Boll. Malacol., **44** (5-8): 101-107 (2008)

The status of *Otala punctata* (Müller, 1774), a recently established terrestrial gastropod in Malta

Nicholas Barbara[1,2] (✉) & Patrick J. Schembri[3]

[1] Centre for Ecology & Conservation, University of Exeter in Cornwall, Tremough Campus, Treliever Rd., Penryn TR10 9EZ, UK

[2] Present Address: 139, St. Anthony Str., Zabbar ZBR3474, MALTA
Tel: (+356) 7905 3084; (+356) 2166 6672
Fax: N/A
nikbarbara@gmail.com; nbar001@um.edu.mt
(✉) corresponding author

[3] Department of Biology, University of Malta, Msida MSD2080, MALTA;
Tel.: (+356) 2340 2789
Fax: (+356) 2132 3781
patrick.j.schembri@um.edu.mt

Abstract
A population of the alien helicid *Otala punctata* (Müller, 1774) has recently been found on the island of Malta (Central Mediterranean), located around a single plant nursery at Mosta in the central part of the island. Extensive field collections indicate that this species was very probably introduced via the horticultural trade and is gradually extending its range from its point of introduction, occupying a variety of natural and anthropic habitats. Analysis of size-frequency data suggests that *Otala punctata* has successfully bred through at least three consecutive reproductive events until 2006. We hypothesise that *Otala punctata* was originally imported accidentally with plant material and established itself in the nursery, from where it then escaped into the surrounding land since 2003. This situation represents the introduction of yet another alien species on Malta with the potential of becoming an agricultural pest, and a threat to the islands' biodiversity.

Riassunto
Una popolazione del gasteropode terrestre esotico *Otala punctata* (Müller, 1774) è stata recentemente trovata sull'isola di Malta. La popolazione si trova attorno ad un vivaio a Mosta, nella parte centrale dell'isola. Estese raccolte sul campo indicano che questa specie è stata molto probabilmente introdotta attraverso il commercio di piante da coltivazione. Essa sta gradualmente espandendo la sua distribuzione a partire dal punto di introduzione, occupando un'ampia tipologia di ambienti naturali ed antropizzati. L'analisi della frequenza delle dimensioni degli individui suggerisce che *Otala punctata* si è riprodotta con successo per almeno tre volte consecutive fino al 2006. Si ipotizza che questa specie sia stata introdotta accidentalmente assieme alle piante e si sia stabilita nel vivaio dal quale è sfuggita verso i terreni circostanti a partire dal 2003. Questo rappresenta un ulteriore caso di introduzione di specie a Malta. *Otala punctata* potrebbe rivelarsi una specie dannosa per l'agricoltura ed una minaccia per la biodiversità dell'isola.

Key words
Helicidae, land snail, Maltese Islands, naturalisation, non-indigenous species.

Introduction

Otala punctata (Müller, 1774) has been documented from most of the western Mediterranean lands, with a distribution extending from France to Northwest Algeria (Sanz, 2006; Falkner, 1990), although Martinez-Ortì & Robles (2001) consider the species as endemic to the Iberian peninsula. Whatever its original native range, *Otala punctata* has been subject to anthropogenic dispersal and has been recorded as introduced in Sardinia (Malatesta & Settepassi, 1954; Carrada et al., 1967), South Africa (Macdonald et al., 2003) and North America (Frank, 2006). Owing to its ready establishment in various temperate habitats, *Otala punctata* has gained popularity as a delicacy in some countries, for example in France, where it is protected (Journal Officiel No 273 du 24 Novembre 1992), but it is considered as an agricultural pest and subject to eradication programmes in other countries (Macdonald et al., 2003).

There are no native species of *Otala* on the Maltese Islands (Giusti et al., 1995), and neither have there been any records of introduced *Otala punctata* before, although there are reports of the similar *Otala lactea*: Feilden (1879) collected a number of beached specimens, presumably transported by the sea, while Machin (1972) claimed to have obtained a culture of *Otala lactea* from Malta, although it is more likely that these were the common *Eobania vermiculata* (Müller, 1774), which shell superficially resembles that of *Otala lactea*. Recently, Mifsud et al. (2003) claimed to have recorded *Otala lactea* within a plant nursery in central Malta. On visiting the surrounding areas of the same nursery we found a substantial population of *Otala punctata*, probably being the same species misidentified by Mifsud et al. in 2003.

The biology of *Otala punctata* is not well documented; more literature has been published on the similar helicids *Otala lactea* and *Eobania vermiculata*, which are all thermophilic Mediterranean species sharing a similar morphology, ecology and life cycle. *Otala lactea*, for example, occurs sympatrically with *Otala punctata* in parts of the Iberian peninsula and both species are thought to exhibit similar life cycle patterns (Robinson et al., 1998).

