questionnaire administered face-to-face. The citizen's samples showed great interest in the green areas (97%) and indicated a traditional Mediterranean plant as *Nerium oleander* as the preferred palm substitute candidate.

Keywords:

Citizens' perceptions; Urban landscape; Palms; Red Palm Weevil.

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1 Introduction

1.1 The impact of invasive pests on landscapes

Alien insects are increasingly being dispersed around the world through international trade causing a multitude of negative impacts on ecosystems, agriculture, forestry, and landscapes, with consequences on human health in addition to annual economic losses of billions of dollars (Bacon et al. 2012).

The main share of these alien insects is confined to man-made habitats (Roques et al. 2009). Human habitats may be more readily invaded by insects than natural habitats because insects linked to human environments and activities are more likely to be carried by human transport into a new region than insects living in natural areas (Kenis et al. 2009). On the other hand, the green urban areas are of crucial importance in towns not only for their ornamental and recreational role, but also for their effect on local temperature reduction (Takebayashi, Moriyama 2007). Therefore, the augmentation of urban vegetation as a possible mitigation strategy for the so called 'urban heat islands' is recommendable (Susca et al. 2011). Furthermore, the extreme simplified structure of urban ecosystems makes these habitats particularly susceptible to the invasive species.

Italy is particularly vulnerable to the ingress of alien insects due to its geographical position as it is a nodal point for commerce and tourism in the centre of the Mediterranean basin. Furthermore, the range of Italian climatic parameters allows the establishment of subtropical species in the southern regions (Pellizzari et al. 2005). These facts expose Italy to greater risks of having alien species dangerous not only for agroecosystems and forestry but also for the ornamentals of green spaces of urban areas. In particular, herbivore outbreaks in urban environments have been linked to improved host quality resulting from environmental stress associated with impervious surfaces and elevated temperatures as well as fleeing from natural enemies (Raupp et al. 2010). A recent example of such outbreaks is the invasion of the Red Palm

Weevil (RPW) *Rhynchophorus ferrugineus* Olivier that, after its accidental introduction in 2005 (Longo, Tamburino 2005), determined, over the years, a progressive impact on the Italian green landscape areas (Ferry, Gomez 2002; Kontodimas et al. 2006; European Commission 2011; Pasini, Rumine 2014). In 2007, the Italian Ministry of Agriculture, Food and Forestry, in order to contrast the widespread of the RPW, decreed a series of guidelines for the mandatory control of this pest (Ministerial decree, 9/11/2007). Later, the Regional Phytosanitary Services of the most affected regions started to adopt regional decrees (RDs) for the control of the RPW (e.g. Campania RD 31/1/2006 and 18/1/2008; Sicily RD 23/3/2007; Latium RD 5/6/2007). These RDs provided for management measures to be taken in infested areas, which included penalties for non-compliance. From the actuation of these directives in infested areas, all citizens who found a new RPW-infested palm had to alert the Regional Plant Protection Services to assess the most suitable phytosanitary measures and inform the relevant municipal administration. These measures permitted the recognition of around 20,000 RPW-infested palms in Sicily in the period 2006-2011, of which 16,000 were cut and destroyed (Raciti et al. 2013). However, these control procedures were hindered by several factors such as the lack of adequate funding, structures and number of skilled people for the destruction of the infested palms and so the pest continued to expand through the country.

1.2 The spread of RPW

The RPW attacks mainly *Phoenix canariensis* Hort. ex Chabaud, the Canary island palm (Longo et al. 2011). In Sicily observations conducted from 2007 to 2010 revealed that 99.7% of the RPW-infested palms belonged to the *P. canariensis* species while the remaining 0.3% belonged to other palm species, such as *Phoenix dactylifera* L., *Washingtonia* spp. and *Chamaerops humilis* L. (Peri et al. 2013).

P. canariensis is mainly used for ornamental purposes in Sicily (Noto, Romano 1987), and it is the most widespread palm species planted in historical gardens (Raciti et al. 2013) and consequently the RPW became a serious pest of the monumental,

urban and country landscape. The historical study carried out by Raciti et al. (2013) showed that *P. canariensis* plants were reduced because of the RPW invasion by 90% between 2006 and 2012 on the eastern coast of Sicily.

