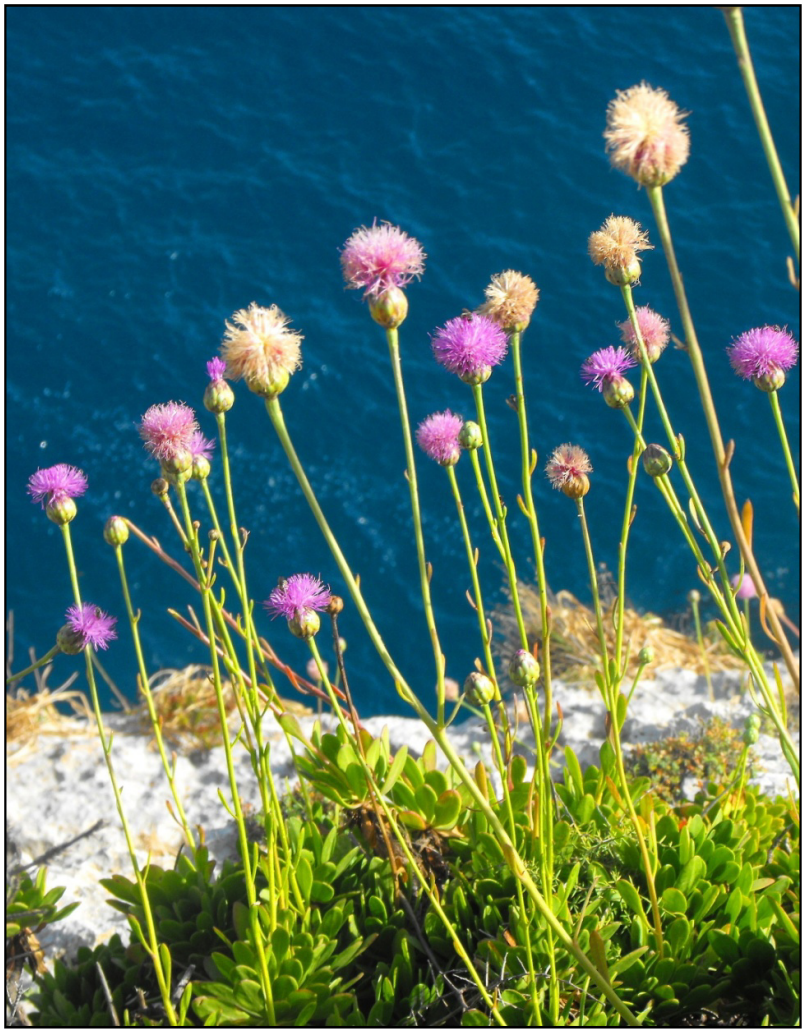
THE CENTRAL MEDITERRANEAN NATURALIST



VOLUME 5 PARTS 3 & 4 MALTA, 2011-2012

NTM
nature trust (malta)

In 1998, three N.G.O.s sharing the common aim of promoting the awareness, conservation and study of Malta's natural heritage decided to join forces so as to form a single, more effective association. The organizations were the Society for the Study and Conservation of Nature (SSCN), founded in 1962, and the more recently formed groups Arbor and Verde. This merger resulted in the formation of Nature Trust (Malta) which was officially launched by His Excellency the President of the Republic on Friday 8th January 1999. In June 2001, another organization, the Marine Life Care Group (MLCG) also joined Nature Trust (Malta).

Mission Statement

'Committed to the conservation of Maltese nature by promoting environmental awareness, managing areas of natural and scientific interest, and lobbying for effective environmental legislation.'

Cover photo: Malta's National Plant *Palaeocyanus crassifolius* by Jeffrey Sciberras.

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THE CENTRAL MEDITERRANEAN NATURALIST

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CONTENTS

EDITORIAL

Most scholarly journals, and rightly so, do not have editorials. The reader is not interested in the musings of an editor but in perusing the contributions contained therein. However an exception can be made for this issue of *The Central Mediterranean Naturalist* since it marks the 50th anniversary since the foundation of the Natural History Society of Malta (NHSM) in December 1962. Since then the society had to change its name a few times and is currently incorporated in Nature Trust (Malta).

Mr Guido Lanfranco addressing the first meeting of the Natural History Society of Malta in 1962

The first 'periodical' issued by the NHSM was *News and Views* which first appeared in 1963 and contained news about the Society, about natural history in Malta, bibliographical updates but also original contributions to the natural history of Malta, some of which were illustrated. In those days the finances of the NHSM hardly ever touched the three-figure mark and had to make do with cyclostyling its publications. The *News and Views* evolved into *The Maltese Naturalist* in 1970 and this consisted entirely of papers and short contributions of Maltese Natural History interest. Due to legislation prohibiting the use of terms like 'Malta' and 'Maltese' in non-official publications and bodies, both the NHSM and *The Maltese Naturalist* were forced to change their name. For a brief period the NHSM became just the Natural History Society and, shortly thereafter the Society for the Study and Conservation of Nature (SSCN) which name was retained until the formation of Nature Trust Malta on the 8th January 1999. It was decided to rename *The Maltese Naturalist* as *The Central Mediterranean Naturalist*, taking the opportunity to introduce significant changes i.e. to open its scope to a wider geographical area and to issue it in printed format. This new journal was first published in 1979.

Edwin Lanfranco
Editor

DEDICATION

This issue of the Central Mediterranean Naturalist marks the 50th anniversary since the foundation of the Natural History Society of Malta (later: Natural History Society, Society for the Study and Conservation of Nature and, now, incorporated in Nature Trust (Malta). It is therefore appropriate that this issue should be dedicated to **Guido Lanfranco**, since it was due to his efforts that the society was founded in 1962, with Guido himself as first president.

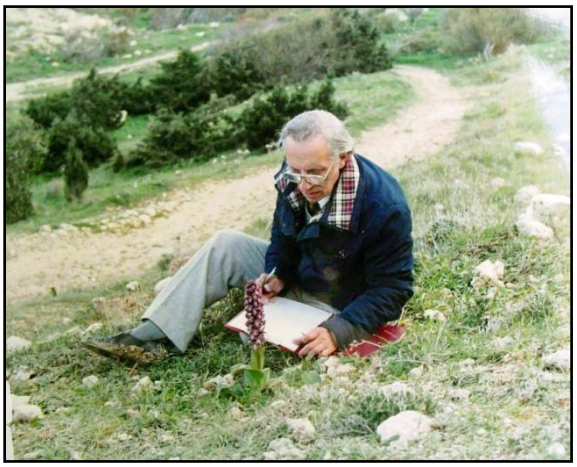

Photo Sandro Lanfranco

Guido Lanfranco sketching the Giant Orchid (*Barlia robertiana*) in the field in January 1991

Since childhood Guido revealed an inquisitive mind and he was especially drawn to the world of nature; in the late 1940s he started to explore the countryside observing wildlife and geology. Being blessed with a gift for painting he started to illustrate the subjects of his interest. Unfortunately he came at a time when the generation of eminent Maltese naturalists such as Alfredo Caruana Gatto, John Borg and Giuseppe Despott had died out and publications about Maltese natural history were scarce and hard to come by. As a beginner his principal mentors were Anthony Valletta, particularly for entomology, and Carmelo Penza, who was Head Gardener at the Argotti Botanical Gardens and who had absorbed botanical knowledge from his mentors Caruana Gatto and John Borg. Being conscious of the lack of resources for those with an interest in natural history, he set out to provide these himself with a long series of articles, starting in 1953, in newspapers and other periodical publications. This finally culminated in the publication of his first book *Guide to the Flora of Malta* (1955) in which 300 wild plants were briefly described and illustrated by line drawings. It was the first publication illustrating a significant number of Maltese wild plants. This was soon followed by *A Complete Guide to the Fishes of Malta* (1958) wherein he illustrated all local fish species known at the time. A string of other publications followed and continues to the present day. Early in his career he was also involved in broadcasting, with regular features on the then Rediffusion. With the introduction of Maltese television in 1962 he also started a series of regular programmes illustrated with specimens, paintings and photographs of Maltese wildlife. He thus became a household name and his contributions in the media helped to foster a growing interest in local wildlife.

Seeing that the number of natural history enthusiasts was growing, and also fuelled by the presence in Malta of the British armed forces and numerous British retirees, he, together with other enthusiasts, embarked on the launch of a society to cater for those interested in wildlife and to stimulate public awareness about the need for its protection, at a time when the term 'nature conservation' had hardly entered the vocabulary. This actually resulted in the foundation of two societies: The Malta Ornithological Society, now Birdlife Malta (April 1962), and the Natural History Society of Malta (NHSM, December 1962), of both of which he was the first president. The societies started to publish newsletters and, eventually, journals. In the case of the NHSM the first substantial periodical was *News and Views* (1963) which, apart from news items, also included short articles of natural history interest, often illustrated with line drawings, in some cases hand-coloured by Guido himself. At the time all publications were cyclostyled, and illustrations were cut directly on waxed stencil paper, work carried out mainly by Guido himself. This was later followed by *The Maltese Naturalist* (1970) which eventually morphed into the *Central Mediterranean Naturalist*, the society's first printed journal.

Vince Attard
President, Nature Trust Malta

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CONTRIBUTIONS TO THE MALACOLOGY OF MALTA, I: A NEW LOCATION FOR SUBFOSSIL *OXYLOMA ELEGANS* (RISSO, 1826) (PULMONATA: SUCCINEIDAE) FROM THE SALINI HOLOCENE DEPOSITS IN MALTA

David P. CILIA[1] and Constantine MIFSUD[2]

ABSTRACT
A shell of *Oxyloma elegans* (Risso, 1826) is reported from the Holocene deposits at the Salini watercourse.

KEYWORDS: *Oxyloma*, Holocene, Gastropoda, Succineidae, Malta.

INTRODUCTION

The Salini area in northwest Malta is a saltmarsh hosting a number of species which are restricted or absent from the remainder of the Maltese Islands. A valley leading from the Burmarrad area to the seashore intersects Salini, ending in an estuary where freshwater gradually mixes into the seawater, creating a salinity gradient with a large number of microhabitats exploited by a great variety of species. Especially interesting from a malacological perspective are populations of *Hydrobia acuta* (Draparnaud, 1805), *Truncatella subcylindrica* (Linnaeus, 1767), and *Myosotella myosotis* (Draparnaud, 1801). Loose shells of *Melanoides tuberculata* (Müller, 1774), *Auriculinella bidentata* (Montagu, 1808), and *Ecrobia ventrosa* (Montagu, 1803) occur as well; any indigenous populations of the former two species are now most probably extinct.

The banks of the watercourse are composed of a slightly indurated, sandy Holocene sediment of a pale brown colour (Figures 1 and 2). It contains a large number of subfossil mollusc shells that are, with care, easily separated from their matrix. During a recent investigation on a number of such shells, a single, intact subfossil shell of the succineid *Oxyloma elegans* (Risso, 1826) was found. While not to be considered a freshwater snail, this species is found in habitats of high humidity levels, such as river banks, marshes, and wetlands, usually occurring at the base of vegetation growing in water or very damp soil (Welter-Schultes, 2010).

MATERIALS AND METHODS

The shell discussed in this note occurred in a sample of material collected from a freshly-exposed site. This block of sediment was carefully dissolved in warm water, after which the resulting sediment was fractionated and examined carefully with a magnifying glass.

DISCUSSION

Fresh shells of *O. elegans* are smooth and translucent brown with a hyaline lustre. Subfossils, on the other hand, are identifiable by an opaque white shell, and, for Malta, they were previously reported by Giusti *et al.* (1995) from the Wied il-Baħrija quaternary deposits exclusively.The shells in this case were found in association with an assemblage of 'typical' freshwater and wetland gastropods, mainly planorbids, such as *Planorbis moquini* Requien, 1848 and *Gyraulus crista* (Linné, 1758).

In contrast to the assemblage from Wied il-Baħrija, the deposit at Salini yielded several species which are generally considered to be inhabitants of brackish or saline water, as well as a few terrestrial species that were probably carried into the sediment by fresh water. A single juvenile shell of *Rumina decollata* (Linnaeus, 1758), some *Cochlicella acuta* (Müller, 1774), and unidentified hygromiid juveniles are the only representatives of strictly terrestrial families. Freshwater and wetland species are represented by *O. elegans* and *Pseudamnicola moussonii* (Calcara, 1841), together with some species generally regarded as preferring brackish water, namely *H. acuta*, *M. myosotis*, and, up to a certain extent, *Potamides conicus* (Blainville, 1829). In addition, *T. subcylindrica* lives in plant debris close to the edge of the seashore or brackish water bodies. All other finds belong to species from marine families. A full list of specimens found is given in Table 1. Together with these molluscs, a number of tests of different benthic foraminifera and five tubes of the polychaete *Spirorbis* sp. were found.

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Figure 1 (left). Is-Salini estuary, Malta. Figure 2 (right) Holocene sediment on the banks of the Salini estuary. Figure 3 (bottom). Three views of the same subfossil shell of *Oxyloma elegans* (Risso, 1826) from the Holocene deposit at Salini, Malta. Photos David P. Cilia, 2011.

Table 1. List of sub-fossil mollusc shells recovered from Holocene sediment at is-Salini, Malta.

Class	Family	Species	Number
Bivalvia	Cardiidae	*Cerastoderma glaucum* (Bruguière, 1789)	12 valves
Gastropoda	Cerithiidae	*Bittium latreilli* (Payraudeau, 1826)	2
		Bittium reticulatum (da Costa, 1778)	several
	Cochlicellidae	*Cochlicella acuta* (Müller, 1774)	5
	Ellobiidae	*Myosotella myosotis* (Draparnaud, 1801)	1 juvenile
	Hydrobiidae	*Pseudamnicola moussonii* (Calcara, 1841)	7
		Hydrobia acuta (Draparnaud, 1805)	several
	Hygromiidae	indet.	8 protoconchs
	Muricidae	*Hexaplex trunculus* (Linnaeus, 1758)	6 fragments
	Nassariidae	*Nassarius cuvierii* (Payraudeau, 1826)	5
	Potamididae	*Potamides conicus* (Blainville, 1829)	several
	Pyramidellidae	*Turbonilla pusilla* (Philippi, 1844)	2
		Turbonilla sinuosa (Jeffreys, 1844)	1
	Retusidae	*Retusa truncatula* (Bruguière, 1792)	2
	Rissoidae	*Pusillina radiata* (Philippi, 1836)	1
		Rissoa membranacea (Adams, 1800)	several
		Rissoa sp.	1 juvenile
	Subulinidae	*Rumina decollata* (Linnaeus, 1758)	1
	Succineidae	*Oxyloma elegans* (Risso, 1826)	1
	Truncatellidae	*Truncatella subcylindrica* (Linnaeus, 1767)	1

The specimen of *O. elegans* is subadult, with 2.5 whorls and a height of 8mm (Figure 3). *O. elegans* is now extinct in the wild from the Maltese Islands. Extinction may have been the result of several factors, at the forefront of which could be the lack of stable freshwater habitats in Malta and the high temperatures and low rainfall experienced throughout most of the year.

The finding of a shell of *O. elegans* in the sample further confirms that the species did not become extinct in the wild until relatively recent times in the Holocene. Mifsud *et al*. (2003) report its re-introduction in the Maltese Islands through Zammit Nurseries, where it is found together with the smaller confamilial *Succinea putris* Linnaeus, 1758. Whereas Mifsud *et al.* (2003) report the finding of two fresh shells of *O. elegans* in compost;

unpublished research carried out since then by the present authors has revealed numerous live snails at the same place and also in another location (Flower Power plant nursery), mostly inhabiting wet compost beneath bushes of *Lantana* spp. and *Plumbago* spp.