Otala lactea typically occupies disturbed habitats such as vacant lots, fence rows and roadsides (Elliot & Pierce, 1992), tolerates dry and humid environments, and is documented as capable of aestivating for up to four years (Gaskoin, 1862). On studying an introduction of *Otala lactea* in Southern California (which has a Medi-

terranean climate), Albrecht (2001) noted that aestivation initiated in mid-April, with individuals aggregating on stalks of the giant fennel *Foeniculum vulgare* at not less than 0.2 m above ground in order to evade ground heat, but probably also to escape rodent predation, which this author describes as being the most significant mortality factor. Albrecht (2001) also describes the species as exhibiting bimodal circadian activity, correlated positively with increasing relative humidity and negatively with increasing air temperature.

Populations of *Eobania vermiculata* in Greece have been extensively studied by Lazaridou-Dimitriadou & Kattoulas (1981, 1985, 1986, 1990). On the basis of a covered or uncovered umbilicus to distinguish between adults and juveniles respectively, the authors concluded that at any one time during the year, two generations normally co-exist, this being sometimes complemented by a third generation of adults past their egg-laying stage, a stage normally associated with a high incidence of mortality. *Eobania vermiculata* is also reported as being highly adaptable to climate variations, hibernating or aestivating depending on season.

In view of the characteristics exhibited by close relatives in Mediterranean type climates, it is thus highly probable that *Otala punctata* is similarly highly adaptable to Malta's climate and environment, prompting us to investigate the possibility that *Otala punctata*, originally introduced through the horticultural trade, has established itself outside the confines of the controlled environment of the plant nursery and is dispersing into the Maltese countryside.

Should this be the case, then the spread of this species in yet another location outside its natural range is of great concern. Besides the potential for altering ecosystems, some of which host Malta's threatened endemic helicids (Giusti et al., 1995), the presence of the species within a plant nursery and close to or within agricultural land, may signify an uncontrolled spread of a potential pest. The information hereby presented is thus crucial in assessing the spread of a newly introduced species still at its early stages of establishment and dispersal.

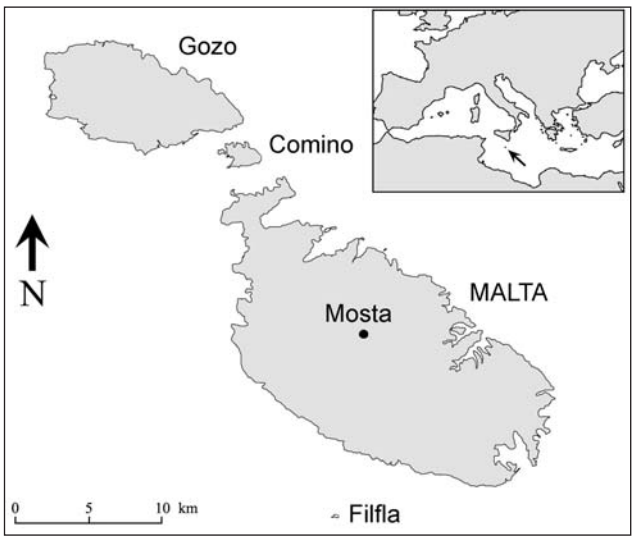

Fig. 1. Location of Malta in the central Mediterranean (inset). Marked location represents the study area on the outskirts of the town of Mosta, central Malta.

Fig. 1. Ubicazione di Malta nel Meditrraneo centrale (riquadro). È indicata l'area di studio, nella periferia della città di Mosta.

Material and methods

Following the discovery of *Otala punctata* at the Mosta nursery (**Fig. 1**), we revisited the area in 2006 and conducted a survey within an area of 400 metre radius around the same nursery (**Fig. 2**), checking for alien snails and noting their habitat preferences.

Twelve sampling plots each measuring 10 m by 10 m were randomly selected within the study area; these comprised a range of available habitats as follows: barren soil, cultivated land, abandoned fields with steppic grassland, and derelict land used as a dumpsite for construction waste. Other features included in these plots were country lanes, surfaced roads, dry-stone walls, reservoirs and sheds, all characteristic components of the Maltese rural landscape. All gastropod species within each sampling plot were collected and then identified and counted.

So as to determine whether this introduction had a single point of origin, we also visited all the plant nurseries of the Maltese Islands (10 on Malta, and 2 on Gozo) and searched their surroundings for *Otala punctata.*

Population density (estimated as number of individuals per square metre) was calculated for each sampling plot and analysed for changes with distance from the plant nursery.

We also measured maximum shell diameter for each *Otala punctata* specimen to the nearest 0.1 mm (as per Forsyth, 1999) so as to study variation in size. Shell diameter, unlike shell height and shell thickness which are allometric growth factors in similar helicid genera such as *Eobania* (pers. obs.), is a reliable morphological trait for aging snails (Lazaridou-Dimitriadou & Kattoulas, 1981). These measurements were used to assess variation in size (and therefore age) of individuals, with the aim of identifying different generations or cohorts resulting from progressive reproductive events. Such variation is normally exhibited as a polymodal frequency-size distribution. We analysed shell diameter data using probability plots on MINITAB v.14.2, following the methodologies of Harding (1949) and Cassie (1954, 1962). We then decomposed the shell diameter data into modal classes using Bhattacharya's method for modal class progression analysis (Bhattacharya, 1967), employing FAO's FISAT II v.1.2.0 suite of programmes (Gayanilo et al., 2002), and following similar studies carried out on population parameters of molluscs (Mohammed & Yassein, 2002; Katsanevakis, 2005). A one-way ANOVA (using SPSS for Windows v.11.0) was used to test the significance of the decomposed modal classes, using values for population size, mean and standard deviation for each derived modal class (Pezzullo, 2005).