The impact of RPW on landscape had strong economic consequences both for the public administration due to the management of the dead plants, as these had to be removed, destroyed and sometimes substituted, and of the nurseries, an important economic activity within the Sicilian region, where nearly 50% of the national production of ornamental palms is concentrated (Giovino et al. 2009). The nurseries, in fact, have suffered a drastic reduction on the palm commerce and consequently high operating costs due to storage: Giovino et al. (2009) estimated damages of nearly 12 million euros in the period 2005-2008.

1.3 The rehabilitation of urban green spaces

The RPW invasion posed questions on the problem of rehabilitation of urban green spaces and landscape contexts, in which the palms were one of the most distinctive features in the past, specifically if considering that their substitution appears difficult from an aesthetic, functional and economic point of view (Manachini et al. 2013; Raciti et al. 2013). It is also important to take into account that when the public decision-maker is planning to carry out choices about preservation, creation and management of urban green areas, which often require large-scale capital investments, the support of professional skills in biological sciences is not enough for him, but it is often necessary to assess socio-economic aspects and to identify the social welfare resulting from such interventions (Marone, Riccioli 2008; Dempsey, Burton 2012; Gomez-Baggethun, Barton 2013). Furthermore, the involvement of citizens in public decision-making to meet community expectations on green areas preferences can contribute to generate better decisions for the municipal administration in properly allocating the scarce public financial resources available (Marone, Riccioli 2008; Lanfranchi et al. 2015; Giannetto et al. 2016). However, today the rehabilitation and/or improvement of urban green spaces is

underestimated and/or not effectively faced by the public decision-maker, who merely implements mostly routine maintenance interventions of green areas (Lorenzo et al. 2000). In the meantime, citizens are making greater demands for a more active role in the planning and decisions about the management of green spaces in their communities (Roseland 1998; Simonsen, Robbins 2000; Sanesi, Chiarello 2006; Chan et al. 2012; Martin-Lopez et al. 2012). It is essential for urban planners and policy makers to understand these factors as better urban greening participation processes are seen as crucial provisions to better functioning and valued urban spaces (Konijnendijk 2000; Simonsen, Robbins 2000; Trakolis 2001; Van Herzele et al. 2005, Jim, Chen 2006; Buchel, Frantzeskaki 2015). Moreover, possible solutions to problems that threaten the ecosystem require the expertise of biologists and, at the same time, their complexity demands integrated efforts involving other disciplines such as sociology, and economics (Palmer et al. 2005; Eigenbrode et al. 2007; Manachini et al. 2013).

1.4 Goals of the study

In this research, realized with an interdisciplinary approach, the case-study of the green public areas of the town of Sant'Agata di Militello (Sicily, Italy) was examined. This town on the northern coast of Sicily, presents maximum temperatures generally above 27 degrees Celsius from June to September. Consequently, in such an environment the importance of mitigating green spaces the summer heat is particularly important.

During the last 50 years, *P. canariensis* trees, which were recently destroyed by the RPW invasion, were mainly used in public gardens and tree-lined streets in the city centre and alongside the seaside promenade.

This study focuses on the environmental and historical value of palms in urban areas, the effect of the RPW in determining changes in urban landscape, the perception and interest of the citizens for the green areas and the relative problem of substituting the killed palms.

2 Palms in urban areas

Modern cities are planned with a variety of green spaces including parks, small home gardens and tree-lined streets. We can identify different kinds of urban ecosystems manipulated and managed by man such as street trees, lawns/parks and urban forests (Bolund, Hunhammar 1999). All of these green spaces constitute biodiversity hotspots (Jim, Chen 2009; Goddard et al. 2010) and also provide crucial habitats for urban flora and fauna (Freestone, Nichols 2004; Khera et al. 2009). They are planned for several purposes providing recreational, social and psychological functions, helping to clean air (gas regulation), to limit noise levels, to control rainwater drainage and to buffer microclimatic variations (Chiesura 2004). Trees reduce air pollution (Islam et al. 2012) and the filtering capacity increases with more leaf area. The positive actions on the environment depend not only on the characteristics of the green areas but also chiefly by the tree species. Urban vegetation, generally, exhibits a great heterogeneity of species and it is characterized by a high level of diversity with a large proportion of exotic species (Khera et al. 2009).