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CONTRIBUTIONS TO THE MALACOLOGY OF MALTA, II: ON THE SECOND RECORD OF *OTALA PUNCTATA* (MÜLLER, 1774) (GASTROPODA: HELICIDAE) FROM MALTA

David P. CILIA[3]

ABSTRACT: *Otala punctata* is recorded for the second time in a locality different from that of the original record. Details of the snail's ecology and habits are given.

KEYWORDS: *Otala punctata*, Gastropoda, Helicidae, Alien Species, Malta.

The first Maltese record of the helicid *Otala punctata* (Müller, 1774), a species variously considered as being an Iberian (Martinez-Ortì & Robles, 2001) or a west Mediterranean (Falkner, 1990) endemic, dates back to only a few years (Barbara & Schembri, 2008). This record was documented from an area close to a garden centre in Ta' Qali (35°53'58"N, 14°25'43"E), suggesting an introduction via the importation of plants of commercial interest. An earlier record from the same area by Mifsud *et al.* (2003) cited as being *Otala lactea* (Müller, 1774) may be a misidentification referring to *O. punctata*. Incidentally, *O. lactea* was also recorded by Feilden in 1879, possibly in error, on the basis of beached shells.

In April 2011, an empty juvenile shell and an aestivating adult of this species were found in a vineyard at Baħrija (35°53'28"N, 14°20'40"E), a small village in southwestern Malta about 7.5km west of Ta' Qali. Due to slight lip damage on the adult snail, the assigned identification was confirmed through dissection of the adult specimen by Dr. Giuseppe Manganelli (University of Siena

Figure 1:

Top Left. The *Helianthus tuberosus* plantation where most of the helicid specimens were found.

Top Right. *Otala punctata* specimens at the base of *Helianthus*.

Left: Dead *Otala punctata*, *Cantareusaspersus* and *Eobania vermiculata* specimens close to molluscicide residue.

Photographs by David P. Cilia, 2011.

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In October 2011, a search of the area where the first specimens were found was carried out by the author, resulting in the collection of 14 live adults and eight empty shells (seven adults and one juvenile). Two of the live snails were attached to the stems of two grapevines, *Vitis vinifera* L., in a vineyard of about 1450m^2, with the rest being found in a plantation of Jerusalem artichoke, *Helianthus tuberosus* L., covering about 210m^2 (Figure 1a), thus with a preference ratio of 1:40 in favour of *Helianthus*. In a laboratory setting, it was observed that the collected snails do show a predilection for leaves of *Helianthus tuberosus* L., at least as a source of food.

In the field, they are generally found at the base of the plants (Figure 1b) and beneath associated irrigation pipes, suggesting that high soil surface temperatures of summer have prevented them from colonizing less sheltered areas such as relatively bare soil or even rubble walls where substantial populations of *Cantareus aspersus* (Müller, 1774) and *Eobania vermiculata* (Müller, 1774) may be found. Five of the dead specimens were found in close proximity to molluscicide residue on soil together with empty shells of *C. aspersus* and *E. vermiculata* (Figure 1c).

Since the two areas from which *O. punctata* is currently known are not continuous with each other, one can safely assume that introduction in each was a separate event. It is tempting to conclude that the snails or their eggs at Baħrija were introduced with *Helianthus* seedlings, plants or soil not too long before their discovery, perhaps even with material from the Ta' Qali garden centre (though *Vitis* as vectors are unlikely, due to the age of the shrubs involved and to the snails' disinclination for using their leaves as food). However, two juvenile snails, albeit dead, were found in the vineyard on the two separate occasions, therefore the notion that *O. punctata* is breeding in the area must not be completely overlooked.

ACKNOWLEDGEMENTS

The author would like to thank Prof. Patrick J. Schembri (University of Malta) for valuable recommendations and to Mr. Nicholai Galea and family (Baħrija, Malta) for allowing access to private land.

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RECENT RECORDS OF SPIDERS (ARACHNIDA: ARANEAE) FROM MALTA

David DANDRIA[1], **Albert GATT FLORIDIA**[2] **and Stephen MIFSUD**[3]

ABSTRACT

Two spider species are recorded from Malta, one for the first time (*Zora* sp., Family Zoridae) and one for the second time (*Aphantaulax cincta*, Family Gnaphosidae). Observations and other information about the species together with photographs are provided.

KEYWORDS: *Aphantaulax cincta*, *Zora*, Araneae, Malta.

INTRODUCTION

The most recent checklist of the spider fauna of the Maltese Islands, comprising 141 species in 31 Families, was published in 2005 (Dandria *et al.*, 2005). The two species recorded here, one of which is new to the Maltese fauna, were observed and photographed but not collected. These records bring the number of araneid species in the Maltese fauna to 142 in 32 Families.

THE SPECIES

Family Gnaphosidae

Aphantaulax cincta L. Koch 1866 (Figure 1)
Malta, Rdum il-Bies, limits of Mistra, 35" 57' 35 N, 14" 23' 39 E, 1 ♀, May 2012. (photographed by Stephen Mifsud)

This spider, with its unmistakable white dorsal markings on a black body, was first recorded in Malta in 1991 (Kritscher, 1996). Kritscher's record is of a male spider, but there is some doubt as to location, Kritscher's indication being quite anomalous, clearly due to his lack of familiarity with local geography. In fact, while he indicates that it was found "between Kalkara Valley and Mistra Bay" (*"Zwischen Kalkara Ravine und Mistra Bay"*), the map showing Kritscher's collecting points puts the locality in the vicinity of Mağtab. The specimen in question is deposited in the Natural History Museum of Vienna. The present record is the second for this species and is based on observation and photography by one of the authors (SM). The spider, a female, was near a silken sac in which it had probably moulted, as shown by the presence of exuvial remains inside the sac. The sac was located on the infructescense of the wild carrot, *Daucus carota* L., found in a garigue habitat at the border of coastal cliffs and scree facing east; 30m a.s.l. and about 100m away from the coast.

World Distribution: Europe, North Africa, Israel (Platnick, 2012).

European Range: Corsica, Croatia, Czech Republic, France Greece, Italy, Malta, Portugal Romania, Sardinia, Sicily, Slovakia, Spain, Ukraine, 'Yugoslavia' (Fauna Europea, 2011).

Family Zoridae

***Zora* sp.** (Figure 2)
Malta , Għar is-Sienja, l/o l-Imġarr, 35" 55' 39 N, 14" 21' 16 E 1 ♂, 22 March 2012 (photographed by Albert Gatt Floridia)

This is the first record of the family Zoridae in the Maltese Islands. The spider was found under a stone. Although very similar to *Zora spinimana*, the spider photographed at Għar is-Sienja cannot be definitely identified as such because of some differences, including the dark, almost black coloration (whereas *Z. spinimana* is usually brown) and the lateral stripes on the cephalothorax which are darker and broader than those of *Z. spinimana*. *Z. spinimana*

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is a grassland spider, usually found in grass roots or leaf litter, but also under stones or other objects. The female guards her egg-sac, which is covered by a dense white silken sheet, under stones (Spider Recording Scheme, 2011). The spider at Għar is-Sienja was found under a stone in a typical garigue community.

Figure 1: Female *Aphantaulax cincta* from Rdum il-Bies, limits of Mistra, Malta. Photos by Stephen Mifsud, 2012.

Figure 2: Male *Zora* sp. from Għar is-Sienja, limits of l-Imġarr, Malta. Photos by Albert Gatt Floridia, 2012.

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THE GENUS *XANTHORIA* (TELOSCHISTACEAE, LICHENISED ASCOMYCOTA) IN THE MALTESE ISLANDS

Jennifer FIORENTINO[1]

ABSTRACT

The occurrence of *Xanthoria calcicola* Oksner, *Xanthoria aureola* (Ach.) Erichsen and *Xanthoria parietina* (L.) Th.Fr. are confirmed for the Maltese Islands. The morphological features and ecological preferences of these lichens are described and illustrated. The lobe widths and thallus thicknesses of these three species are measured. Three other species of *Xanthoria* with ecological requirements that can be met locally are also described briefly. These species have so far not been recorded for the Maltese Islands. Finally an identification key for all six species of *Xanthoria* is included.

KEYWORDS: *Xanthoria,* Malta, Mediterranean, calcareous.

INTRODUCTION

Most lichens represent an association between a fungus and an alga with the fungus contributing the greater part of the mass of the thallus. The algae are protected by fungal hyphae which, being incapable of photosynthesising, depend on the algal cells for survival.

The *Teloschistaceae* is a widespread family of lichen-forming ascomycete fungi that includes the genera *Caloplaca, Fulgensia* and *Xanthoria* (Gaya *et al.* 2008). Lichens of the genus *Xanthoria* are described as being foliose since they consist of horizontal or partly ascending lobes which are not strongly attached to the substrate. The algae of *Xanthoria* belong to the genus *Trebouxia* (Wirth, 1995). The bright orange colour is due to the lichen substance parietin (physcion). It is produced by the top fungal hyphae of the upper cortex and is deposited as tiny extracellular crystals. Its main role is to protect algal cells from excessive solar radiation (Nash, 2008). Like most members of the *Teloschistaceae* the lichens of the genus *Xanthoria* give a K + purple result due to the presence of parietin. Most *Xanthoria* species have conspicuous apothecia with an orange disc and a paler orange thalline margin. Ascospores are polarilocular and colourless.

From a distance, a casual observer may mistake *Xanthoria* with some members of the closely related genus *Caloplaca* that are bright yellow-orange and have radiating lobed margins (placodioid). However the thalli of such *Caloplaca* species are encrusted onto their substrates (crustose) since they lack a lower cortex (Smith *et al*, 2009) and have to be literally scraped off in order to be removed from their substrate. On the other hand *Xanthoria* thalli are foliose with both an upper and lower cortex. Their lobes can be easily lifted off by means of a pair of tweezers notwithstanding the presence of hapters (masses of adhesive hyphae) on the lower surface which serve to attach the lichen to its substratum.

The genus *Xanthoria* contains about 15 species (Wirth, 1995) and has a wide global distribution. Members of this genus may be found growing on bark and on subneutral to basic rock. The genus still presents several taxonomic problems (Nimis & Martellos, 2008).

The purpose of this study is to describe the species of *Xanthoria* encountered so far on the Maltese islands. These are *Xanthoria calcicola, X. aureola and X. parietina.* Three other species namely *Xanthoria mediterranea, X. stiligera* and *X. steineri*
have so far not been recorded for the Maltese Islands even though they have been reported from different Mediterranean regions where they were growing on substrates and in conditions similar to those found locally (Giralt *et al.*,1993).
An identification key is given for all the six species mentioned (refer to Table 2).

MATERIAL AND METHODS

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Most of the specimens of *Xanthoria* studied were freshly collected from different regions in the limits of Rabat, Malta (35.881667, 14.398889) specified below. Material is deposited in my personal herbarium.

Lichens were examined with a stereo microscope (X20). The marginal lobe widths were measured following Lindblom (1997) at three regions: (i) at the outermost lobe tip; (ii) at the widest point which usually falls just before the lobe tips ramify; and (iii) just inside the widest point where lobes tend toconstrict. Lobe thickness was taken 1.0 mm from edge of dry lobe. Spores were mounted in water and measured using a compound microscope (X400).

***Xanthoria calcicola* Oksner**

The large bright orange foliose thalli which cover rocky outcrops of garigue and steppes are most likely to be *Xanthoria calcicola* (Fig.1). Several specimens collected from Il-Kunċizzjoni and Dingli Cliffs (both sites being in the limits of Rabat) were examined. This is the commonest saxicolous species of *Xanthoria* to be encountered preferring greatly exposed, calcareous substrates (Fig. 2). Size of the thallus of examined lichens varies between 5 to 15 cm. Thallus forming regular or irregular rosettes of adpressed, ± wrinkled, ± plicated (folded into pleats), orange lobes which touch, overlap or are separate. The lobes broaden towards the apex which may be rounded or notched. Lobe width (i) range: 0.2 mm–1.00 mm; mean: 0.6 mm (ii) range 1.5 mm–5.0 mm; mean: 2.2 mm (iii) range: 0.5 mm–3.0 mm; mean: 1.00 mm. Mean lobe thickness: 125 µm.

Figure 1 (above): Typical *Xanthoria calcicola* landscape in late August at Dingli Cliffs.

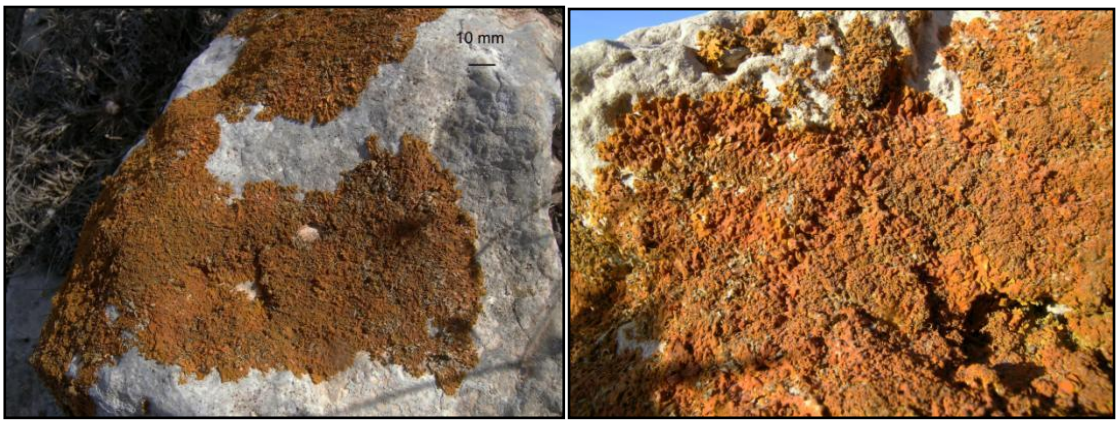

Figure 2 (left): *Xanthoria calcicola* on rock. Figure 3a (right): Dense covering of isidia on the surface of *X. calcicola*.

Underside of the lobes creamy-white except for the edges where some of the orange anthroquinone of the upper cortex spills over. Adhesive hapters present on the underside, either scattered or gathered in groups.

X. calcicola is distinguished by the numerous isidia covering the central areas of the upper surface of its thallus (Fig. 3a). Isidia are outgrowths of the cortex of lichens containing both algal cells and fungal hyphae and serve for vegetative (asexual) propagation.

Isidia of *X. calcicola* wart-like or peg-like (up to 0.75 mm high) ± capitated. Diameter of isidia between 0.15mm to 0.25mm. Some of the shorter (0.3 – 0.4 mm high) isidia branching into two. Some isidia flattened and lobule-like (Fig 3b). Great variation in the number and distribution.

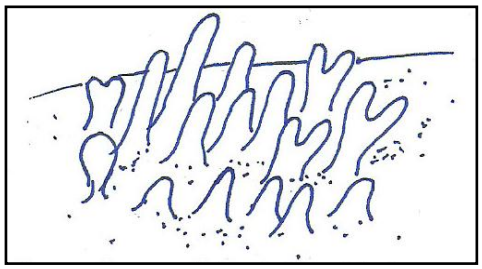

Figure 3b: Different shapes of isidia in *X. calcicola*.

Some specimens with a few scattered isidia while others displayed a dense covering across the greater part of the thallus.

There was also great variation in the number of apothecia present in the specimens examined. Some thalli of *X. calcicola* were totally devoid of apothecia, others had a few ± scattered on the upper surface; in others apothecia were rather numerous (Fig 4a and b). Apothecia up to 3.5 mm in diameter, round to oval-shaped with a dark orange disc and a rough, warty, orange thalline exciple (rim). Ascospores polarilocular 11.5–14 µm X 6-8 µm (Fig. 4a).