Results

Otala punctata was found to occupy various sites and habitats around the nursery (**Fig. 2**). The snails did not

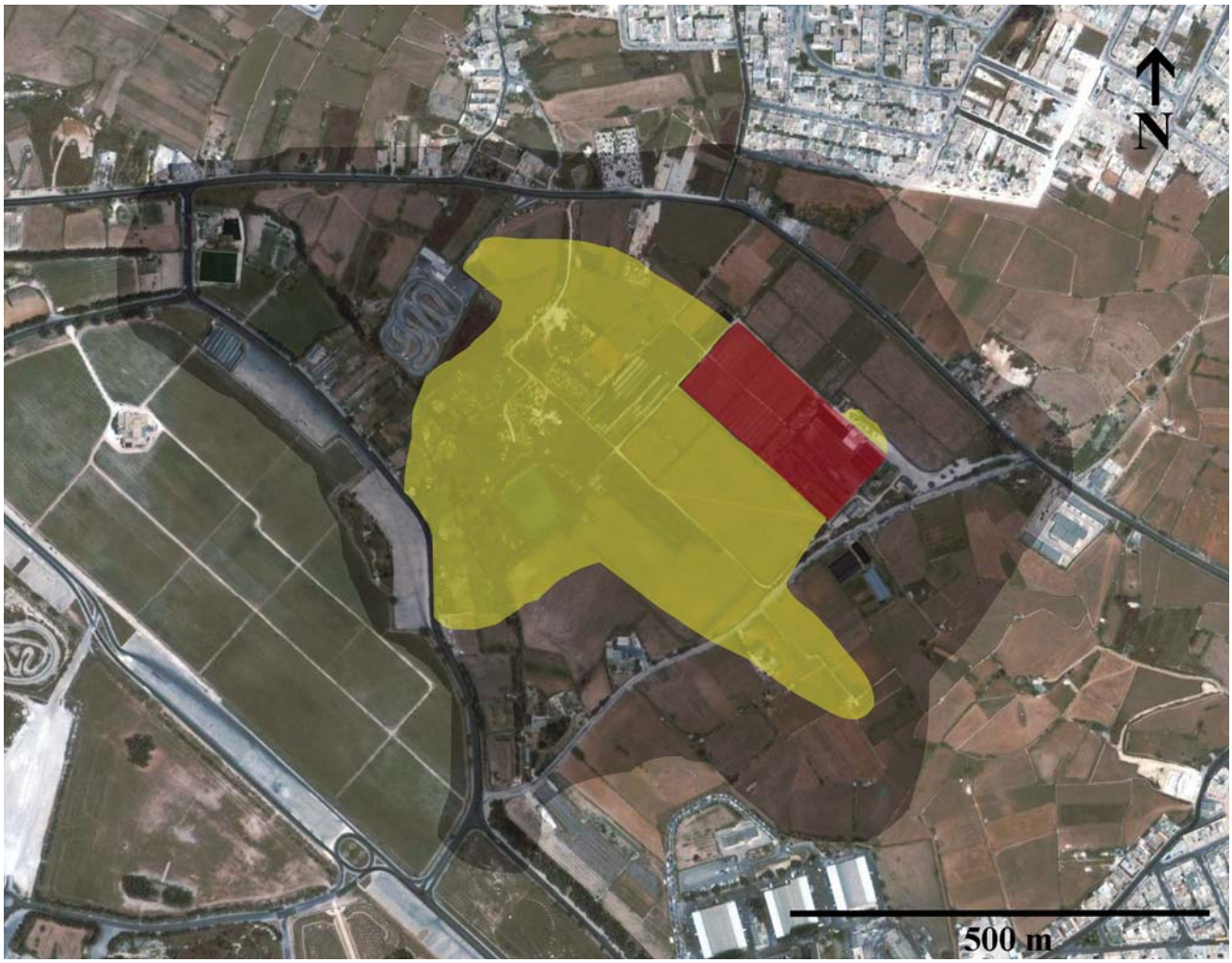

Fig. 2. An aerial view of the study area (in black) showing the approximate distribution of *Otala punctata* (in yellow) around the plant nursery at Mosta (in red).

Fig. 2. Veduta area dell'area di studio (in nero) con la distribuzione approssimativa di *Otala punctata* (in giallo) attorno al vivaio a Mosta (in rosso).

have particular substratum preferences and individuals were found on dry-stone walls, under stones and on a variety of ubiquitous flora including wild carrot *Daucus carota*, perennial wall rocket *Diplotaxis tenuifolia*, giant fennel *Ferula communis*, common fennel *Foeniculum vulgare*, tree mallow *Lavatera arborea*, boar thistle *Galactites tomentosa*, and crown daisy *Glebionis coronaria*.