The presence of palms in historical and traditional gardens located in Sicily has been observed by many authors (Pavone, Salmeri 1994; Salmeri et al. 2007; Barbera, Romano 2009). Palm trees play a key role in the Mediterranean landscapes with numerous species of ancient introduction. The high rusticity and longevity, the non-invasive roots and the canopy characteristics justify their wide dissemination in both public and private gardens. Some palm trees are planted in areas near the sea, where the vegetation is exposed to the mechanical action of the wind and sand, abrasive salt, and sometimes to the same spray of sea water. Moreover, palm trees can even live in soils, which do not have the optimal physicochemical characteristics as the urban ones (Noto, Romano 1987). Among the widespread species in Sicilian gardens, *P. canariensis* is the most observed (87% of gardens reviewed), followed by *C. humilis* (56%), *Washingtonia filifera* (Lindl.) H. Wendl. (49%), *Washingtonia robusta* (Lindl.) H.

Wendl. (48%) and *P. dactylifera* (39%) (Raciti et al. 2013). Furthermore, several palms belonging to the *Phoenix* genus have particular relevance in Sicily for their ornamental role in the surroundings of ancient churches, monuments and other places of high historical value (Barbera, Romano 2009).

3 The impact of the invasive species in urban landscapes, a model study in the town of Sant'Agata di Militello

Sant'Agata di Militello is a small town (almost 12,000 inhabitants) located on the north coast of Sicily where palms, mainly the species *P. canariensis* and marginally *C. humilis*, and *Washingtonia* spp., have been widely used as ornamentals in streets and gardens. The latter counted around 300 trees before the arrival of the invasive RPW. The first Canary palm infested by the RPW in this town was observed in September 2012, almost seven years after the introduction of the RPW in Sicily. Since then, the number of infested Canary palms has rapidly increased.

In this contest a monitoring study was carried out to assess the increase in the number of palms killed and symptomatic in the period 23/11/2013 - 10/5/2014. The total number of Canary palms monitored was 165.

The palms were visually inspected at the beginning and at the end of the study and categorized into:

- Symptomatic palms, i.e. plants with a loss of symmetry of the leaves and tendency of the canopy to flatten (Figure 1 A-B);
- Killed palms, i.e. plants with all the leaves dried and hanging downward in a typical 'umbrella shape' (Figure 1 C);
- Healthy plants, i.e. plants not showing any visual symptoms.

The position of each palm was recorded using a GPS system.



Figure 1 (A-E): *Phoenix canariensis* at different levels of infestation: (A) early symptoms; (B) symptomatic palm with loss of symmetry of the leaves of the canopy; (C) late symptoms on a plant with the leaves dried and hanging downward in a typical 'umbrella shape'; Sant'Agata di Militello main road at the beginning (D) and at the end (E) of the monitoring period of the study.

At the start date, 23rd November 2013, the number of killed and symptomatic palms was respectively 42% and 14% of the total number of trees monitored.

However, at the end of the sampling period, 10th May 2014, the number of killed and symptomatic palms increased respectively to 46% and to 27% of the total number of trees monitored (Figure 1 D-E).

The decrease of the percentage of healthy palms during this period is particularly severe as it comprised all the winter season, in which new palm infestations unlikely occur as it is generally considered a non-flying period of the RPW. Therefore, it is conceivable that the infestations probably occurred in March-April, in correspondence to the RPW adult emergence. The increase of killed and/or symptomatic palms in this period might also have been determined by the lack of proper sanitation and eradication activities during the winter of 2013-2014; indeed, these measures, treating symptomatic plants and removing and

destroying the killed ones, could help in reducing the RPW population and preventing further attacks (Faleiro 2006). The killed palms in the urban gardens of the town also concerned the potential danger of falling trees. Unfortunately, in some cases, the attempt of eradication of infested palms was carried out by private companies which were not adequately prepared and were without entomological skills. The correct application of eradication measures to manage invasive species of the urban green is quite difficult as they are expensive and because citizens, municipalities, nurseries, and other involved stakeholders frequently oppose the destruction of infested palm trees due to their landscape, cultural, tourism-related, and economic value (Nardi et al. 2011). Moreover, RPW populations showed tendency to rebuild rapidly even after significant control efforts as observed for example in other invasive species such as *Cameraria ohridella*, a leaf-mining moth, which determines aesthetic damage to horse chestnut trees (Gilbert et al. 2005).