Nimis & Martellos (2008) describe *X. calcicola* as a mainly Mediterranean to mild-temperate lichen, found on the top of isolated calcareous and basic siliceous boulders. It proliferates in strongly eutrophicated situations. Smith *et al.* (2009) report the lichen as being common in the east of the British Isles especially on calcareous, nutrient rich stonework and monuments but rare on bark and wood. Clauzade & Roux (1985) use the synonym *Xanthoria parietina* ssp. *calcicola* (Oksner) for *X. calcicola* and quote the species as being found in the Mediterranean and Atlantic regions, preferring mostly calcareous rock especially if this is enriched with bird droppings.

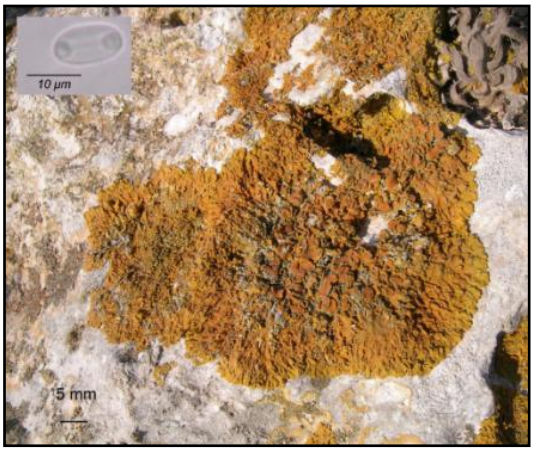

Figure 4a (left): *X. calcicola* thallus with apothecia and detail of one spore. Figure 4b (right): Close-up of *X. calcicola* apothecia.

In a previous paper (Fiorentino, 2002) I attempted to give a list of synonyms for the lichens reported in Sommier & Caruana Gatto (1915) the only existing checklist of lichens for the Maltese Islands. The lichens in this checklist had been identified by Antonio Jatta (Sommier & Caruana Gatto, 1915). In Fiorentino, (2002) I suggested the

synony *X. calcicola* Oksner for *Xanthoria parietina* var. *aureola* (Ach) Fr., being aware that Coppins (2002) suggests the synonym *X. calcicola* Oksner for *Xanthoria parietina* var. *aureola* auct. and not for var. *aureola* (Ach) Fr. Had I not made this decision none of the lichen names used in the 1915 checklist (Sommier & Caruano Gatto, 1915) would have been referring to *Xanthoria calcicola* Oksner. It is unlikely that Sommier and Caruana Gatto did not provide Jatta with a specimen of *X. calcicola* considering that the species is rather common. The lichen collection at the Argotti Herbarium (ARG) includes a number of specimens which had been donated by Sommier and Caruana Gatto. Unfortunately a number of labels from this collection have gone lost and many others misplaced. The only specimen from this collection which is a *Xanthoria* species carries the label *Physcia parietina* Körb var *aureola* which name is not listed in Sommier and Caruana Gatto (1915). When examined the specimen was in fact found to be *Xanthoria calcicola* Oksner.

***Xanthoria aureola* (Ach.) Erichsen**

Two specimens of *Xanthoria aureola* were collected from maritime rocky steppes (Dingli Cliffs, limits of Rabat). Both specimens lacked isidia and only one had apothecia which were few in number and not mature enough to contain spores (Figs. 5 & 6). The thalli of both specimens were dark orange in colour and not larger than 12 cm. Both had strap-like lobes which overlapped extensively towards the inner parts of the thallus. Lobes tended to display dichotomous branching but this became obliterated due to immediate rebranching especially towards the edges of the thallus. Lobe width was (i) range 0.25 mm–0.75 m; mean: 0.46 mm (ii) range 0.75 mm–2.5 mm;mean: 1.6 mm (iii) range: 0.3 mm–2.0 mm; mean: 0.72 mm. Mean lobe thickness: 135 μm. Both specimens had scattered hapters on the cream-coloured underside of their lobes.

At this stage it is useful to comment about the substrata on which the two specimens of *X. aureola* were growing in light of what is usually suggested as a typical substrate for *X. aureola.* Smith *et al.* (2009) refer to this species as a saxicolous lichen which prefers exposed, nutrient-rich or, rarely, basic rock on sea cliffs. Nimis & Martellos (2008) define it as a Mediterranean-Atlantic species, with optimum on basic siliceous rocks near the coast, but also found on limestone and on eutrophicated, acid siliceous rock.

The greater part of the thallus of one of the specimens (Fig. 5) seemed to be growing on calcareous rock. Close examination revealed that the lobes of *X. aureola* were actually growing on other species of saxicolous lichens including *Verrucaria* spp (Fig. 5) and *Caloplaca* spp. That part of the specimen which was not on rock was growing on what looked to be the bark of an unidentified dead shrub stub. However even here *X. aureola* was actually growing on decaying thalli of *X. parietina* which had been epiphytic on the shrub (Fig. 6).

The second specimen was growing on calcareous rock but close examination also revealed that its lobes were actually growing over the dying thallus of a saxicolous *Caloplaca* sp. at one end (Fig. 7) and over decaying *Solenopsora* sp. at the other end (Fig.8). This substrate preference seems to suggest that rather than growing directly on calcareous surfaces with a basic pH, the two specimens of *X. aureola* examined were using decomposing corticolous or saxicolous lichens. These may provide them with an enriched source of nitrogen and probably with a lower pH. It is however difficult to say whether *X. aureola* settles on other lichens once these have started to die or whether this lichen invades living lichen thalli eventually causing their death.

The strap-like lobes and lack of isidia should distinguish *X. aureola* from *X. calcicola.* However a number of *X. calcicola* morphs which contained few isidia and whose lobes look strap-like were also encountered. This is when identification becomes difficult in the field.
X. aureola may also be confused with morphs of *X. parietina* which grow on stone or rocks. In such a situation one should observe whether the lichen contains numerous crowded apothecia, which suggest *X. parietina* or whether apothecia are few and dispersed or totally lacking, which would more likely be indicative of *X. aureola.* This confusion has induced some authors (e.g. Clauzade & Roux, 1985) to consider *Xanthoria aureola* as an ecotype of *X. parietina*. Recent molecular data has however confirmed that these are separate species (Lindblom & Ekman, 2005; 2012).

Sommier & Caruana Gatto (1915) include *Xanthoria parietina* var *ectanea* Ach in their checklist of lichens of the Maltese Islands. However no specimens carrying this label have been found so far in the lichen collection at the Argotti Herbarium. In Fiorentino (2002) I suggested that this synonym was referring to *Xanthoria ectaneoides* (Nyl.) Zahlbr. However Robert *et al* (2005) suggest that *Xanthoria parietina* var *ectanea* Ach and *Xanthoria parietina* subsp. *ectanea* (Acharius) Clauzade & Cl. Roux are synonyms. Nimis and Martellos (2008) give *Xanthoria parietina* subsp. *ectanea* (Ach.) Clauzade & Cl.Roux as well as *Xanthoria parietina* var. *ectanea* auct.

non (Ach.) J.Kickx fil. as synonyms of *Xanthoria aureola* (Ach.) Erichsen. All this seems to suggest that Sommier & Caruana Gatto (1915) were referring to *X. aureola* (Ach.) Erichsen.

Figure 5 (left): *Xanthoria aureola*. Figure 6 (right): Lobes of *X. aureola* (on the right) encroaching *X. parietina* (on the left) with its numerous apothecia.

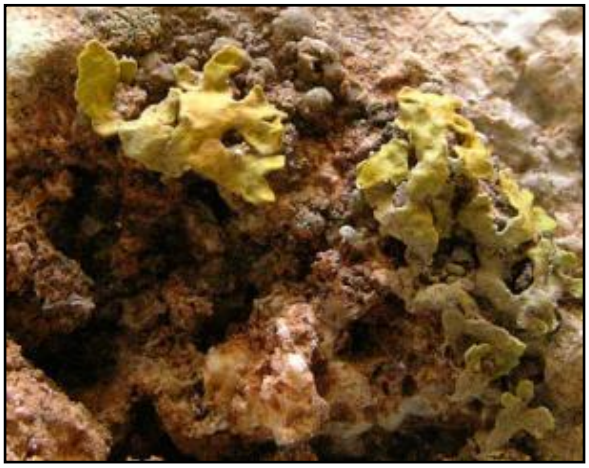

Figure 7 (left): *X. aureola* thallus growing over another lichen of genus *Caloplaca*.
Figure 8 (right): *X. aureola* growing on other lichens such as *Solenopsora* sp.

***Xanthoria parietina* (L.) Th.Fr.**

This might well be the most easily recognisable corticolous species of the Maltese islands due to its widespread distribution and its habit of growing profusely on the bark of trees and shrubs. It has been found growing on trees of different species including Aleppo pine, carob, eucalyptus, bitter almond amongst others (Fig.9). More rarely *X. parietina* was observed growing on calcareous rocks (Fig.10).

The thallus of *X. parietina* can reach up to 10 cm in diameter though this is obvious only if the lichen is growing on the bark of the main trunk. When growing on minor branches and twigs the thallus of *X. parietina* thallus tends to be narrower along the axis which encircles the branch. It forms ± regular, greenish-orange to green-grey rosettes of wrinkled, ± overlapping lobes. The colour of the lobes depends on the lichen's extent of exposure to sunlight. It was observed that the more shaded the site is the less orange and more greyish-green will the thallus be. This concurs with Wasser & Nevo (2005). The orange colour always shows up in the numerous apothecia which often cover the upper surface of this lichen (Figs.10 &11).

Lobes tend to broaden towards the apex reaching a width of up to 7.5 mm at the widest part. The edges of the lobes are rounded to indented and are often delineated by a thin orange outline. Lobe width was (i) range: 0.75 mm–3.0 mm; mean 1.92 mm (ii) range 2.5 mm–7.5 mm; mean 5.0 mm (iii) range 1.25 mm–4.5 mm; mean: 2.83 mm. Mean lobe thickness: 100 µm.

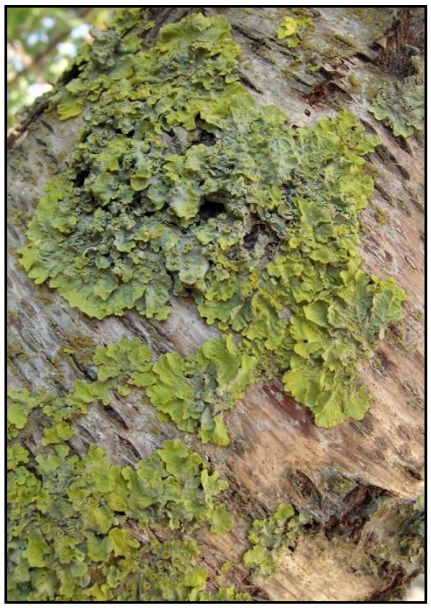

Figure 9 (top left): *Xanthoria parietina* growing on a tree trunk. Figure 10 (top right): *X. parietina* growing on rock. Figure 11 (bottom): *X. parietina* apothecia and (inset, lower right) their typical polarilocular spores.

Apothecia numerous, scattered or clustered, of various sizes reaching even up to 3 mm diameter, usually rounded or contorted with an orange, flat or concave disc (Fig.11). The slightly raised rim (thalline exciple) is of the same colour as the thallus. Paraphyses septate, unforked and capitate. Ascospores polarilocular measuring between 10.5-15 µm X (5-)7-8 µm (Fig.11).

Smith *et al.* (2009) describe *X. parietina* as a cosmopolitan species found on a wide variety of nutrient rich and enriched substrata. Nimis & Martellos (2008) report it as absent only from heavily polluted areas, mainly epiphytic, but sometimes present on calciferous or basic siliceous rocks. Sommier & Caruana Gatto (1915) wrote that the species was found growing locally on rocks, walls as well as on trees.

Other *Xanthoria* species that might occur in the Maltese Islands

When Giralt *et al* (1993) revised some species of *Xanthoria* with isidia-like propagules they included *X. mediterranea* and *X. stiligera* quoting them as two new taxa from the Mediterranean region. Wasser & Nevo (2005) report *Xanthoria steineri* I.M. Lamb as being found in southern Europe, Egypt, Israel and Tunisia. In view of the ecological requirements of these three species one cannot exclude their possible presence in our islands. A brief description of each species is being included.

1) *Xanthoria mediterranea* Giralt, Nimis & Poelt is found in the central and southern Mediterranean and has been reported amongst other places from Calabria, Sardegna, Siracusa, Croatia, Corfu, Crete and Cyprus (Giralt *et al.*, 1993). It grows on calcareous somewhat nitrogen enriched rocks, on flat to steeply sloped surfaces often associated with *Caloplaca aurantia* (Giralt *et al*., 1993). The thallus of *X. mediterranea* may grow up to 5 cm diameter (Wasser & Nevo, 2005) and adheres to the substrate by means of irregularly distributed strong hapters. Lobes beween 2-3mm wide and isidia are between 0.08 – 0.15(- 0.2) mm in diameter (Giralt *et al.*1993). Apothecia are very rare (Giralt *et al.* 1993).

2) *Xanthoria stiligera* Giralt, Nimis & Poelt has been reported from Egypt, Greece, Israel, Morocco, Spain and Cyprus amongst other places suggesting a clear Southern Mediterranean distribution. This species grows on calcareous, somewhat N-enrichedrocks, mostly on sloped surfaces (Giralt *et al.* 1993). Its red-orange lobes are narrower (0.5-1.0mm) than those of *X. mediterranea.* The hapters of *X. stiligera* are smaller than those of *X. mediterranea* and aggregate in rows rather than being irregularly distributed. Isidia are between 70-90µm in diameter (Giralt *et al.* 1993).

Neither *X. mediterranea* nor *X. stiligera* have so far been reported from the Maltese islands. Their ecological requirements may suggest an expected presence. However Giralt *et al.* (1993) report that though *X. mediterranea* and *X. stiligera* may be common in localised areas of the Mediterranean the two species seem to be missing on several small islands close to Sicily. The Maltese Islands were not included in their survey.

3) *Xanthoria steineri* I.M. Lamb has been reported from southern Europe, Egypt, Israel and Tunisia (Wasser & Nevo, 2005). This lichen grows on twigs and may look similar to *X. parietina* but its thallus grows to not more than 3 cm in diameter. Lobes are between 2-3 mm across, loosely attached to substratum and with rounded, slightly raised orange margins. Apothecia are abundant and often crowded in the central area of the thallus. Galun (1970) describes the spores as ellipsoidal with the lumina in the form of two drops connected at their acute ends (hourglass shape). Galun (1970) also reports the paraphyses of *X. steineri* as septate, forked and capitate (with enlarged apical cells).

A number of fresh and dead specimens collected from different trees and shrubs from various parts of the Maltese Islands and which seemed potential *X. steineri* were examined. Some of these specimens did have hourglass spores but the paraphyses were not forked as suggested by Galun (1970). Instead they were unforked and capitate which is the arrangement usually found in *X. parietina*. At this point it is worth mentioning that many *X. parietina* specimens examined also had a good number of hourglass spores. One should however keep in mind that spore morphology is known to vary depending on whether spores are coming from fresh or herbarium material (Steiner & Peveling, 1984).

Nimis & Martellos (2008) refer to *X. steineri* as a poorly known taxon of the *X. parietina* complex found near the coast in Mediterranean Italy and Portugal and needing further study. Once the morphology and taxonomical status of this lichen are clarified one can be in a better position to investigate its presence in the Maltese Islands.

CONCLUSIONS

Three species of *Xanthoria* have been recorded and described. These are *Xanthoria parietina*, *X. calcicola* and *X. aureola*. All three species were recorded in Sommier & Caruana Gatto (1915) though the last two were at that time considered as varieties of *Xanthoria parietina*.