A total of 222 individuals of *O. punctata* were collected from eight of the twelve quadrats sampled; no snails were found beyond a maximum distance of 378 m from the nursery. Where found, population densities ranged from a minimum of 0.025 m^2 to a maximum of 1.73 m^2, with *O. punctata* generally having a higher density than native snail species. No particular correlation with population densities of other species was observed (**Tab. 1**), although this needs further investigation. We also noted that specimens exhibited two distinctive morphs: a dark brown banded shell (**Fig. 3E-H**, and a less common light coloured unbanded shell (**Fig. 3I-L**).

No statistically significant correlation was found bet-

Quadrats	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12
Cantareus apertus	5	0	0	0	0	0	0	0	0	0	0	0
Cantareus aspersus	0	0	0	1	0	0	8	63	0	0	0	0
Cernuella caruanae	278	2	22	3	0	5	0	78	0	10	0	0
Eobania vermiculata	8	1	2	0	0	5	32	165	0	38	0	1
Otala punctata	173	18	28	17	0	50	0	69	0	3	0	14
Papillifera papillaris	0	0	0	0	0	0	0	6	0	0	0	0
Theba pisana	102	3	22	11	1022	510	104	98	0	53	0	3

Tab. 1. Population densities (individuals per 100 m^2) of gastropod species from 12 quadrats in the study area.

Tab. 1. Densità delle popolazioni (individui per 100 m^2) delle specie di gasteropodi in 12 quadrati nell'area di studio.