4 The perceptions of green areas and the citizens' proposals

4.1 General aspects and survey design

Local, as well as regional and national, authorities are significant and often the central players in urban forestry and greening (Lawrence et al. 2013). However, successful urban green space planning processes cannot dismiss citizen participation to avoid a failure of social and environmental functions that form a context for economic activities (Balram, Dragičević 2005). In this context, municipal planners, designers, and researchers are starting to recognize this need (Kühn 2003; Chiesura 2004; Frischenbruder, Pellegrino 2006; Janse, Konijnendijk 2007; Greene et al. 2011).

In the case of the town of Sant'Agata di Militello, during the last 50 years, the municipality has planned several gardens and boulevards in the town centre and alongside the sea promenade using numerous botanical ornamental species in order to favour the changing needs of the community on public green areas and to improve the tourism potential of the town. Among the ornamentals chosen in this specific context, *P. canariensis* has had a primary role, being used alongside the sea promenade and in the main public gardens.

After the RPW invasion and the consequent palm destruction, an intense debate among the citizens took place about the substitution of the destroyed plants of *P. canariensis*. The aim of this sociological study was to explore the perception and interest of the citizens for urban greening and directly involve them in the choice of ornamental plants for substitution of the killed palms. The explorative pilot survey proposed to the citizens was designed with the aim to detect their preferences on some tree species suitable for a possible replacement of *P. canariensis* specimens destroyed by the RPW. In addition to the major socio-demographic indicators of the respondents and their opinions on the interest on the management and maintenance conditions of public parks of their town. On the basis of other research studies carried out in the sector of perception of green spaces (Lorenzo et

al. 2000; Ascuito et al. 2004a; Jim, Chen 2006; Sanesi, Chiarello 2006; Ascuito et al. 2015; Lee, Kim 2015), a questionnaire was specifically drawn up and divided into 3 parts. In the first part the main social and demographic indicators of the citizens interviewed were reported (gender, age, education and occupation); in the second part, questions were asked in order to assess the citizens interest about their fruition, the management and upkeep of the public green areas of Sant'Agata di Militello; in the third part, the survey investigated the preferences of the respondents between three plant species indicated in the questionnaire -*Nerium oleander* L., *Tamarix gallica* L. and *W. filifera*- as possible substitutes of the killed palms. The three ornamental plant species were selected considering both their adaptability to the climatic conditions of the area and their tolerance to phytophagous insect species or pathogens.

Nerium oleander is a fast-growing, tough, versatile evergreen shrub of great ornamental interest, largely utilized in urban environments (Pagen 1988) for its tolerance to drought (Bjorkman et al. 1980) and pollution (Dongarrà et al. 2003). Moreover, oleander is an easy-propagation plant and there is a large availability of genotypes with different flower colours in the local nurseries.

Tamarix genus is a group of plants naturalized extensively in dry and saline habitats in many countries (Brock 1994; González et al. 2010). The tamarisks are widely distributed in different natural habitats such as dunes, inland hilly districts, gravelly banks of rivers in all the Sicilian territory (Raimondo et al. 1982). Floristic data on the presence of *T. gallica* and *T. canariensis* L. from different localities of eastern Sicily and *T. africana* from the isles of Salina, Lipari and Vulcano (Aeolian Archipelago) and on the Etna volcano was provided by many Sicilian naturalists (Venturella et al. 2007). *Tamarix gallica* is the most widespread species occupying coastal dunes and the riverbanks of southern regions in Italy tolerating many abiotic stresses including salinity, drought, flooding, and extreme temperatures (Kuzminsky et al. 2014).