The identification of *Xanthoria aureola* has been based on its lack of isidia, maximum lobe width, low presence of apothecia and substrate preference. Although this phenotypic evidence may seem adequate to distinguish this species from *X. calcicola* it is still quite difficult to do so owing to the great variation in morphology observed in *X. calcicola* where thalli with few isidia, few apothecia and having lobes encroaching other lichens were also found. In these situations *X. calcicola* becomes morphologically quite similar to *X. aureola.* These observations are

supported by molecular data (Lindblom & Ekman, 2005) which has shown that *X. aureola* is closely related to the morphologically similar *X. calcicola*. The main differences in the external features of the three species recorded is summed up in Table 1 below.

Table 1. The main differences in the external features of the three species recorded.

	X. calcicola	*X. aureola*	*X. parietina*
Substrate	Saxicolous (calcareous)	Saxicolous (calcareous) / on decaying lichens	Corticolous and saxicolous
Thallus size max	15 cm	12 cm	10 cm
Thallus colour	orange	orange	Grey-green to orange green depending on light exposure
Thallus thickness (dry)	125 µm	135 µm	100 µm
Marginal max lobe width	5.0 mm	2.5 mm	7.5 mm
Apothecia	Few to numerous; dispersed or crowded	Lacking or few	Abundant, crowded

None of the three species X*anthoria mediterranea*, *X. stiligera* and *X. steineri* have so far been found in the Maltese Islands even though they are potential candidates to the local lichen biodiversity considering their ecological requirements and geographical distribution.

The following key (Table 2) is based on the author's observations for the three species of *Xanthoria* found locally as well as on observations quoted in literature for the three other *Xanthoria* species which may be potentially present in the Maltese Islands:

Table 2. Key to the six species of *Xanthoria* cited.

1 a Growing mostly on trees but also on rock 2
b Growing on rock 3

2 a Thallus up to 10 cm, isidia absent, max^{m} lobe width 7.5mm, apothecia abundant and crowded, unforked, capitate paraphyses ……..... *X. parietina*
b Thallus up to 3cm, max^{m} lobe width 3mm, forked, capitate paraphyses …….....*X. steineri*

3 a Having isidia …….....4
b Isidia absent, apothecia lacking/few, max^{m} lobe width 2.5mm …..... *X. aureola*

4 a Thallus 5-15cm, max^{m} lobe width 5mm, scattered or grouped hapters, diameter of isidia 150 to 250µm, some flat isidia, apothecia absent, few to numerous .....…….....*X. calcicola*
b Thallus rarely more than 5cm, max^{m} lobe width up to 3mm, apothecia rare 5

5 a Hapters irregularly distributed on underside, isidia 80-150µm in diameter, max^{m} lobe width 2-3mm ……..... *X. mediterranea*
b Hapters ± marginal, wrinkled underside, isidia 70-90 µm in diameter, short pencil-like or granular, max^{m} lobe width 0.5-1.00mm…….....*X. stiligera*

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The author thanks Prof. Dr. Elfie Stocker-Wörgötter, Department of Organismic Biology, University of Salzburg, Austria for finding time to check my translation of the paper by Giralt, M. *et al.* (1993) originally written in German. Thanks are also due to Dr. Louise Lindblom, Senior Engineer at the Museum of Natural History of the University of Bergen, Norway for her generous availability. Dr. Lindblom went through the first draft of this paper and made a number of comments and suggestions all of which served to greatly improve the content of the final version.

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THE WART-LIKE BARNACLES, VERRUCIDAE (CRUSTACEA: CIRRIPEDIA) PRESENT IN MALTESE WATERS

Constantine MIFSUD[1]

ABSTRACT

Two species of wart-like barnacles, from the genus *Metaverruca* are reported from the deep waters round the Maltese Islands at the centre of the Mediterranean Sea.

KEY WORDS: Verrucidae, Cirripedia, Malta

INTRODUCTION

The species of the Mediterranean Cirripedia were treated by Relini (1980), while those present in Maltese waters have been revised by Rizzo and Schembri (1997). However, no species from the family Verrucidae were known at that time for our Islands. Recent research has revealed a living deep water species and the presence of plates of another species of possibly Pleistocene age.

Young (2002) has shown that the shallow water species of *Verruca* from the Mediterranean belong to *Verruca spengleri* Darwin, 1854 and not to *Verruca stroemia* O.F. Müller, 1776, as has been cited in the past by various Mediterranean authors (e.g. Relini 1980). This was also confirmed by Young *et al.* (2003) and also by Relini (2010). Surprisingly, this, the most common Mediterranean shallow water species, is absent in Maltese waters, notwithstanding the fact, that it is found at shallow depths of 1-10 metres in nearly all the coastal shores around the Mediterranean and the Black Sea. The species found during this study belong to the genus *Metaverruca*, and include *Metaverruca imbricata* (Gruvel, 1900) and *Metaverruca trisulcata* (Gruvel, 1900). These are both deep water species.

MATERIALS AND METHODS

Most of the material studied was obtained during the RV/Urania MARCOS Cruise (2007), the MEDITS 2007 Research Cruise and from a fisherman's bycatch. During the MARCOS research cruise several live specimens of *Metaverruca imbricata* were found attached inside crevices of fossil corals or pieces of the rocky substratum brought up by the heavy dredge. These were preserved in alcohol and later sent to Dr. R. Di Geronimo (Catania) for study (Zibrowius pers. comm.). The material from the fisherman's bycatch consisted of 6 live specimens. These were attached at the base of an old nylon rope used for anchoring the 'Kannizzati', the floats used for harvesting the fish *Coryphaena hippurus* (Linnaeus, 1758). Material of *Metaverruca trisulcata* was obtained from grab samples in both the MARCOS cruise and the MEDITS 2007 cruise.

The live material from the MARCOS cruise was collected and preserved by Dr. H. Zibrowius. The material from the MEDITS cruise was collected by Dr. M. Dimech and the live material from the fisherman's bycatch was collected by the author.

MATERIAL STUDIED

Metaverruca imbricata (Gruvel, 1900) Fig. 1A.

Malta: South, RV/Urania, Marcos Cruise, Station MS 44, Heavy Dredge:

Start: 35°30.506'N-14°06.230'E. End: 35°31.228'N-14°05.698'E, 632-467m, 12-iv-2007, a small number of live specimens and a few loose plates.

Malta: South, MEDITS 2007, Station G19-2, Grab: 35°31.30'N-14°05.22'E, 460m, ix-2007, a few loose plates.

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Malta: SW, attached to old nylon rope brought up from 35°51.315'N-14°11.707'E in 250m, 27-viii-2008, 6 live specimens + 1 shell.

Metaverruca trisulcata (Gruvel, 1900) Fig. 1. B-C.

Malta: South, RV/Urania-Marcos Cruise, Station MS 44, dredge, Start:35°30.506'N-14°06.230'E. End: 35°31.228'N-14°05.698'E, 632-467m, 1 plate +1 rostrum with a thick basal part, 12-iv-2007.

Malta: South, MEDITS 2007, Station G19-2 Grab, 35°31.30'N-14°05.22'E, 460m, ix-2007, a few loose plates.

CONCLUSIONS

All the study material was determined by Dr. R. Di Geronimo (University of Catania, Sicily). *M. imbricata* seems to be quite frequent in the southern Maltese waters, but always at moderate to great depths. Although the material of *M. trisulcata* appears fresh, it is subfossil of Pleistocene age. However, it cannot be ruled out that the species is still extant in the depths of the Mediterranean. Recent research has brought about quite a few surprises of species which were thought to be extinct here and even a species new to science (in study) was found to be still living at still scantily studied depths. *M. trisulcata* is found living in the eastern Atlantic and West Africa at depths of 622-1378 m (Young 2001; 2002). Both of these species are treated extensively by Young (2002).

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A CONTRIBUTION TO THE KNOWLEDGE OF THE PHYLUM SIPUNCULA IN THE MALTESE ISLANDS (CENTRAL MEDITERRANEAN)

Constantine MIFSUD[1] and José I. SAIZ SALINAS[2]

ABSTRACT

Specimens of the phylum Sipuncula collected through a span of eleven years from around the Maltese Islands have revealed the existence of fifteen species and subspecies. The majority of these animals are new records for the Maltese Islands.

INTRODUCTION

Sipunculans can be found in various habitats including mud, muddy sand, rocks, algae, weeds, empty mollusc shells, polychaete tubes, foraminiferan tests, barnacles and sunken wood. Earlier, sipunculans were considered close relatives of holothurians. Recently, there is general agreement that these animals are protostomes and closely related to annelids (Wollesen & Wanninger 2008). Sipunculans are known to play an important role in the bioturbation of sediments and as a food source for higher trophic levels.

Sipunculans occur in cold, temperate and tropical marine benthic habitats. They have been found in all depths from the intertidal zone to great abyssal depths in 6,800m. The phylum consists of two classes, four orders, six families, 17 genera, and 150 species worldwide.

In the Mediterranean Sea a total of 36 species are presently known (Açik, 2011; Ferrero-Vicente *et al.* 2012). Saiz Salinas (1993) listed the species living in the western Mediterranean, while Murina *et al.* (1999) published a list including 20 of these species from the eastern Mediterranean. Pancucci-Papadopoulou (undated) has cited 25 species for the Italian waters. Recently Açik (2010; 2011) also published a list of eighteen species from the southern coast of Turkey and found a new record for the Mediterranean. Ferrero-Vicente *et al.*, (2012) had also found a new record for the Mediterranean, namely *Phascolion caupo* Hendrix, 1975 from the southeastern coast of Spain.

Locally, species of the phylum are usually neglected, or at times rarely mentioned in published lists or general works treating the local marine fauna. A few odd occurrences are recorded in students' dissertations and unpublished works, mostly as "Sipunculid species". This was due mostly to the difficulty in the taxonomy, especially at species level. Micallef & Evans (1968) mentioned two species in their fauna list for the Maltese Islands, *Sipunculus nudus* (Linnaeus, 1766) and *Phascolosoma granulatum* (Leuckart, 1828). The latter species was not found in our study. *Phascolosoma granulatum*, *Aspidosiphon* (*Akrikos*) *mexicanus* (Murina, 1967) and *Aspidosiphon muelleri* Diesing, 1851 were also reported for Malta by Schembri and Jaccarini (1978), Borg *et al.* (1998) and Pancucci-Papadopoulou *et al.* (1999). However, no specific studies on the local sipunculan species have ever been published.

MATERIALS AND METHODS

During the last eleven years the first author had collected several specimen samples of these animals from material obtained through several sources. These included, dredging, trawlers and fisheries bycatch, scuba divers, snorkelling, and weed washings. The animals were temporarily preserved in alcohol (75%). Another small collection obtained during the Rv/Urania Marcos cruise (April 2007) (collected by H. Zibrowius) was also examined. This research cruise was centred round the Maltese Islands (Costantini *et al.* 2009: Taviani *et al.* 2009). In all, 15 species and subspecies are recorded herein from the Maltese Islands.

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RESULTS

a. The species studied belong to two classes, three orders, five families and eight genera.

b. The numbers in brackets behind each station are relevant to the station's approximate position on Map in Figure 1.

c. A short comment is added on particular characteristics for each species.

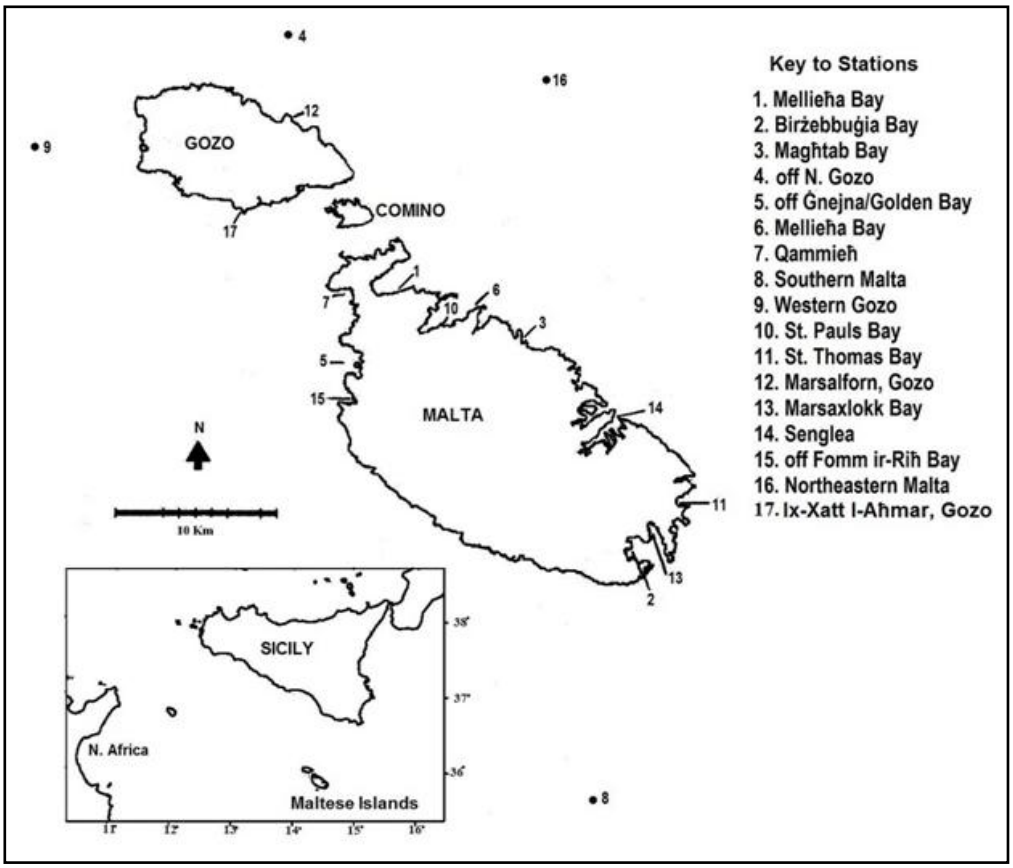

Figure 1. The Maltese Islands in the central Mediterranean Sea, with an enlarged view of the Islands, indicating approximate position of stations studied.

CLASS SIPUNCULIDEA
ORDER SIPUNCULIFORMES

FAMILY SIPUNCULIDAE

Sipunculus* (*Sipunculus*) *nudus Linnaeus, 1766 [Fig. 2 A]

- Mellieħa Bay (1): beached after NE Storm, 5-xi-2001, leg. E. Cauchi. 1 specimen.
- Birżebbuġa Bay (2): beached after NE storm (force 8), 3-ii-2006. 2 specimens.
- Birżebbuġa Bay (2): beached after NE storm, iii-2007. 1 specimen.
- Magħtab Bay (3): in weed washings from shallow water, 1 juvenile specimen.

This is the largest species found all over the Mediterranean. It is well characterized by a trunk divided into squares. The species can reach 25cm in length. It is used locally as fish bait and is known as "Ħanex tar-Ramel".

FAMILY GOLFINGIIDAE

Golfingia* (*Golfingia*) *elongata (Keferstein, 1862).

- Off Northern Gozo Island (4): found inside sunken wood from fisherman's by-catch, in 300m. 2 specimens.

The species is easily separated by the hook arrangement in rings at the foremost end of the introvert.

Golfingia* (*Golfingia*) *vulgaris (De Blainville, 1827) [Fig. 2F]

- Off Ġnejna Bay and Golden Bay (5): in 40-60m, in muddy sand and dead decaying leaves of *Posidonia*, 3 specimens.

The species shows scattered hooks at the distal end of the introvert.

Nephasoma* (*Nephasoma*) *confusum (Sluiter, 1902).

- Off Ġnejna Bay (5): found in mud in 160m, 2 specimens.
- Off Northern Gozo Island (4): attached to fossil coral block, 250m, from fisherman's bycatch, 13-vii-2009. leg. E. Cauchi, 3 specimens.

This is an uncommon species. It is well characterized by the scattered, thick, bent hooks on the introvert.