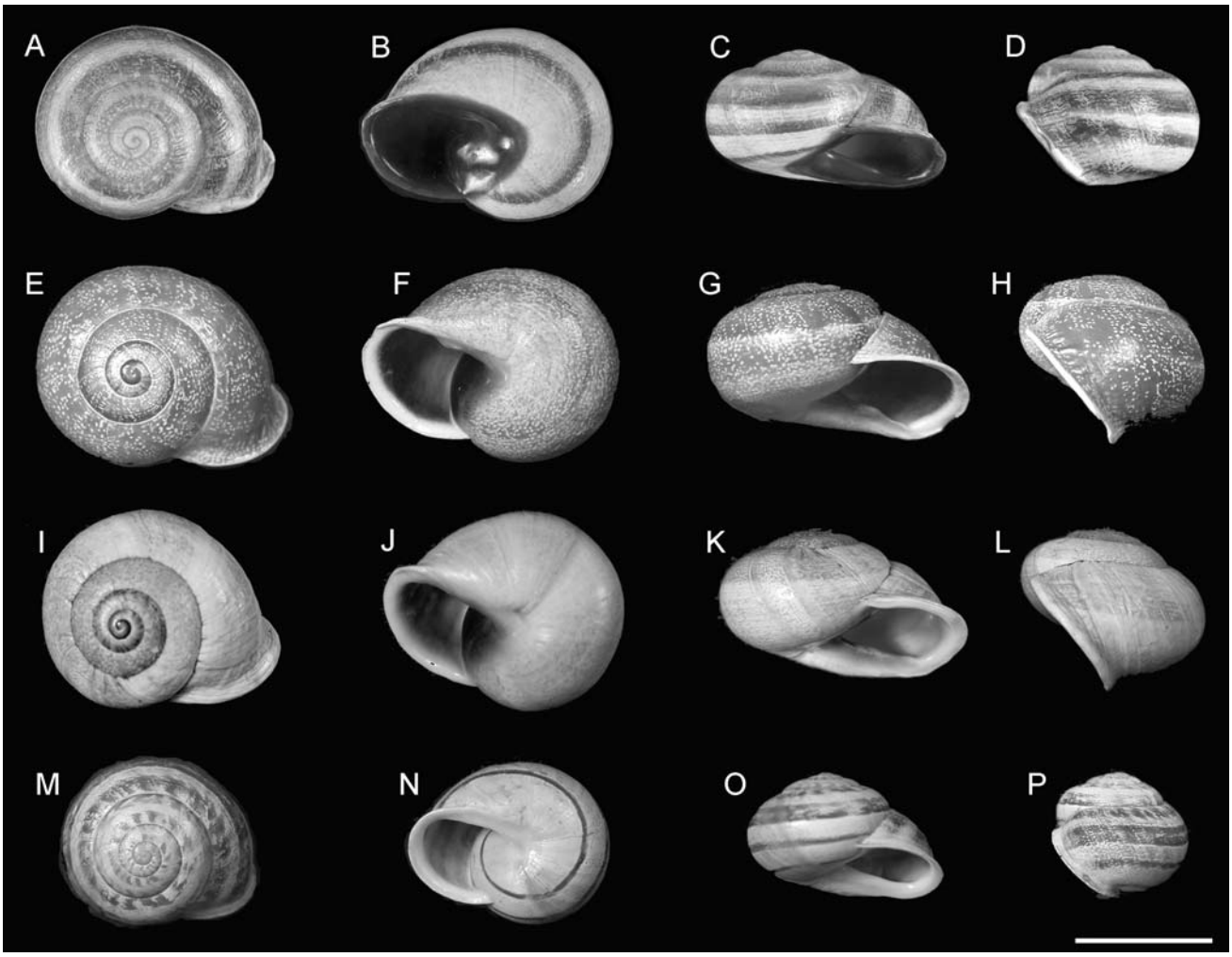

Fig. 3. Apical (1st column), basal (2nd column), apertural (3rd column) and abapertural (4th column) views of shells of (**A-D**) *Otala lactea* (Spain, Murcia, L. Pagliacci 20/4/92, Folco Giusti collection no. 36802), (**E-H**) *Otala punctata*, dark brown morph (Malta, Mosta, N. Barbara, 29/5/06), (**I-L**) *Otala punctata*, light brown morph (Malta, Mosta, N. Barbara, 30/5/06), (**M-P**) *Eobania vermiculata* (Malta, Zabbar, N. Barbara, 19/5/08). Scale bar = 20 mm. Photographs of *O. lactea* by Viviana Fiorentino; all others by Nicholas Barbara.

Fig. 3. Veduta apicale (1a colonna), basale (2a colonna), aperturale (3a colonna) e abaperturale (4a colonna) della conchiglia di (**A-D**) *Otala lactea* (Spagna, Murcia, L. Pagliacci 20/4/92, collezione Folco Giusti n. 36802), (**E-H**) *Otala punctata*, morfotipo marrone scuro (Malta, Mosta, N. Barbara, 29/5/06), (**I-L**) *Otala punctata*, morfotipo chiaro (Malta, Mosta, N. Barbara, 30/5/06), (**M-P**) *Eobania vermiculata* (Malta, Zabbar, N. Barbara, 19/5/08). Scala = 20 mm. Foto di *O. lactea* di Viviana Fiorentino, le altre di Nicholas Barbara.

ween population density and distance from the plant nursery. Almost all snails were located outside the nursery premises except for two individuals found attached to trees in the nursery's parking area, as opposed to Mifsud et al. (2003) only finding individuals within the confines of the nursery.

Shell diameter varied considerably in the sampled population: **Tab. 2** gives minima, maxima and mean shell measurements for adult *Otala punctata*, which constituted 20.6% of the collected individuals. Decomposition of shell diameter measurements using Bhattacharya's method showed a polymodal frequency distribution with three distinct modal classes **(Fig. 4)**. The means for the three derived modal classes were found to be significantly different following a one way ANOVA test (Pezzullo, 2005) ($F2 = 682.6228$, $p < 0.05$).

	Min	Max	Mean	Standard deviation
Diameter	23.8	35.3	31.7	1.9
Height	17.1	29.0	19.9	1.4

Tab. 2. Shell measurements (in mm) of adult *Otala punctata*.

Tab. 2. Misure della conchiglia (in mm) di individui adulti di *Otala punctata*.

Discussion

Our preliminary results and analyses of the occurrence of *Otala punctata* in Malta indicate that this species was introduced to the island from as early as 2003 (referring to Mifsud et al.'s record of *Otala lactea*), and that it has since established itself within an estimated area of 50,000 m^2 in the immediate vicinity of the Mosta nursery.

The recorded variations in shell diameters (from neonates to adults) confirm that *Otala punctata* has established a successfully breeding population. Moreover, analysis of size-frequency data has shown the presence of three distinct size classes which we believe may be attributed to yearly cohorts. Being a thermophilic helicid, *Otala punctata* is expected to undergo alternating periods of reduced and active growth and reproductive activity, corresponding to aestivating (April to September) and