Finally, to avoid upsetting the original landscape based on palm trees as a dominant component, *W. filifera* was proposed, since among the palm species

it seems to be one of the more resistant to the RPW attacks (Dembilio et al. 2009), probably also determined by the presence of a recently observed compound in the leaf tissues with larvicidal activity called filiferol (Cangelosi et al. 2015).

Before the actual data collection, we performed a pre-test, administering the questionnaire in a face-to-face manner to a few city council technicians and citizens. The need to indicate in the third part of the questionnaire a fourth species to be eventually specified by the respondent (as an open answer) in alternative to the three initially provided emerged from the results. The questionnaire was also completed with a brief description, including photos, of each species. The use of visual information in surveys (e.g., pictures of plant types), has a positive influence on people’s understanding of the subject at hand (Asciuto et al. 2004b; Van Herzele et al. 2005).

The face-to-face interview survey involved a sample of 100 residents of over 15 years of age from Sant’Agata di Militello, who had agreed to collaborate in the research.

The size of the sample was determined with the formula of the simple casual sampling, considering a maximum estimation error of 10% and, in particular,

$$n = \frac{p(1-p) \left(z_{\frac{\alpha}{2}} \right)^2}{d^2} = \frac{0.50 * (1-0.50) * 1.96^2}{0.010^2} = 96$$

where p is the maximum population variance that is assumed to be equal to 0.5, α represents the 5% significance level and d is the maximum estimation error, and $z_{\frac{\alpha}{2}}$ is the critical value for a significance level of 5% ($\alpha = 5\%$). The sample size formula suggested setting the number of interviewees at more than 96 units.

4.2 Sample description

Table 1 gives the complete demographics of the sample. Our sample is formed by 50% males and 50% females, individuals mainly between 15 and 24 years of age (36%), prevalently with a high school education (46%) and students (28%). The extracted sample is a convenience sample (non-

probabilistic sample) as it has been composed with the first 100 people who agreed to take part in the interview. In this specific case, people over 55 years of age showed very little willingness to collaborate. Therefore, the sample is faithful to the official data from the 15th Population Census (Istat, 2011) about the resident population in Sant’Agata di Militello in terms of sex distribution but slightly different in terms of distribution according to age classes and, consequently, also in the distribution of education and occupation.

Table 1: Socio-demographic characteristics of the sample (n = 100)

Gender	Males	50%
	Females	50%
Age (in years)	15 - 24	36%
	25 - 34	21%
	35 - 44	12%
	45 - 54	14%
	55 - 64	8%
	65 - 74	6%
	75 - 80	3%
Education	Primary school	4%
	Lower secondary school	29%
	Upper secondary school	46%
	University degree	21%
Occupation	Unemployed	18%
	Employed	25%
	Students	28%
	Freelance professionals	10%
	Retailers	5%
	Self-employed	6%
	Retired	8%