FAMILY PHASCOLINIDAE

Phascolion* (*Phascolion*) *caupo Hendrix, 1975

- Mellieħa Bay (6): in gastropod shell from muddy sand, 20 m, 1 specimen.
- Qammieħ, iċ-Ċumnija (7): dredged in 40-60m, in gastropod shell, vii-2003, 1 specimen.
- Fomm ir-Riħ Bay: in gastropod shells, 30m, x-2008, 1 specimen.

The species is quite similar to *Phascolion strombus* but characterized by broad-based, recurved hooks at the apical end of the introvert. This is the second record of this species for the whole Mediterranean Sea. The first record was published recently by Ferrero-Vicente *et al.* (2012) from the southeastern coast of Spain. The species frequently inhabits gastropod shells.

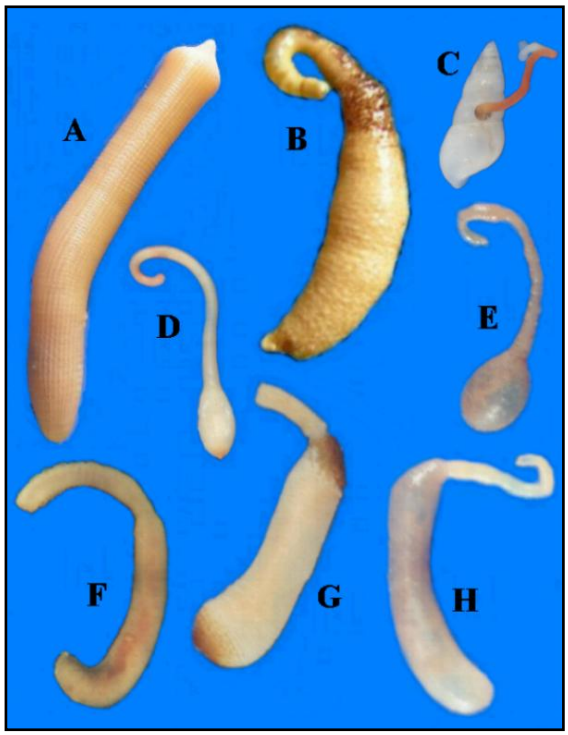

Figure 2. External morphology of a few sipunculid species; A, *Sipunculus nudus*, B, *Phascolosoma stephensoni*, C, *Aspidosiphon muelleri* (in gastropod shell), D, *Onchnesoma steenstrupii*, E, *Apionsoma murinae*, F, *Golfingia vulgaris*, G, *Aspidosiphon misakiensis*, H, *Aspidosiphon mexicanus*. (Not to scale).

Phascolion* (*Phascolion*) *strombus (Montagu, 1804)

- Off Ġnejna Bay (5): in sand from 40-60m, vii-2000, 1 specimen.
- Off Golden Bay (5): in mud and algae fragments, 140m, 1 specimen.

- Southern Malta station (8): MEDITS research cruise, St. M130 Trawl. Start: 35°57.66'N-14°14.24'E, End: 35°59.76'N-14°12.11'E, 195-201m, x-2004, leg. M. Dimech, 1 specimen.

The species exhibits sharp, claw-like hooks and horseshoe-shaped holdfast papillae over the trunk.

Phascolion* (*Isomya*) *tuberculosum Théel, 1875

- Off Ġnejna Bay (5): in muddy sand in 80m, inside a gastropod shell, 1 specimen.

This seems to be an uncommon species locally. It is characterized by its stout recurved hooks and holdfast papillae, without a dark hardened border over the trunk.

Onchnesoma steenstrupii Koren & Danielssen, 1876 [Fig. 2D]

- Qammieħ (7): dredged in 60-80m, in mud & dead weeds, vi-2009, 2 specimens.
- Off Ġnejna Bay (5): dredged in mud, 120m, viii-2008, 21 specimens + 2 fragments.
- Off Ġnejna Bay (5): dredged in mud from 140m, 26-vi-2005, 7 specimens.
- Southeastern Malta station (8): MEDITS 2005 research cruise, St. M28, Trawl, Start: 35°36.66'N-14°31.25'E, 421m, End.35°39.03'N-14°33.41'E, 302m, ix-2005, leg. M. Dimech, 1 specimen.
- Western Gozo station (9): MARCOS cruise: St. 49: Epibenthic Trawl: Start: 35°52.730'N-014°56.570'E, 84m, End: 35°52.520'N-014°54.640'E, 82m, 22-iv-07, 1 specimen.

A small common species with a pyriform trunk found in mud and sand from several local stations.

CLASS PHASCOLOSOMATIDEA
ORDER PHASCOLOSOMATIFORMES
FAMILY PHASCOLOSOMATIDAE

Phascolosoma* (*Phascolosoma*) *stephensoni (Stephen, 1942) [Fig. 2B]

- Ġnejna Bay (5): in weed washing 0.5 m, near boat slipway, 1 specimen.
- Off Ġnejna Bay (5): in mud, 80m, vii-2000, 1 specimen.
- St. Paul's Bay, "Tal-Għażżenin" (10): from weed washings on offshore rocks, 1 m, 11- x-2001, 14 specimens + 1 fragment.
- St. Thomas Bay (11): in weed washing from 1m, viii-1995, 1 specimen.
- Gozo Island, Marsalforn, Qbajjar Bay (12): in weed washing from 2-3m, 8-x-2005, 1 specimen.
- Marsaxlokk Bay (13): in dead oysters with mud, attached to hull of salvaged old patrol boat wreck, i-2008, 2 specimens.
- Off Ġnejna Bay (5): in by-catch material from fishermens' nets, 80m, iii-2009, 1 specimen.
- Senglea (14): in mass of Bryozoa attached to mooring ropes from shore, iii-2006, 1 specimen.

Locally, this is one of the most common species. It is found in algae and in mud mostly in shallow depths. The species was in the past probably misidentified as *Phascolosoma granulatum* (Leuckart), a species not found in our study but present in localities around the Mediterranean Sea. It is separated by the presence of a large crescent area on the concave part of the introvert hooks.

Apionsoma* (*Apionsoma*) *misakianum (Ikeda, 1904).

- Off Fomm ir-Riħ Bay (15): in mud and gravel, 140m. 10-ix-2005, 1 fragment.
- Off Ġnejna Bay (5): 80-100m, muddy sand, 17-vii-2010, 1 specimen.
- Off Ġnejna Bay (5): dredged in muddy sand and weed, 60-80m, vii-2006, 1 specimen.
- Western Gozo station (9): MARCOS cruise: St.M58: Agassiz Trawl: Start: 36°02.91'N- 14°09.41'E, 184m, End: 36°01.022'N-14°10.343'E, 162m, 14/04/2007, 4 specimens.
- Western Gozo station (9): MARCOS cruise: St.M49: Epibenthic Trawl: Start: 35°52.730' N-14°56.570'E, 84m, End: 35°52.520'N-14°54.640'E, 82m, 22-Jul-07, 8 specimens + 1 fragment (introvert).

This seems to be a frequent species in various stations around our shores. Specimens were found in muddy sands in depths of 60-140 m. The species exhibits small papillae on the posterior end of the trunk.

Apionsoma* (*Apionsoma*) *murinae (Cutler, 1969) [Fig. 2E]

- Southern Malta station (8): MEDITS 2005 research cruise, St. M28- Trawl, Start: 35°36'66'N-14°31'25'E, 421m, End 35°39'03'N-14°33'41'E, 302m, ix-2005, leg. M.Dimech, 1 specimen.

- Southern Malta station (8): MARCOS cruise: St.M45: Epibenthic Trawl, start: 35°30.741'N-14°06.077'E, 620m, End: 35°31.276'N-14°05.680'E, 470m, 23-
  Jul-07, 2 specimens.
- Western Gozo station (9): MARCOS cruise: St.M49: Epibenthic Trawl, Start: 35°52.730'N-14°56.570'E, 84m, End: 35°52.520'N-14°54.640'E, 82m. 22-Jul-07, 1 specimen.

This species is easily separated by its large mammiform papillae at the trunk end.

ORDER ASPIDOSIPHONIFORMES
FAMILY ASPIDOSIPHONIDAE

Aspidosiphon* (*Akrikos*) *mexicanus (Murina, 1967) [Fig. 2H]

- Northeastern Malta station (16): MEDITS research cruise, St. M38, grab, 36°26.320'N- 015°05.030'E, 84m, 21-vii-2007. leg. M. Dimech, 1 fragment (introvert).
- Northeastern Malta station (16): MEDITS research cruise, St. M36- Trawl- Start: 36°09.49'N-15°15.63'E, 139m, - End: 36°10.59'N-15°16.98'E, 146m, 2005, leg. M. Dimech, 2 specimens.
- Western Gozo station (9): MARCOS Cruise, St.M55: Epibenthic Trawl, Start: 35°59.740'N-014°42.680'E, 124m, End: 36°01.110'N-014°43.420'E, 126m, 14-Jul-2007, 1 specimen.
- Off Fomm ir-Riħ Bay (15): in gastropod shells, 30m, x-2008, 1 juvenile.

This species is more frequently present in circalittoral muds. It possesses scattered hooks and poorly developed shields. The species was recorded earlier for these Islands by Pancucci-Papadopoulou *et al*. (1999) and Murina *et al*. (1999).

Aspidosiphon* (*Aspidosiphon*) *misakiensis Ikeda, 1904 [Fig. 2 G]

- Gozo Island, ix-Xatt l-Aħmar (17): in gastropod shells, 60-80m, ii-2009, 2 specimens.
- Off Ġnejna Bay (5): in muddy sand, 60-80m, v-2000, 3 specimens.
- Off Fomm ir-Riħ Bay (15): in gastropod shells, 50m, x-2008, 1 specimen.
- Off Ġnejna Bay (5): 80-100m, muddy sand, 17-vii-2010, 1 specimen.
- Off Golden Bay (5): 40-50m, in sand and weeds, iii-2006, 1 specimen.

This species is usually found in muddy sands in 40-120m. It is characterized by the anal shield, in possessing closely packed, irregular-shaped areas with only a few, or no furrows.

Aspidosiphon* (*Aspidosiphon*) *muelleri muelleri Diesing, 1851 [Fig. 2C]

- Off Ġnejna Bay (5): in muddy sand, 60m, v-2000, 1 specimen.
- Off Golden Bay (5): 40-50m, in sand and weeds, iii-2006, 6 specimens.
- Off Ġnejna Bay (5): in muddy sand, 40-60m, vi-2007, 1 specimen.
- Off northern Gozo station (4): in a *Trophon echinatus* shell in 250 m, 1 specimen.

An infrequent species characterized by an anal shield with a dorsal zone of longitudinal furrows and a middle zone of large polygons. The species was recorded earlier by Schembri and Jaccarini (1978) and Borg et al. (1998).

Aspidosiphon* (*Aspidosiphon*) *muelleri kovalevskii Murina, 1964.

- Off Golden Bay (5): 40-50m, in sand and weeds, iii-2006, 1 specimen.

This seems to be another rare species locally. It is separated from the nominal subspecies by the sharp, large spines at the ventral end of the anal shield.

DISCUSSION AND CONCLUSIONS

In the past these sipunculan animals were neglected in published literature treating the local marine fauna. This short work presents at least a data compilation to instil further research on these important animals. The number of species and sub-species, fifteen, for these Islands, at the centre of the Mediterranean, although significant, may not indicate the complete situation. This is due to the low number of stations examined (17) and therefore, further work will surely add to the present number of species. Most of the local species have a wide distribution or are even cosmopolitan. The author's collection will be deposited at the Museum of Natural History, Mdina, Malta).

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A STUDY OF THE GENUS *PERSICARIA* MILLER (POLYGONACEAE) IN THE MALTESE ISLANDS

Stephen MIFSUD[1]

ABSTRACT

A detailed study on the taxonomy, distribution and populations of *Persicaria* spp. occurring on the Maltese Islands is carried out based on field surveys between 2008 and 2011. Four taxa are recognised in this study: two forms of *Persicaria senegalensis*, *P. lanigera* and *P. salicifolia*, of which only the latter is native. A taxonomical overview of these species and a detailed account of the distribution and size of the populations of each species (including new records) is given. Habitat preference of the species and their significance in Maltese wetland ecosystems are discussed.

KEYWORDS: ***Persicaria, Polygonum*, Taxonomy, Distribution, Wetland flora, Malta.**

1. Introduction

Persicaria, commonly known as smartweeds, is a genus debatably segregated from the parent genus of *Polygonum* by Miller back in 1754. Currently, it comprises about 150 mostly cosmopolitan species. Most species are found in temperate regions, few others in tropical and sub-tropical regions from sea level to a range of different altitudes. (Heywood *et al.*, 2007).

While some authors do not recognize *Persicaria* as a genus but only as a section of *Polygonum* s.l. – for example Webb (1993),Watson & Dallwitz (1992) and Alvarez (2001); systematic research based on pollen studies and anatomical data commencing from that of Hedberg (1946) together with recent phylogenetic analysis such as that by Lamb Frye & Kron (2003) gives evidence that the segregated genus of *Persicaria* as proposed by Ronse De Craene & Akeroyd (1988) is valid. *Persicaria* is currently an accepted genus by several authorities such as Wilson (1990), Henwood *et al.* (2007), Morris (2009), Kantachot *et al.*, (2010), TPL, FNA and FZB.

According to the keys provided by Webb (1993) species of Sect. *Persicaria* (and *Bistorta*) differ from Sect. *Polygonum* as follows:

"ochreae entire or fimbriate but scarcely lacerate; flowers usually in dense spikes, rarely in lax, leafless spikes (Sect. *Bistorta* & *Persicaria*)

ochreae usually becoming deeply lacerate; flowers in small, subsessile axillary clusters, or in lax, slender, often leafy spikes (Sect. *Polygonum*) "

Additionally, flowers of *Persicaria* have 2 styles (rarely 3) while *Polygonum* have 3 styles, rarely 2. (Webb, 1993)

Species of *Persicaria* are herbaceous plants or climbing shrubs with swollen nodes. The ochrea is a tubular sheath with an entire or ciliate margin but not lacerate. Leaves are simple, large, alternate or spiral, glabrous or pubescent often long elliptic, lanceolate to ovate. Flowers are arranged in singular spikes, less often a spicate panicle or capitate panicle, rarely a singular capitulum. Bracts either absent or few and inconspicuous. Perianth is petaloid, 3-5-merous, tepals united at the base. Corolla is often pink, but also white or rarely yellow, with the tepals often persistent in fruit. Stamens 5-9. Styles 2 or rarely 3, cleft-like, united below. Nut shape is lenticular, trigonous or slightly circular. (Kantachot *et al.*, 2010)

[1] Flat 5, Busy Bee, Triq tal-Konti, iz-Zebbug, Gozo. E-Mail: info@maltawildplants.com

2. Historical literature and recent records of *Persicaria* spp. in Malta.

In historical Maltese floras, *Persicaria* species were, as expected, given under the genus *Polygonum.* In the flora of Borg (1927), 8 taxa under five *Polygonum* species are given:

- *3 varieties of P. aviculare* - found in fields and roadsides:
  - var. *aviculare* (common);
  - var. *depressum* (frequent)
  - var. *bellardi* (rare at Mara, San Anton and Għajn Tuffieħa);
- *P. maritimum* - a sand dune and salt marsh species, at that time rather frequent.
- *P. convolvulus* - found on irrigated land and gardens, frequently in mainland Malta, rare on the island of Gozo.
- *2 varieties of P. lapathifolium* - found on irrigated land and gardens
  - var. *lapathifolium* (rare at Ġnien Ingraw, Għajn Zejtuna, Ġnien Fieres, Burmarrad and Attard)
  - var. *persicaria* [syn = *P. persicaria*] (rare at Ġnien Ingraw, Baħrija and Imtaħleb)
- *P. minus* var. serrulatum- found in streamlets, ditches and moist places at Ġnien il-Kbir, Imtaħleb, Gnien Ingraw and Baħrija

Only the last three taxa from the list above are now assigned to *Persicaria* that is:- *Persicaria lapathifolia* (L.) Delarbre, *P. maculosa* Gray and *P. salicifolia* (Brouss. ex Willd.) Assenov respectively.