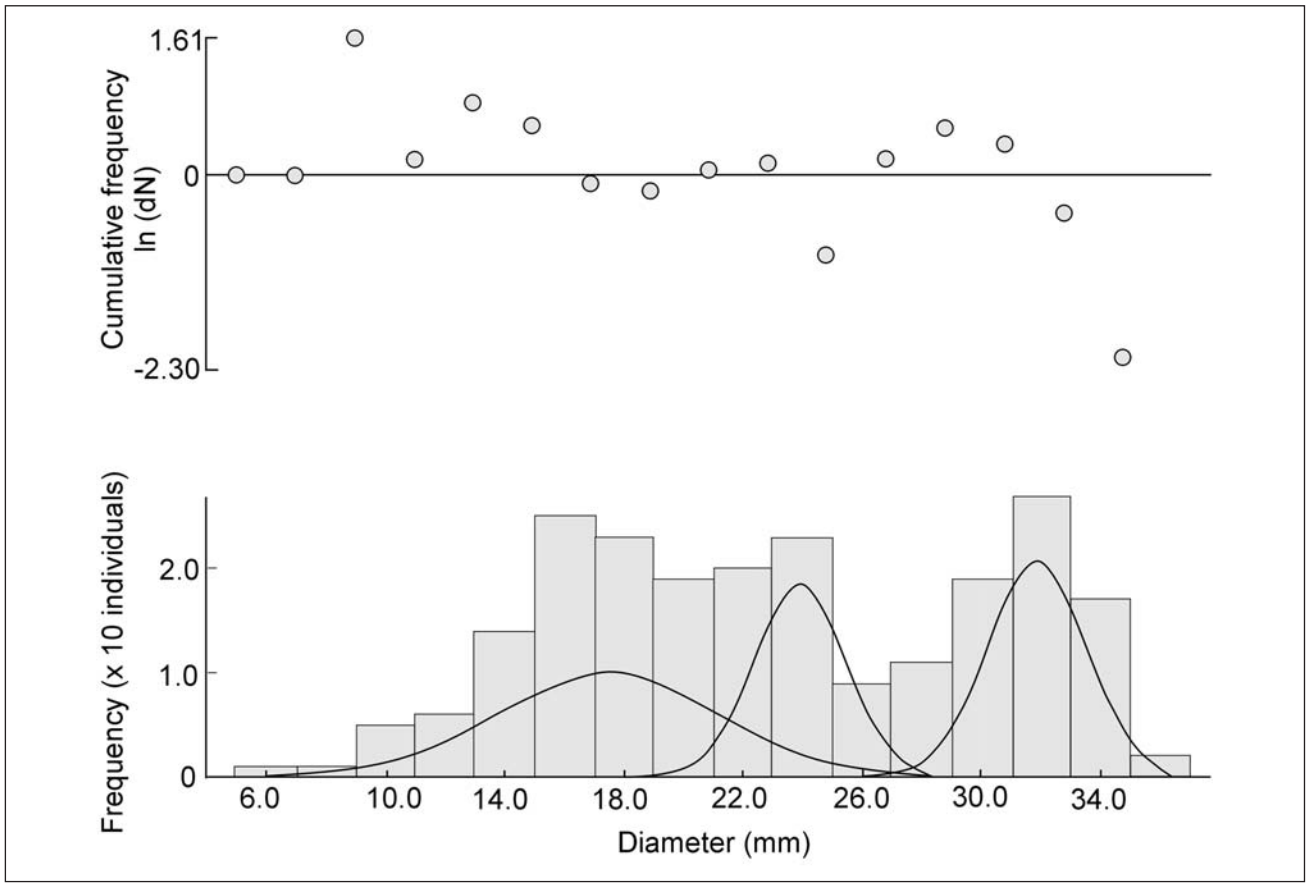

Fig. 4. Composite modal classes for maximum shell diameter of *Otala punctata* using Bhattacharya's method (1967).

Fig. 4. Classi modali composite relative al diametro massimo della conchiglia di *Otala punctata* tramite il metodo di Bhattacharya (1967).

active (October to March) phases in the strongly bi-seasonal Mediterranean climate of Malta. Alternating periods of dormancy and activity in a Mediterranean type climate have been similarly documented for introduced *Otala lactea* in Southern California where mid-April marks the start of aestivation (Albrecht, 2001). It is possible that *Otala punctata* is easily capable of altering its reproductive pattern and dormancy periods to suit different climatic conditions as is the case in the similar helicid *Eobania vermiculata* (Lazaridou-Dimitriadou & Kattoulas, 1981; Medynskaya & Popov, 1998).

Accordingly, we estimate that by 2006, a significant population of *Otala punctata* had 'escaped' from the point of introduction (the plant nursery) into the surrounding land, and contributed at least two successive filial generations, each corresponding to the size classes identified through Bhattacharya's method. Studies on *Eobania vermiculata* by Lazaridou-Dimitriadou & Kattoulas (1981) have shown the co-existence of two distinct generations of the snail at any one time of the year, with a possibe third generation of aged adults past their laying stage and estimated mean two-year lifespan. This pattern may correspond to the three size classes or generations of *Otala punctata* we found around the Mosta nursery. By 2006, the population within the nursery's premises had been eradicated, as confirmed by our failure to find any individuals during various visits to the nursery. Comparing density with distribution did not reveal any particular patterns, showing that the collected specimens were not recent escapes from the nursery as otherwise higher population densities closer to the nursery would have been found.

The behavioural patterns shown by this Western Mediterranean species have clearly played a significant role in *Otala punctata* establishing a breeding population at Mosta. Like native Helicidae, *Otala punctata* is mostly nocturnal, and aestivates, seeking refuge from the scorching summer ground temperatures by attaching itself by means of an epiphragm to stalks or walls. Its association with a variety of common plants also suggests that it possibly has an unspecific diet and is thus potentially able to disperse to a variety of other habitats in Malta.

The dispersal mechanism involved in the proliferation of this species in the Maltese countryside may be complex and certainly cannot be resolved without further insight into this introduction. The impact of *Otala punctata* on Malta's biodiversity and agro-ecosystems can be negative, beneficial or insignificant. It is generally believed that the introduction of invasive species coincides with the modification of the functioning of ecosystems (Pointier & Augustin, 1999; Gurevitch & Padilla, 2004). Moreover, exotic species are equally rated with habitat destruction as key agents causing loss of native biodiversity (Didham et al., 2005).