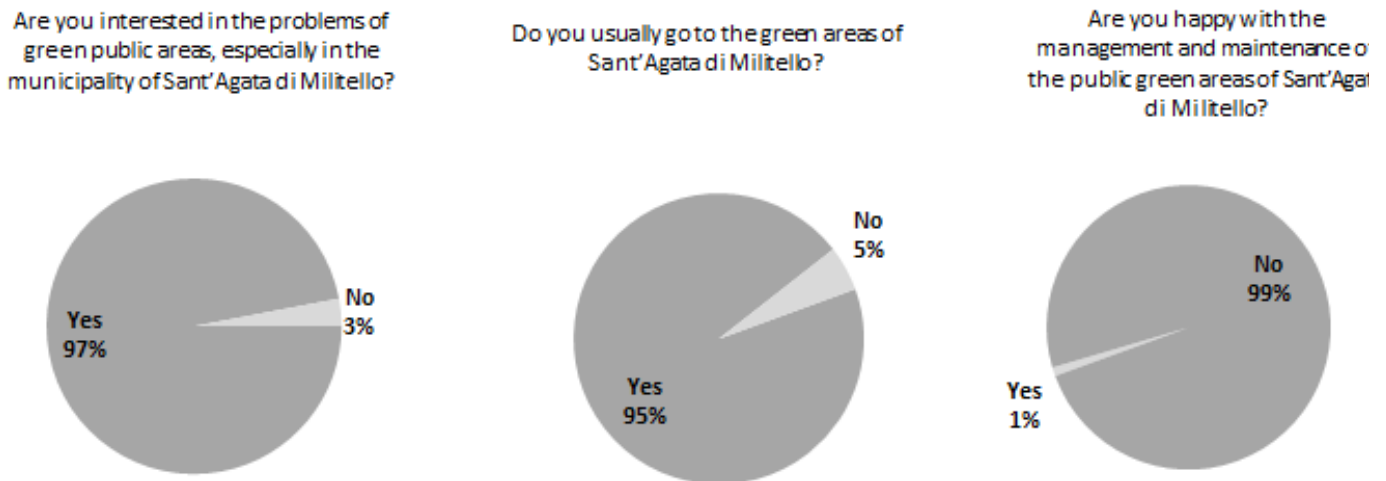


Figure 2: Degree of interest, fruition and satisfaction of the sample

4.3 Results

The great majority (97%) of the sample declared to have an interest in the city council's urban green areas (Figure 2). As to the actual fruition of the green areas of the town, 95% answered positively. Finally, 99% of the sample declared to be unsatisfied with the management and maintenance of the green public areas, which confirms the critical management and financial situations to be found in the municipalities, which are fairly common problems to the whole region.

As for the choice of the species to substitute the *P. canariensis*, 46% of the sample indicated a preference for *N. oleander*, 27% indicated *W. filifera*, while 26% chose *T. gallica*. Only one respondent was not satisfied with the provided species and indicated a different one, i.e. *Cupressus sempervirens* L. (Figure 3); this last one was indicated by the male subsample, which in general had shown a lower preference for *N. oleander* (40%) and a higher one for *W. filifera* (30%) and *T. gallica* (28%) in comparison with the whole sample.

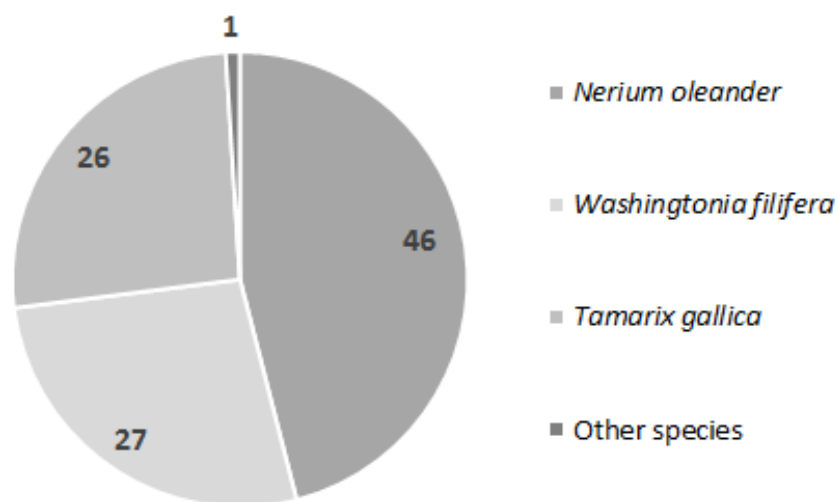


Figure 3: Species indicated by the sample for the substitution of the destroyed specimens of *Phoenix canariensis*

5 Discussion

Invasive phytophagous species, which threaten ecosystems, habitat, or indigenous species, are an important element of global change and are contributing to biodiversity loss, ecosystem degradation, impairment of ecosystem services and landscape modification worldwide (Hulme 2009). Over recent decades, an increasing number of biological invasions have occurred worldwide, facilitated by climate change and trade market, causing economic impacts that can be valued as financial costs, based on expert extrapolations of high-profile alien pests (Pimentel et al. 2001; Born et al. 2005; Pimentel et al. 2005; Olson 2006). Moreover, alien insect invasions have subtle socioeconomic consequences, which are difficult to assess using traditional monetary approaches and market-based models (Binimelis et al. 2007). In many cases alien insect species attack ornamental plants that have become part of the landscape of urban environments, parks and gardens causing these to change (Pantaleoni et al. 2012).