Persicaria salicifolia (basiosyn. *Polygonum salicifolium* Brouss. ex Willd.*)* is recorded from Mtaħleb (Grech Delicata, 1853), Ġnien il-Kbir (Sommier & Carauna Gatto, 1915) Ġnien Ingraw and Baħrija (Borg, 1927) but in this study based on man ysurveys, the species was only found at Wied il-Baħrija ('wied' = valley). Its occurrence at the other three stations is also questioned by Lanfranco (1989), where he states that it is "restricted to just two stations" of which one is Wied il-Baħrija and the other is an unpublished record at Rdum Ħurrieqa at Dingli Cliffs found some 2 decades ago (pers. comm.., Edwin Lanfranco). On surveying the latter location on the 27th November 2011, no population of *Persicaria* spp. was observed, instead, the area was disturbed and overcrowded by strands of *Arundo donax*, L., while the spring of water was found to be in short supply.

Pesicaria lapathifolia s.l. was not confirmed in surveys at the stations reported in past literature. Haslam (1977) cites the same historical records of Borg (1927), while no records have appeared in recent publications (Lanfrnaco, 1989; Weber, 2006; Tabone, 2008). The last appearance of *P. lapathifolia* on Malta was a casual occurrence that persisted for few years about 30 years ago. It was spotted by Mr. E. Lanfranco on the granaries at St.Elmo, Valletta and believed to have become extinct a few years later (pers. comm., Edwin Lanfranco). Similarly, *Persicaria maculosa* has never been confirmed or reported in recent work.

Finally, Lanfranco (1971) reports *Polygonum equisetiforme* from Manoel Island, Ta' Xbiex, but he states that this population was destroyed by development. Some specimens were transplanted to the Argotti Botanical Gardens, Floriana (Lanfranco, 1989) where it still survives.

On the 16th April 1987, Michael Briffa had found a population of a white-flowering *Persicaria* at Għajn il-Kbira and Wied il-Girgenti, located at the limits of Siggiewi, Malta (pers. comm., Michael Briffa). This was first identified as *Polygonum mite* Schrank and published under that name in the Red Data Book for the Maltese Islands (Lanfranco, 1989). Later, it was determined to be a different species - *Persicaria senegalensis* (Meisn.) Soják (basiosyn. *Polygonum senegalense* Meisn.). The same population was observed in 1992 by Tabone (2008) and was observed by the author of this work on (May 2010) at Wied ta' Brija, a segment of the valley system following Għajn il-Kbira and Wied il-Girgenti. Tabone (2008) recorded a new population of *P. senegalensis* at Wied tal-iSperanza, Mosta, Malta. Moreover, a new population was found scattered along the valley bed of Wied il-Għasel on the 14th Feb 2010, by the author of this work. Both populations were observed again on September 2011

On the 18th June 1990, Michael Briffa, discovered another *Persicaria* population with rose-pink flowers at wied tal-Ħżejjen, located at the limits of Mġarr, Malta. This was identified to him as *Persicaria glabra* (Willd.) M.Gómez (pers. comm. Michael Briffa). The discovery of clustered populations with similar rose-flowered specimens is attributed to the author of this work, located at Wied tal-Grazzja, Victoria, Gozo (30th Jan 2008), Wied l-Ort, Għasri, Gozo (23rd Apr 2008) and Wied Sara, Victoria, Gozo (23rd, Apr 2008). These are valley segments of a 7km-long valley system running from the village of Għasri eastwards to Victoria and then southwards to Wied Marsalform where finally it flushes in the shore of Marsalforn bay. These populations were observed again in October 2011. Tabone (2008) recorded *P. glabra* from Wied Sara on the 10th of June 2008.

Persicaria lanigera (R.Br.) Soják - another species that was new for the Maltese flora - was discovered from Wied Sara and Wied tal-Grazzja, Gozo on October 1992 by Tabone (2008). Later, on the 12th of April 1993, Mr. Anthony Bonnici and Mr. Michael Briffa found another population at Wied tas-Seqer, Ghasri, Gozo (pers. comm., Michael Briffa), while another population was spotted at Wied il-Ghajn (l/o Bidni), Marsascala, Malta by Stevens & Tanti (1997) on the 15th July 1997. Tabone (2008) recorded another population at Wied Għasri, Għasri, Gozo on the 30th of September 2000. With the exception of Wied tas-Seqer, the author confirmed these populations in the beginning of October 2011.

3. Materials & Methods.

Fifteen different morphological characters where studied from twelve *Persicaria* spp. populations (table 1). The resulting character states are summarised in table 2a and 2b. Taxonomy of these populations has been studied at different periods between 2008 and 2011, but in order to study these characters in the same period of time, a fresh study on all material was conducted between 15 September and 18 October 2011. The exceptions are population **PSN1** (refer to Table 1) because this population was destroyed and the results are hence based on previous studies and **PSN5** which was studied in Nov 2013 after it was reported to the present author later in 2012 (pers. comm., E. Lanfranco & D. Stevens). The size and distance between adjacent meta-populations of each population were recorded. The first metapopulation given in the list below is that located most upstream along the valley, where the subsequent metapopulations downstream are then given serially till the last metapopulations met along the water course.

A 10x magnifying glass and a 20x – 40x stereo light microscope were used to study the structure of the glands on the leaves and peduncles. The ochreae studied were those located at the upper part (terminal third) of the stem; normally being well developed and not destroyed or damaged by weathering as those at the lower parts of the stem. Ochreae at this part of the stem had the best representation of their indumentum and apical margin. With regards to the measurement of leaves, 10 to 12 leaves were randomly selected from the upper foliar rosette of the stem, each from a different specimen and an average was calculated. The length includes the petiole, while the width was measured at the widest part of the leaf. The measurement of the nuts includes the tiny beak.

4. Taxonomy

4.1 *Persicaria salicifolia* (Brouss. ex Willd.) Assenov

Persicaria salicifolia (= *Polygonum salicifolium* Brouss. ex Willd., *P. serrulatum* Lag., *P. serrulatoides* H. Lindb.) is a perennial plant with rooting, procumbent or decumbent stout stems reaching up to 70cm in height. The 7-15cm long, linear-lanceolate leaves are glabrous except for some stiff hairs on the margins and the veins beneath. It produces pink flowers, in long, lax, very slender spikes. Nuts 2-2·5 mm, black, glossy, usually trigonous. It is native to the South of Europe dwelling in wet places and river-banks (Webb, 1993). It is distinct from the other *Persicaria* species in Malta mainly from its lax flowers in narrow spikes, trigonous nuts, and smaller linear-lanceolate leaves.

This species is quite variable, with a history of numerous synonyms and several subspecies and varieties described, of which now, they are all treated as synonyms (FZB, TPL). It seems that there is no consensus which taxon is accepted; for instance, according to FZB and GRIN, *P. salicifolia* is a synonym of *P. decipiens* (R. Br.) K.L. Wilson while, according to TPL, it is a synonym of *P. serrulata* (Lag.) Webb & Moq. It is beyond the scope of this account to discuss which taxon must be applied, but the conventional *Persicaria salicifolia* is used in this paper, in line with that used in the Red data book (Lanfranco, 1989) under the basionym of *Polygonum salicifolium* Brouss. Ex Willd. and by the Malta Environment Planning Authority, such as in their recent educational article in local media (TOM, 2011).

4.2 *Persicaria lanigera* (R.Br.) Soják

Persicaria lanigera (= *Polygonum lanigerum* R. Br.) is an erect, villous, perennial plant reaching up to 200cm in height. It forms shortly petiolated, lanceolate to ovate-lanceolate leaves (10-25 × 2-6 cm in size), with a cuneate base and acuminate tip, densely covered with white lanate hair especially beneath. It produces dense spikes of pink flowers. It is rather easy to distinguish owing to its characteristic eglandular lanate leaves making them appear greyish and hoary, the shortly villous ochreae with a line of wooly cilia over 5mm long on its apical margin and the presence of white woolly hair on the eglandular peduncles (Thiselton-Dyer, 1913; Webb, 1993).

Table 1: List of populations of *Persicaria* spp. in Malta from which material has been studied.

Popl. Code	Site, locality, island	First record	Reported or identified as	Date of study
PSL1	Wied il-Baħrija, Rabat, Malta.	1853 by Grech Delicata	*Polygonum minus*	Oct 2011
PSN1	Wied il-Girgenti / Wied ta Brija, Siġġiewi, Malta	1987 by M. Briffa (pers. comm.)	*Persicaria senegalensis* (s.l.)	May 2010
PSN2	Wied l-iSperanza, Mosta, Malta.	1992 by Tabone (2008)	*Persicaria senegalensis* (s.l.)	Sep 2011
PSN3	Wied il-Għasel, Mosta, Malta.	2010, in this work (new record)	n/a	Sep 2011
PSN4	Tar-Rummien Quarry, Kirkop, Malta	2000 by Lanfranco (2000)	Not identified (*Persicaria* spp.)	Nov 2013
PGL1	Wied il-Hżejjen, Mġarr, Malta.	1990 by M. Briffa (pers. comm.)	*Persicaria glabra*	Sep 2011
PGL2	Wied l-Ortolan, Għasri, Gozo.	2008, in this work (new record)	n/a	Oct 2011
PGL3	Wied Sara, Victoria, Gozo.	2008 (by Tabone, 2008)	*Persicaria glabra*	Oct 2011
PGL4	Wied tal-Grazzja, Victoria, Gozo.	2008, in this work (new record)	n/a	Oct 2011
PLA1	Wied il-Għajn (tal-Bidni), M'Scala, Malta.	1997, by A. Bonello and A. Falzon in Stevens & Tanti (1997)	*Persicaria lanigera*	Sep 2011
PLA2	Wied il-Għasri, Għasri, Gozo.	2000 by Tabone (2008)	*Persicaria lanigera*	Oct 2011
PLA3	Wied Sara, Victoria, Gozo.	1992 by Tabone (2008)	*Persicaria lanigera*	Oct 2011

4.3 *Persicaria senegalensis* (Meisn.) Soják and *Persicaria glabra* (Willd.) M.Gómez

The following debate concerns the other two *Persicaria* species reported from Malta as *P. senegalensis* (= *Polygonum senegalense* Meisn.) and *P. glabra* (= *Polygonum glabrum* Willd.). It does not seem a coincidence that from such local accounts and personal communications, there is a misconception that the pink- or rose-flowering *Persicaria* (**PGL1-4**) are attributed to *Persicaria glabra*; while the white flowering populations (**PSN1-3**) to *Persicaria senegalensis*. Since both taxa are described as forming flowers ranging from white to pale pink to rose-pink (Graham, 1958; FIN; FNA; FOC; FZB), flower colour is not a distinguishing character.

Both *P. senegalensis* and *P. glabra* are large, perennial plants similar in habit and inflorescence to *P. lanigera*. From the various floras researched (FCN; FNA; FZB; Thistleton-dyer, 1913; Graham,1958; Maire, 1961; Miller *et al.*, 1996; and Jansen, 2004) the main distinguishing differences between *Persicaria glabra*, *P. senegalensis* and *P. lanigera* are chiefly based on the following characters:

(i) the pilosity of leaves and flower peduncles,
(ii) yellowish sessile glands on the abaxial leaf surfaces and flower peduncles
(iii) the indumentum and apical margin of the stem's ochreae and
(iv) the shape of the nuts.

Other taxonomical differences of minor importance include plant size and robustness, redness of stems, and width of leaves. One must early point out that these two species are rather variable with marginally overlapping distinguishing character states (Wilson, 1990) that makes their identification not a straight forward process.

Jansen (2004) describes *P. senegalensis* to be, "*variable in its indumentum, from glabrous to densely white woolly tomentose. This has resulted in the distinction of several subspecies, varieties and forms, but numerous intermediate types exist, sometimes even on the same plant*". The same author also states that that *P. senegalensis* much resembles *P. glabra* (Willd.) M.Gómez, but it is usually larger with wider leaves longer perianth and fruit never triangular.

The flora of Thiselton-Dyer (1913) covers 20 keyed and described *Polygonum* species which comprises *Polygonum lapathifolium*, *P. lanigerum*, *P. glabrum*, *P. senegalense* and *P. sambesiacum*. Here, *P. lanigerum* is distinguished from other species by having leaves with white dense lanate hair. *P. senegalense* and *P. sambesiacum* are distinguished from *P. glabrum* by having leaves moderately hairy below compared to *P. glabrum* which is glabrous. *P. sambesiacum* differs from *P. senegalense* by having yellow glands at the underside of the leaves, but *P. sambesiacum* is now treated as a synonym of *P. senegalense* (APD, TPL).

Reference to the pilosity and yellow glands at the lower side of leaves of *Persicaria senegalensis* is made by Graham (1958), Maire (1961) and FZB the latter stating "*glabrous apart from hairs on the midrib and margins to densely white-woolly on both surfaces, often more densely so on the lower surface, covered with small yellowish glands on the lower surface*". These three authors also mention the presence of amber glands on the flowering peduncles. For example "*peduncles up to 7 cm long, with orange glands, glabrous or with adpressed hairs" (FZB) and "peduncles covered with orange glands, puberulent varying to white-tomentose*." (Graham, 1958). The ochreae are generally glabrous or glabrescent, without cilia or with up to 3 mm long slender cilia according FZM; with few short, sparse cilia according Maire (1963) and eciliate according Thisleton-Dyer (1913). Finally one should mention that this species exudes a yellow substance from its glands onto herbarium papers when pressed (Graham, 1958).

According to FZW, APL and TPL there are two accepted forms of *Persicara senegalensis*: forma *senegalensis* and forma *albotomentosa* (R.A. Graham) K.L. Wilson, where, as the epithet suggests, the latter differs from the nominal form by having a white tomentum. FZM further states that forma *senegalensis* is glabrous with green leaves whereas forma *albotomentosa* has whitish leaves due its tomentose hairs.

Persicaria glabra is characterised to be a glabrous plant throughout (Thiselton-Dyer,1913; FCN; FPK; FIN) though FNA states that rarely, it could be pubescent distally. The leaves are normally glabrous but some authors make reference to the presence of scabrous hairs only on the midrib and main nerves (Thiselton-Dyer , 1913; FNA; FIN) - such varieties were even described as *P. glabra* var. *scabrinervis* (Hook.f.) H. Hara. Thiselton-Dyer (1913), Miller at al.(1996), FNA, FCN, FPK or FIN, give no indication that *P. glabra* has pubescent or tomentose hair at the abaxial surface of the lamina. With regards to the foliar glands, there are mixed descriptions. Thiselton-Dyer (1913) and FCN does not mention presence of any foliar glands; FPK and FZB states completely glabrous, sometimes red-gland dotted; FIN states "*minutely pustulate, otherwise usually smooth*" ; FNA's description is "*sometimes glandular-punctate*" while Miller *et al.*, (1996) writes "*minutely yellow glandular*".