It is justified to argue that given the present findings, the possibilities for further dispersal of this species are large. The species has shown an ubiquitous presence in a number of habitats throughout the study area and is associated with ruderal vegetation. Moreover, further

dispersal through anthropogenic means is highly probable - possibilities for passive transport include the transportation/selling of agricultural and horticultural products from the area, transport by agricultural and other vehicles visiting the area, and transportation of eggs and/or adults with soil for landscaping, horticultural or agricultural purposes (Cowie & Robinson, 2003). *Otala punctata* is palatable, as a result of which it may also attract deliberate dispersal.

The recent introduction of *Otala punctata* sheds light on a very important aspect associated with the horticultural trade – that of the anthropogenic dispersal of species outside their natural range. Gastropods are particularly hardy species which resist long transitions and due to their small size and inconspicuous nature, are generally overlooked when it comes to importation/exportation checks. In Malta, gastropods are excluded from the list of quarantine species governed by local legislation (Plant Health Department, 2008). This is important to Malta, which already has a number of introduced alien gastropods (Guisti et al., 1995; Mifsud et al., 2003) and is susceptible to further introductions unless measures are taken.

Conclusion

Otala punctata still has a very limited range in Malta, but its adaptability to a variety of habitats and the local climate, and its association with ubiquitous flora, may favour its dispersal, be it deliberate or accidental, to other parts of the country. Consequently, this introduction needs to be closely monitored and if necessary, *Otala punctata* should ideally be eradicated while it is still in the initial stages of establishment and dispersal, especially given its potential to become an agricultural pest and/or a threat to local biodiversity.

The accidental introduction of *Otala punctata* into Malta results from a global trade situation where different countries adopt different approaches to checking the importation and export of goods, in particularly horticultural products. This situation is rendered worse in the case of liberalized trade between affiliated countries such as Malta and the EU.

Acknowledgments

We are grateful to Prof. Giuseppe Manganelli of the Department of Environmental Sciences of the University of Siena (Italy) for identifying *Otala punctata* and providing us with essential literature, and to Dr. Viviana Fiorentino from the same Department for the photographs of *Otala lactea.* We would like to thank the reviewers, Prof. Folco Guisti and Prof. Francisco Welter-Schultes, and the editor Prof. Rafael La Perna for their useful suggestions for improving an earlier draft of this paper. The first author submitted this research in part fulfilment of the requirements for the MSc in Conservation and Biodiversity at the University of Exeter in Cornwall (UK).

References

Albrecht C., 2001. Invasion biology of a species with low mobility – the Mediterranean helicid snail *Otala lactea* (O.F. Müller, 1774) in Southern California. *Diplomarbeit, Institute of Ecology, University of Jena:* 71.

Bhattacharya C.G., 1967. A simple method of resolution of a distribution into Gaussian components. *Biometrics*, **23**: 115-135.

Cassie R.M., 1954. Some use of probability paper in the analysis of size frequency distributions. *Australian Journal of Marine and Freshwater Research*, **5**: 513-522.

Cassie R.M., 1962. Frequency distribution models in the ecology of plankton and other organisms. *Journal of Animal Ecology*, **31**: 65-92.

Carrada G., Parisi V. & Sacchi C., 1967. Dati per una biogeografia dei molluschi continentali in Sardegna. *Atti della Società Italiana di Scienze Naturali, Milano*, **105**: 377-388.

Cowie R.H. & Robinson D.G., 2003. Pathways of introduction of non-indigenous land and freshwater snails and slugs, in Ruiz G. & Carlton J.T., 2003 (eds), *Invasive species: vectors and management strategies*, Island Press, Washington DC: 93-122.

Didham R.K., Tylianakis J.M., Hutchison M.A., Ewers R.M. & Gemmel N.J., 2005. Are invasive species the drivers of ecological change? *Trends in Ecology and Evolution*, **20** (9): 470-474.

Elliott A.C. & Pierce B.A., 1992. Size, growth rate, and multiple-locus heterozygosity in the land snail (*Otala lactea*). *Journal of Heredity*, **83**: 270-274.

Falkner G., 1990. Binnenmollusken. *Steinbachs Natürfurher*, **10**: 236.

Feilden H.W., 1879. The land and fresh-water mollusca of the Maltese Group. *The Zoologist (III)*, **3**: 193-199.

Forsyth R.G., 1999. *Terrestrial gastropods of the Columbia basin, British Columbia*. Living Landscapes. The Royal British Columbia Museum, British Columbia: 11-16.

Frank B., 2006. Florida land snail gallery: *Otala punctata* (Müller 1774). http://www.jaxshells.org/galleryz.htm. Last access 12 Jun 2007.

Gayanilo F.C., Sparre P. & Pauly D., 2002. Welcome to FISATII's online user guide. Food and Agriculture Organisation of the United Nations, Rome. http://www.fao.org/fi/statist/fisoft/fisat/WebHelp/FiSAT2.htm. Last access on 12 Jun 2007.

Gaskoin J.S. (1852). On the habits of *Helix lactea. Proceedings of the Zoological Society of London*, **18**: 243–244.