Over the last years, the devastating impact of the introduction of the RPW in the landscapes of several Sicilian cities has been widely documented (Longo, Tamburino 2005; Peri et al. 2013). Palm trees have had a strong influence in the urban architecture and landscapes of many important cities of the Mediterranean basin (Manachini et al. 2013), and the urban landscape of many coastal areas of Italy is principally based on palms, many of which represent a patrimony of high value (Jucker, Lupi 2011). The RPW invasion has brought about a drastic decrease in the number of palms and a consequent radical change in urban spaces that may yet continue to transform the urban landscape. This landscape alteration poses in danger the place-identity itself defined by Lynch (1961) as *'the extent to which a person can recognize or recall a place as being distinct from other places.'* Moreover, it is not to exclude that the settlement of this weevil not only represents a serious environmental problem but will also have significant consequences on tourism (Jucker, Lupi 2011).

Normally, landscape pests do not need to be managed constantly, as their damage in general decreases through time (Weissling, Broschat 1999). By contrast, the RPW is lethal to palms and has required strong control measures such as quarantine and eradication to limit the widespread of this pest. Several attempts, such as chemical treatments, monitoring and mass trapping with pheromone-kairomone traps and eradication of killed palms have been made to limit the destructive activity of the weevil from the beginning of its introduction (Abbas et al. 2001; Guarino et al. 2011, 2013, 2015; Vacas et al. 2013; Dembilio et al. 2014; Peri et al. 2017). However, the concealed nature of this pest and the fact that the infested palms are often located in urban areas where chemical treatments are not viable determined the fact that the RPW continued to expand and spread to other areas.

Consequently, doubts have been raised about the opportunity to continue to put efforts in RPW control measures. The basic parameter to be considered is cost-effectiveness: i.e., does the value of the plant needing protection always justify the costs of the protective measures?

The establishment of the RPW determined evident changes in the ecosystem of the island (Sicily), so the strategy to replace the killed palms with other ornamental plants could be an economically sustainable solution rather than continue fighting a losing battle.

On the other hand, it is important to directly involve the people that live and exploit the green areas of the regions affected by the RPW on decisions concerning residential landscape management. Our findings show that citizens have a great interest in green areas and a positive attitude towards urban green spaces, indicating a willingness to contribute in the planning and the management of green spaces. These findings are in accordance with similar results of studies conducted in several other countries (Balram, Dragičević 2005; Jim, Chen 2006; Sanesi, Chiarello 2006; Janse, Konijnendijk 2007; Greene et al. 2011; Lee, Kim 2015; Ostoić et al. 2017).

6 Conclusions

A clear understanding of the citizens' needs about green areas can improve the management of public parks as well as the effective implementation of protection and preservation programs or rehabilitation projects of urban green spaces, all of which are important to provide the experience of nature and to contribute to urban biodiversity and living quality.

Thenceforth it is reasonable to involve citizens on the natural resource management using public participation processes that are normally designed to enhance communication and consultation through methods such as public information, public hearings, conferences, and formation of advisory groups (Janse, Konijnendijk 2007).

In the case study reported, the involvement of the citizens of Sant'Agata di Militello in the choice of tree species suitable for the replacement of *P. canariensis* specimens destroyed by the RPW was a useful exercise of collective responsibility in the planning decisions of urban green areas, which should be extended to other municipalities affected by the problem of the RPW and to all aspects of the management and care of the urban green more generally. This is suitable for the preparation of further and more in-depth surveys within a work path allowing to explore the citizens' needs and opinions about urban green areas planning when these ecosystems are threatened by biotic or abiotic factors. The involvement of the population in decisions on urban green planning can lead to a correct destination of public funds to improve the use and enjoyment of the public green areas. Furthermore, the multidisciplinary aspect of this research highlighted the importance of the involvement of different scientific knowledge in the management of urban green issues.

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