Thiselton-Dyer (1913), FCN, FPK, and FZB do not mention the presence of glands on the peduncles of *P. glabra* - for example "[peduncles are] *glabrous, not glandular*" (Thiselton-Dyer (1913) but FNA and FIN states peduncles can rarely be glandular-punctate. The ochreae of *P. glabra* is described by Thiselton-Dyer (1913), FPK, and FNA to be glabrous and completely eciliate except FIN which states "*apex not ciliate, sometimes with a few bristles ca. 0.5mm long*". Finally, Miller *et al.*, (1996) make emphasis on the nuts which, in their key, apart the yellow glands on the peduncle coherent with the above account, they differentiate *P. senegalensis* from *P. glabra* by (the former) having nuts with dimpled faces against nuts without dimples in *P. glabra*. Apart that, they also state that the nuts of *P. senegalensis* are 3mm and seldom trigonous in shape, while those of *P. glabra* can be either lenticular or trigonous and 2.5mm diameter.

4.4 Taxonomic key for the *Pesicaria* spp. in Malta

To simplify the identification of the Maltese material, a key was adapted from the information given above.

1a. Spikes lax and slender; larger leaves up to 18cm long, finely serrulate; nuts trigonous ……..*P. salicifolia*
1b. Spikes dense and stout, with the flowers crowded and overlapping; larger leaves much over 18cm long; nuts lenticular ……..**2**

2a. Both sides of leaves greyish due to a covering of lanose white hairs, peduncles densely lanate, ochreae shortly lanate with a row of cilia (>5mm long) on the margin .....*P. lanigera*

2b. Upper surface of leaves green, glabrous to glabrescent, peduncles without dense hair, at most scantily strigose; ochreae glabrous, eciliate or with a row of short cilia (<4mm long) on the margin…… **3**

3a. Peduncles glabrous without or with a few punctate glands, apical margin of most ochreae eciliate, nuts lenticular or trigonous ..... *P. glabra*
3b. Peduncles with several sessile (bulging) yellow glands, apical margin of ochreae with 2-3mm long cilia, nuts always lenticular .....**4** (*P. senegalensis* s.l.)

4a. Abaxial side of lamina glabrous apart from strigose midrib, veins and margin……..*P. senegalensis* forma *senegalensis*
4b. Abaxial side of lamina with short white hair to densely tomentose ..... *P. senegalensis* forma *albotomentosa*

5. Identity of the *Persicaria* spp. and notes on the corresponding populations.

A comparison of morphological features of all Maltese populations are given in Table 2a & 2b, and the most distinguishing ones are further illustrated in Figures 1, 2, 3 and 4

5.1.1 Material: **PSL1** - Wied il-Baħrija (Baħrija, Malta) ; Examined: 18 October 2011, October 2013)

A population of *Persicaria* present at Wied il- Baħrija has been known since Borg (1927). Concurring with previous work (Haslam, 1977; Lanfranco 1989, 2002) the species corresponds to *Persicaria salicifolia*, distinguished from its relatively small habit, long stiff bristles lining the apical margin of the ochreae, linear-lanceolate, (willow-like) leaves, lax inflorescence on 1cm thick spikes and trigonous nuts.

During a survey at Wied il-Baħrija on 18-Oct-2011,three metapopulations were observed in this valley bed. Although not anymore a "dominant component of its [Wied Baħrija] vegetation" as reported more than 20 years ago by Lanfranco (1989), the population is still well-defined. The dense stands of *Arundo donax* L. engulfing the wetland habitat of this valley bed is the main natural threat for *Persicara salicifolia*. The metapopulations observed at Wied il-Baħrija are given below of which the largest one was found in one of the very few exposed parts of the valley were *Arundo donax* is not present. 20 to 30 years ago, Edwin Lanfranco (pers. comm.) and Michael Briffa (pers. comm.) recall much larger populations of *P. salicifolia* in parts of this valley which was not overrun by *Arundo donax L.* as is at present

1) First metapopulation		Size: 4m x 2m (hindered by sparse stands of *Arundo donax*)
2) Next metapopulation	280m away	Size: 5m x 2m (beside a footpath)
3) Next metapopulation	60m away	Size: 25m x 3m (in an exposed clearing)
4) Next metapopulation	500m c. away	Size: 3m x 2m (in a depression of the valley bed amongst *A.donax*)

5.2. 1 Material: **PLA1** - Wied il-Għajn (M'Scala Malta) ; examined: 18-Sep-2011

The examined material had eglandular, lanate leaves and flowering peduncles. ochreae tomentose with a line of shaggy cilia more than 5mm long on its apical margin. According the taxonomical discussion above (section 4.2 and 4.4) the material is identified as *Persicaria lanigera*, consistent with the identity given by Stevens & Tanti (1997); Tabone (2008), Edwin Lanfranco and Michael Briffa (pers. comm.)

The population at Wied il-Għajn was first observed by the author back on the 31-Aug-2006 as a large and dominating population of about 60m x 10m. It was visited again on April 2008, and the population was found to have decreased by half. A few specimens were at that time parasitized by *Cuscuta campestris* Yunck; a recent introduction to the Maltese Islands (pers. comm. Edwin Lanfranco). On the 18-Sep-2011, the area that 5 years before was dominated by *P. lanigera*, now exhibited only a clump of about 15 plants occupying an area of merely 4 x 2m in size. They were found surrounded by ruderal species chiefly *Aster squamatus* (Sprengel) Hieronymus, *Amaranthus viridis* L., and few specimens of *Mirabilis jalapa* L., *Datura innoxia* Mill, *Rumex conglomeratus* Murray and *Rumex cristatus* L. The later species is a rare and strictly protected species which was not previously recorded from this site.

Further areas were explored during the survey in Sep 2011, and two other metapopulations composed of few individuals or small clumps were found dispersed downstream. The metapopulations observed at Wied il-Ghajn are as follows:

1) First metapopulation		Size: 4m x 2m (beneath a small bridge)
2) Next metapopulation	50m away	Size: 5m x 5m (individual specimens scattered here and there)
3) Next metapopulation	180m away	Size: 5m x 3m (near a dam built across the valley)

5.2.2 Material: **PLA2 -** Wied tal-Sara (Victoria, Gozo) ; examined: 3-Oct-2011

The only site in Malta which comprises two different *Persicara* spp. growing together is that at Wied Sara, where two small clumps of a *Persicaria* sp. with grayish leaves (**PLA2**) were found intermixed with a larger population of another *Persicaria* sp. with bright green leaves (**PGL2**, discussed below). **PLA2** had the same characters of **PLA1** and identified as *Persicaria lanigera.* This concurs with the species reported from here by Tabone (2008). Only 2 small clumps of about 2-3m diameter and 5-8m apart were observed on a survey carried out on 3-Oct-2011.

5.2.3 Material: **PLA3 -** Wied il-Għasri (Għasri, Gozo) ; examined: 11-Oct-2011

Another population of *Persicaria* was observed colonising an area of 30m x 5m of at the valley bed of Wied Għasri, Gozo. No other metapopulations were found during a survey of this valley on 11-Oct-2011. The examined specimens had the same morphological characters as the material in **PLA1** and **PLA2**, that is, leaves and peduncles covered with the characteristic white, lanose indumentum and with tomentose ochreae with long-ciliated wool-like cilia. The population was hence identified as *Persicaria lanigera*, coherent with the record of Tabone (2008) from this site.

5.3.1 Material: **PSN1 -** Wied il-Girgenti / Wied ta' Brija (Siġġiewi, Malta) ; examined: May-2010

Specimens of this white-flowering smartweed had leaves with conspicuous sessile yellow glands mostly located at the lower surface. Leaves were hairless at both surfaces except scabrous hairs at their margins, midrib and main branching veins. The peduncles were mostly glabrous, covered with similar yellow glands as on the leaves. The ocheae were glabrous and had a line of 3mm long cilia on their apical margin. Nuts were not studied because the population was not anymore extant when this character was being studied for. Nevertheless, with reference to section 4.3 and 4.4 of this account, the characters are those of *P. senegalensis* forma *senegalensis*. Populations from neighbouring sites of Għajn il-Kbira and Wied il-Girgenti had been already identified as *P. senegalensis* by Tabone (2008) and Michael Briffa (pers. comm.)

During a survey in May 2010, this population was about 15m x 5m in size and found in a shallow pond along the valley bed. In summer 2010, the population was missing by dredging of the valley bed. Despite the species produces large amounts of seeds, none had regenerated the population after more than within 3 years. Fortunately, few specimens of this population regenerated and observed in January 2014.

5.3.2 Material: **PSN2 –** Wied l-isperanza (Mosta, Malta) ; examined: 19-Sep-2011

Specimens at Wied l-isperanza exhibited the same morphological characters as in **PSN1**, with the characteristic yellow sessile glands at the abaxial side of the lamina and flower inflorescences. The nuts were all lenticular, 3mm in diameter, many with dimpled faces. This population also corresponds to *P. senegalensis* forma *senegalensis*. The identification concurs with that given by Tabone (2008) from this site.

Wied l-isperanza is part of a large valley system starting from Dingli and Rabat at the North West of Malta and it ends up at Salini, a coastal area located at the East of Malta. The part of Wied Speranza sampled is in the limits of Mosta. The population was found to be scattered in several metapopulations along the valley bed during a survey carried out on 18-Sep-2011. No water was found flowing during this site visit but parts of the valley bed were damp. A series of 8 metapopulations were found along the valley bed for about 500m as follows:

1) First metapopulation		Size: 15m x 5m (In a water pond at the bottom of a bridge)
2) Next metapopulation	200m away	Size: 100m x 5m (close to the *San Pawl tal-Qliegha* chapel)
3) Next metapopulation	20m away	Size: 25m x 3m
4) Next metapopulation	50m away	Size: 5m x 2m
5) Next metapopulation	40m away	Size: 15m x 2m
6) Next metapopulation	65m away	Size: 3m x 2m
7) Next metapopulation	20m away	Size: 5m x 2m

8) Last metapopulation 40m away Size: 10m x 10m (in a rock cavity flooded with water)

All these meta-populations were present in small localised areas were water is retained and flooded for a long time, forming long-lasting temporary ponds. In Summer, such areas dry out, but the ground remains damp and seems to be enough for the rootstock to survive.

5.3.3 Material: **PSN3** – Wied il-Għasel (Mosta, Malta); examined __ 20-Sep 2011

A population of *Persicaria* sp. with white flowers was found by the author at Wied il-Għasel (Mosta) on 2-Dec-2009 during a wetland survey for MEPA. Similar to **PSN1** and **PSN2**, examined material consisted of glabrous leaves with strigose margins and midveins and numerous yellow glands mostly located at the abaxial surface. The peduncles bore similar glands but lacked hair, while the apical margin of the ochreae had a line of cilia about 2mm long. The species was identified as *Persicaria senegalensis* forma *senegalensis* and is a new record from this valley, which belongs to the same valley system from which **PSN2** was recorded, about 1.5km upstream. There is no evidence to confirm whether this rather remote population originated by a dispersal event by water streams from population **PSN2** or if it is a new introduction, but the former seems to be more plausible.

Three metapopulations were found along the valley bed during a survey on 20-Sep-2011:

1) First metapopulation		Size: 15m x 2m
2) Next metapopulation	150m away	Size: 40m x 3m
3) Next metapopulation	220m away	Size: 5m x 2m

5.3.4 Material: **PSN4** – Quarry at ta'Rummien, Kirkop, Malta; examined 2-Nov-2013

A population of *Persicaria* was spotted by Timothy Tabone from an unused quarry flooded with water at Kirkop and tentatively identified and reported as *Persicaria* cf *lanigera* (Lanfranco, 2000). It was not possible for the cited persons to reach and identify the population to species level (pers. comm. Edwin Lanfranco). The present author was informed about this population in May 2013 (pers.comm Darrin Stevens) and visited the quarry on 1-Nov-2013. Two large clumps at the west and northeast side of the quarry together with two smaller clumps at the south side were observed. Access was gained from the south side and voucher specimens were collected and examined.

The plants formed pink flowers with elongate slender lance-shaped leaves giving an instinctive indication that, as in the other pink-flowering populations from Malta, this population corresponds to *P. senegalensis* f. *albotomentosa* or *P. lanigera*. The latter was easily discarded due to the absence of long silky hair on the leaves, ochreae and peduncles. The leaves were generally glabrous, but microscopic examination revealed very short, scabrid hairs only on the veins of the abaxial side. Moreover, the abaxial surface was densely covered by yellow glands that gave the leaf a yellowish tinge. The margin was shallowly undulate and strigose, with stiff, short, appressed bristles. The margin of young ochreae had a row of bristles about 2mm long, although numerous mature ochreae had lost their bristles and appeared glabrous. The peduncles were densely covered with yellow glands but without any hair, hence having the same indumentum as at the abaxial surface of the leaves. The seeds were 3mm in size, black, all lenticular and some (less than half) with a dimpled face. The lack of hair at the lamina and peduncles led the identity to *Persicaria senegalensis* f. *senegalensis* and **PSN4** corresponds to the first population of this subordinate taxon in Malta with pink flowers (PSN1-3 have white flowers).

5.4.1 Material: **PGL1** - Wied tal-Ħżejjen (Mgarr, Malta) ; examined: 21-Sep-2011

Wied tal-Ħżejjen is part of a large valley system running from limits of Mgarr (West of Malta) and joins the valley system of Wied il-Ghasel at Burmarrad (l/o St.Paul's Bay) where it finally meets open sea at Salini, at the North East of Malta. The area where *Persicaria* was found consisted of a large clearing flooded with water during the rainy period with scarce amounts persisting throughout summer. During a site visit on 21-Sep-2011 the valley bed was damp and muddy and a small pond of water was still present close to the population. The main population was about 25m x 10m in size, and there were few smaller satellite clumps of plants close-by. No other metapopulations were found along this valley.

Examined specimens were quite variable in a few important characters. Most notably the indumentum of the leaves, which varied from very hairy (almost tomentose in a few examples) to scantly and shortly hairy (puberulous). Moreover the lamina had a mixture of punctuate green glands and yellow sub-sessile glands. The density of glands appeared to be inversely proportional to the pilosity of the lamina, that is, leaves with dense hair were almost eglandular. Confusingly, some specimens had leaves with a different density of pilosity, while others had a patchy distribution of hairiness on the same leaf. The ochreae were glabrous with a line of cilia, 2-3mm long on the apical margin, similar to that in **PSN1-3**.

The studied peduncles possessed sessile yellow glands, also in different densities between specimens. In general glands were abundant in young inflorescences and on the flattened surface of the lower part of the petiole. Some specimens had glabrescent peduncles with short hair only visible by a x10 magnification glass, while others had obvious white hair visible to the naked eye. Several specimens had numerous yellow glands on the hyaline bracteoles when observed under a light microscope at x40 magnification. The colour of the flowers varied from pink to rose-pink grouped in long, often nodding spikes. All seeds examined were lenticular, black, polished, 3mm in diameter and many (c. two thirds) had dimpled faces.

Based on the detailed taxonomy given above (sect 4.3 and 4.4), the material was identified as *Persicaria senegalensis* forma *albotomentosa*, not *Persicaria glabra* as previously identified. The ciliated ochreae, yellow glands on the leaves and peduncles and the white hair on the leaves were the distinguishing characters for this identification.

5.4.2 Material: **PGL2 -** Wied tal-Ort (Għasri, Gozo) ; examined: 3-Oct-2011
PGL3 – Wied Sara, (Victoria, Gozo) ; examined: 3-Oct-2011
PGL4 – Wied tal-Grazzja, (Victoria, Gozo) ; examined: 3-Oct-2011

Several large-sized clumps of *Persicaria* sp. dwell along the Wied Sara valley system, precisely in valley segments called Wied tal-Ort, followed by Wied Sara and then Wied tal-Grazzja, together making a stretch of little more than 2km.

Wied tal-Ort consists of a series of dams built across the valley to form seven water catchment areas, all deep and narrow (5-10m accross), except the last one which is about 120m x 20m in size and flooded with relatively shallower water all year round. It is exposed to sunlight and lined by clayey soil or open fields, instead of being shaded and cut into limestone rock as in the previous catchment areas.