Giusti F., Manganelli G. & Schembri P.J., 1995. The non-marine molluscs of the Maltese Islands. *Museo Regionale di Scienze Naturali, Torino, Monografie*, **15**: 1-608.

Gurevitch J. & Padilla D.K., 2004. Are invasive species a major cause of extinction? *Trends in Ecology and Evolution*, **19** (9): 470-474.

Harding J.P., 1949. The use of probability paper for the graphical analysis of polymodal frequency distributions. *Journal of the Marine Biological Association of the United Kingdom*, **28**: 141-153.

Katsanevakis, S., 2005. Population ecology of the endangered fan mussel *Pinna nobilis* in a marine lake. *Endangered Species Research*, **1**: 1-9.

Lazaridou-Dimitriadou M. & Kattoulas M.E., 1981. Contribution à l'étude de la biologie et de la croissance des escargots commercialisés en Grèce: *Eobania vermiculata* (Muller) et *Helix aspersa* Muller. *Haliotis*, **11**: 129-137.

Lazaridou-Dimitriadou M. & Kattoulas M.E., 1985. Contribution à l'étude biologique et écologique d'*Eobania vermiculata* (gastéropode, Helicidae). *Biologia Gallo-hellenica*, **10**: 131-137.

Lazaridou-Dimitriadou M. & Kattoulas M.E., 1986. Com-

paraison du cycle biologique et de la croissance d'*Eobania vermiculata* (Müller) dans la nature et dans des conditions expérimentale [sic]. *Bulletin de la Société Zoologique de France*, **111** (1/2): 99-104.

Lazaridou-Dimitriadou M. & Kattoulas M.E., 1990. Energy flux in a natural population of the land snail *Eobania vermiculata* (Müller) (Gastropoda, Pulmonata, Stylommatophora) in Greece. *Canadian Journal of Zoology*, **69**: 881-891.

MacDonald I.A.W., Reaser J.K., Bright C., Neville L.E., Howard G.W., Murphy S.J. & Preston G. (eds.), 2003. *Invasive alien species in southern Africa: national reports and directory of resources*. Global Invasive Species Programme, Cape Town, 62 pp.

Machin J. (1971) Water exchange in the mantle of a terrestrial snail during periods of reduced evaporative loss. *Journal of Experimental Biology*, **57**: 103-111.

Malatesta A. & Settepassi F., 1954. Fossili delle formazioni continentali quaternarie. *Bollettino del Servizio Geologico d'Italia*, **76:** 33-39

Martinez-Orti A. & Robles F., 2001. Biodiversity of the snails in the "Comunidad Valenciana" (Spain), in Salvini-Plawen L., Voltzow J., Sattmann H. et al. (eds), 2001, *World Congress of Malacology 2001, Abstracts*. Unitas Malacologica, Vienna: 201.

Medynskaya O. & Popov V. (1998). Some aspects of the reproductive strategy of the land snail *Eobania vermiculata* (Müller) in the Crimea, in Bieler R. & P. Mikkelsen P. (eds), *Abstracts, World Congress of Malacology*, Unitas Malacologica, Washington, DC: 216.

Mifsud C., Sammut P. & Cachia C., 2003. On some alien terrestrial and freshwater gastropods (Mollusca) from Malta. *Central Mediterranean Naturalist*, **4** (1): 35-40.

Mohammed S.Z. & Yassien, M.H., 2003. Population parameters of the pearl oyster *Pinctada radiata* (Leach) in Qatari waters, Arabian Gulf. *Turkish Journal of Zoology*, **27**: 339-343.

Pezzullo J.C., 2005. Analysis of variance from summary data. http://www.statpages.org/anova1sm.html. Last access 12 Jun 2007.

Plant Health Department, 2008. *Acts and regulations.* http://www.planthealth.gov.mt/acts_&_regulations.htm. Last access 16 Feb 2008.

Pointier J. & Augustin D., 1999. Biological control and invading freshwater snails: a case study. *Life Sciences*, **322**: 1093-1098.

Robinson D.G., Redmond L. & Hennessey R., 1998. Importation and interstate movement of live, edible land snails: *Cantareus apertus* (Born), *Cryptomphalus aspersus* (Müller), *Eobania vermiculata* (Müller), *Helix pomatia* Linné, and *Otala lactea* (Müller) (Pulmonata: Helicidae). *Qualitative Pest Risk Assessment.* USDA APHIS PPQ Scientific Services, Riverdale, MD.

Sanz J.R., 2006. *Otala* (*Otala*) *punctata* (O.F. Müller, 1774). Gualtierianus: Especies. http://www.malacologia.net/gualtierianus/dphp/especies.php?codigo = 78. Last access 12 Jun 200.

Welter Schultes F., 2006. AnimalBase, species summary for *Otala punctata* http://www.animalbase.uni-goettingen.de/zooweb/servlet/AnimalBase/home/species?id = 1656. Last access 12 Jun 2007.

Lavoro ricevuto il 12 marzo 2008
Lavoro accettato il 17 giugno 2008