The largest metapopulation of Wied l-Ort was found dominating the South side of the water catchment area while a smaller one was present along the inner side of the dam. Unlike other populations which tend to grow at the valley bed, this population was offset to the clayey side, likely because the water is too deep at the central part to support its life.

Wied Sara is the subsequent valley segment following Wied l-Ort. Several small-sized metapopulation (**PGL3**) were noted along the valley bed in April 2008, dominated by *Bolboschoenus maritimus* (L.) Palla, *Schedonorus phoenix* (Scop.) Holub. and *Dactylis glomerata* s.l. L. The largest population was located in a pond of water along the valley bed.

Following Wied Sara is the valley segment called Wied tal-Grazzja in which 2 metapopulations of *Persicaria* sp. were found **(PGL4),** one at each ends of this valley and both located at the foot of small bridges crossing the valley. The largest metapopulation was that in a shallowly flooded area behind a dam close to the Cappuchine's convent and church. No further metapopulations of *Persicaria* were observed in the consecutive valley segments of Wied tal-Kappucini and Wied Marsalforn.

The metapopulations recorded along this valley system on the 3rd October 2011 are:

1) First population (Wied tal-Ort)		Size: 5m x 2m
2) Next population (Wied tal-Ort)	20m away	Size:35m x 5m (on clayey soil aside the pond)
3) Next population (Wied tal-Ort)	220m away	Size:25m x 4m (L-shaped, in front of the dam and aside)
2) Next population Wied Sara	20m away	Size:80m x 4m (fragmented metapopulation just behind the dam under large Eucalyptus trees,)
3) Next population Wied Sara	70m away	Size: 8m x 2m (narrow valley bed, weedy sides)
4) Next population Wied Sara	100m away	Size:25m x 3-8m (in a pond of water)
5) Next population Wied Sara	80m away	Size:15m x 3m (beside tunnel under Triq Wied Sara)

6) Next population Wied tal-Grazzja 280m away Size:10m x 3m (beside tunnel under Triq l-imghallem)
7) Next population Wied tal-Grazzja 950m away Size:15m x 10m (beside tunnel under Triq Marsalforn)
8) Next population Wied tal-Grazzja 30m away Size:10m x 3m (last metapopulation)

The morphology of the material at **PGL2**, **PGL3** and **PGL4** were identical in all important characters, and hence belong to the same species. The perennial plants were between 80 to 180cm high, and had swollen stem nodes that varied in colour from green to reddish-wine to brown. They formed bright green leaves that at a glance appeared to be glabrous but under magnification the abaxial side of the lamina had very short, white hair, rather dispersed but constant throughout or somewhat denser towards the edges and tip of the leaf. Moreover, the lamina had punctate dark-green lucid glands and yellow glands. The proportion of the two varied between specimens, but in general there were more punctate glands. The midrib, many of the main lateral veins and the margin of the leaf had short stiff bristles (=strigose). The adaxial surface possessed much less hairs, best described as glabrescent.

Young peduncles holding buds and blossoming flowers were covered by sessile yellow glands, but old peduncles holding last flowers and unripe fruit had much less glands and these were sometimes observed as glabrous to the naked eye. Some specimens had peduncles with white hair ranging from scanty to numerous, especially on the lowermost flowering branch of the inflorescence ramification, but such pilosity never extended to a pilose or lanate one. Under magnification, it could be clearly seen that many peduncles, had white hairs. Few yellow glands were present on the petals of the flowers too.

The ochreae were glabrous, mucilaginous and with a truncate apical margin lined with cilia between 1-3mm long. The cilia were present in more or less the upper 6-8 ochreae, and gradually, they were lost further down the thickening and weathered stem. About a total of 80 nuts were examined from different specimens and all were black with a lenticular shape, never trigonous. A few were measured and examined carefully and had a diameter of 3mm across and around half of the seeds examined had dimpled faces.

According to the detailed taxonomy given in section 4.3 and 4.4, it has been concluded that the combination of characters falls within the variable range of *Persicaria senegalensis* f. *albotomentosa.* The examination of **PGL2-4** concurs with Wilson (1990) that *P. glabra* and *P. senegalensis* are rather variable species with marginally overlapping distinguishing features. Distinct characters that led to this determination include the presence of yellow glands on the leaves and more predominantly on young peduncles, leaves that are hairy (although minutely and scantly so), ochreae with a line of 1-3mm long cilia and all seeds are lenticular (none trigonous) some having dimpled faces.

6. Origin of the *Persicaria* species recorded from Malta and notes on their introduction.

Persicaria salicifolia is native in our islands owing to the fact that part of its distributional range is the South of Europe and North Africa (FZB, GRIN). *P. lanigera* is native to the Old World Tropics (Webb, 1993). It is specifically recorded from Benin, Gabon (GBIF), Israel (FIS) Eygpt (APD; Webb, 1993) and first recorded from Europe in Crete in 1983 (Akeroyd, 1987). *P. senegalensis* is native to South and tropical Africa and reported from the following African countries: Benin, Burkina Faso, Ethiopia, Gabon, Kenya, Ivory Coast, Malawi, Mayotte, (GBIF), Botswana, Mali, Tanzania (GBIF, GRIN), Algeria, Egypt, Somalia, Uganda, Gambia, Ghana, Niger, Senegal, Swaziland, Madagascar, Yemen, Israel (GRIN), Mozambique, Zambia and Zimbabwe (FZ), Palestine, Tropical Asia and Tropical Africa (Maire, 1961). Ethiopia is the country with most occurrences from the countries listed by GBIF. It has also been introduced in the USA and UK (GBIF). Algeria and Egypt are the closest African countries to Malta.

In contrast, *Persicaria glabra* is distributed further away; native in South America, Tropical Asia, Temperate Asia, and Madagascar, located at Western Indian Ocean. (GRIN). The biota of Madagascar has a different origin from that of continental Africa and indeed includes a very large number of endemic taxa, even at the level of higher taxonomic groups.

As stated above *P. lanigera* is first recorded in Europe from Crete in 1983 (Akeroyd, 1987) while the Maltese stations of *P. senegalensis* s.l. reported few years later could be the first European records, however with a doubt because of a single record from the UK (GBIF, BSBI) dating back between 1939-1969 (BSBI). One must mention that this British record was not considered by Webb (1993) in the Flora Europaea, or currently listed by GRIN. Both species are not recorded from Italy, where *Persicaria nepalensis* (Meisn.) H. Gross. and *P. orientalis* (L.) Spach are the only introduced species listed by Conti *et al.* (2005).

According to Akeroyd (1987), *P. lanigera* was introduced into Crete from neighbouring countries like Eygpt as a weed of irrigated cultivation. For the Maltese islands, the vector of recent introduction of *P. senegalensis* s.l. and *P. lanigenera* is not by human intervention. One possible method of introduction is by seeds via migratory birds from North African or Middle East regions, namely Algeria and Egypt. Evidence that birds consume seeds of *P. senegalensis* is given by Ita (1994) where he states that over 300 species of game birds, waders and other avian migrants in Kainji Reservoir, Nigeria make use of *Polygonum senegalensis*. Although seeds are evacuated after ingestion, they can adhere to birds' feathers or muddy feet, to be liberated when the migrant birds land in Maltese valleys; an observation first reported by Darwin (1859: p859).

7. Notes on Habitat and growth.

In its native territories, *P. senegalensis* is found growing in damp places near or in shallow water bodies, such as dam sides, lakes and rivers, as well as in sandy soils of recently dried out channels at altitudes of between 50 to 1700m. (FZB). In Crete, *P. lanigera* is recorded on muddy soil along the river bank of River Yeros (Akeroyd, 1987)

Based on observations during this study, *Persicaria salicifolia, P. lanigera,* and *P. senegalensis* s.l. have a similar habitat on the Maltese islands, that is, wetland areas in valley beds where water has accumulated and remains for a long period of time. Such localised sites tend to remain damp, muddy or flooded even throughout summer and favouring the growth of these semi-hydrophyte species. Examples include water catchment areas formed by dams, natural ponds found along rocky valley beds, and sheltered ponds formed in rock depression immediately downstream from dams. Several metapopulations were located at the foot of bridges passing over valleys, and instead of a coincidence, these structures provide shade, minimize the effects of drought, and leave the area beneath them damp.

Populations in wide valleys such as Wied tal-Ħżejjen, Wied tal-Ort, and, to some extent, Wied il-Għajn, **[PGL1, PGL2, PLA1]** respectively, were found on the muddy areas at the sides of the water catchment areas, but not in the deeper parts of the ponds. Nevertheless, they can withstand or perhaps prefer to be immersed in shallow water rather than in aerial soil. Eutrophication and *Lemnaceae* species were often observed in the waters where *Persicaria* spp. grew. This indicated that the water is nitrogen/phosphate enriched, as expected in valleys that run through agricultural areas where organic farming is seldom practiced. The four metapopulations of *Persicaria salicifolia* [**PSL1**] seem to prefer shallow flooded sites or ponds along the valley bed.

There seem to be no particular association between the *Persicaria* populations and the accompanying flora. Populations [**PGL1], [PGL2]** and **[PGL4**] were found rather isolated from any plant communities, while populations [**PLN1]** and **[PSN1**] were found among ruderal species and *Arundo donax*. Despite that, one can find certain species like *Holoschoenus vulgaris* Link, *Cyperus longus* s.l. L., *Alsima plantago-aquatica* L. and *Rumex conglomeratus* close to the other *Persicaria* metapopulations, namely [**PSN3], [PGL3/PLA2]** and [**PSL1**]. In other words, one cannot tell the wetland habitat-type for *Persicaria* spp. from the accompanying flora, since this was inconsistent amongst the various populations studied.

Persicaria lanigera and *P. senegalensis* s.l. tend to dominate these shallow ponds rather quickly, but they do not colonise drier parts. **[PGL4]** was monitored for three years, and was first observed in January 2008 as a group of five specimens situated in a partially flooded area that measured 10m x 15m. In Feb 2009 there was a clump filling a bit less than half this area, while in Jan 2010 the entire area was occupied by hundreds of specimens of this species. On the other hand, it was demonstrated by some populations that they are not highly resilient. A dense population at **[PLA1]** was for some reason reduced by 95% while the plants at [**PSN1]** regenerated only after three years following a temporary eradication from valley bed dredging in 2010. For sure, *Persicaria* species have a good spreading potential, colonising water pockets by their fast-spreading, subterranean stolons and forming new populations along valley systems by long distance dispersion of seeds through water currents. At the submission of this manuscript (Nov. 2013) three plants of *Persicaria* sp. were observed at the mouth of Marsalforn valley, possibly disseminated from **[PSG4],** about 4km upstream the valley system.

8. Discussion

The introduced *Persicaria* species have successfully naturalised wetland ecosystems in the Maltese islands, and are now becoming an integral part of the Maltese wetland flora. The sites they dominate consist of localised shallow ponds along valley systems and hence they cannot be classified to be invasive or to be of a particular threat to Maltese habitats. As exemplified below, this study did not provide any clear evidence that introduced *Persicaria* species have replaced any native species. However this conclusion might be too hasty and this work

may at least serve, as the first step to monitor the behaviour of *Persicaria* spp, introduced in Malta in the last 25 years.

At Wied Sara and Wied tal-Grazzja [**PGL3-4**] *Persicaria senegalensis* did not replace any considerable patch of the native *Bolboschoenus maritimus* L., *Schedonorus phoenix* (Scop.) Holub, or *Dactylis glomerata* L.; at Wied Għasri [**PLA3**], the only population of *Persicaria lanigera* remained singular for almost 25 years; while the populations of Wied il-Għasel [**PSN3**] and Wied Speranza [**PSN2**] was not widespread over a large area but localised in small patches where ponds formed along the rocky valley bed. On a different note, one can mention the benefits that these *Persicaria* species have to nectar-seeking pollinators in summer, owing to the fact that they produce numerous flowers all year round. Bees and wasps have been observed visiting the flowers of *Persicaria* spp. in Malta. Munched leaves have been also observed in some populations, but the responsible herbivore was not observed in order to determine whether it is a native species. The dense populations that *Persicara* spp. form are in fact very likely to offer shelter to a number of animals and their seeds may provide food to some birds

9. Conclusion

Following taxonomical studies, the species of *Persicaria* present in the Maltese island are *P. salicifolia* (native), *P. lanigera* and *P. senegalensis* (both introduced). Two forms of the latter species exist, of which one - forma *senegalensis* has been found in a new site (Wied il-Għasel, Mosta) and the other - forma *albotomentosa* is a new taxon for the Maltese islands; previously misidentified as *P. glabra.* This form is present at Wied tal-Ħżejjen (Malta), Wied l-Ort, Wied Sara and Wied tal-Grazzja (Gozo).The introduced *Persicaria* spp. naturalised flooded wetland habitats, specifically at banks of water catchment areas or ponds along valley beds. Populations have not shown to be particularly resilient or invasive, though they tend to become dominant in small ponds and shallow parts of flooded areas they occupy. Moreover, as a result of a number of benefits they give to wetland ecosystems (until new studies show otherwise), it is suggested that alien *Persicaria* spp should not be eradicated by competent authorities.

Table 2: Comparison of characters from different populations of *Persicaria* spp. found on the Maltese islands

Morphological character	Bahrija, Malta [PSL1]	Marsascala, Malta [PLA1]	Wied Sara, Gozo [PLA2]
Height of plant	50-100cm	150-200cm	80-100cm
Stem posture	Ascending to erect, thin (4-6mm) stems	Mesh network of prostrate, thick (>0mm) stems forming ascending or erect branched vegetative stems	Mesh network of prostrate, thick (>0mm) stems forming ascending or erect branched vegetative stems
Stem nodes	Not conspicuously swollen, not rooting.	Swollen, not rooting.	Swollen, not rooting.
Cross Section of stem nodes	Solid (unhollowed) with a spongy white tissue at the core	Solid (unhollowed) with a thick reddish-purple border and a white spongy core. In old stems, this spongy tissue becomes hollowed	Solid (unhollowed) with a thick reddish-purple border and a white spongy core. In old stems, this spongy tissue becomes hollowed
Leaf shape	Linear lanceolate or linear-elliptic	Narrow lanceolate	Lanceolate
Leaf base	Obtuse, rounded.	Cuneate	Cuneate
Leaf apex	Acute	Long acuminate	Acuminate to acute
Leaf pilosity	Glabrous	Lanate, densely so at the abaxial surface	Lanate, densely so at the abaxial surface
Leaf margin	Strigose	Entire, lined by tomentose hair of lamina surfaces	Entire, lined by tomentose hair of lamina surfaces
Patches on lamina	Not present	Not present	Not present
Leaf glands at abaxial surface of lamina	Not present	None observed under light microscope (X20)	None observed
Leaf ribs	Numerous, arched or straight with curved endings, not swollen but sunken	Numerous, conspicuous, bulging, slightly arched with swell towards leaf base	Numerous, conspicuous, bulging, shallowly arched
Leaf size L x W (cm)	11-16 x 1.2-2.5	25-34 x 5.0-9.0	26-33 x 6.3 x 8.0
L : W ratio of leaves	8.3	4	4
Ochreae texture	Glabrous	Tomentose, rather sparse giving ochreae a silver-green colour	Sparsely tomentose, becoming denser at the apex
Ochreae margin	Long, well-spaced cilia, 10mm long	Long pilose cilia, 3-7mm long, abundant and conspicuous	Long pilose cilia, 5-6mm long, abundant and conspicuous
Inflorescences	Erect, thin	Erect or more often nodding, stout	Erect or more often nodding, stout
Petioles	Glabrous, polished	Shortly tomentose, eglandular	Shortly tomentose, eglandular
Colour of flowers	Pale pink	Pink and pale pink(some specimens almost white)	Pale pink
Nuts	Trigonous, lanceolate, black, shiny, 2mm long (incl. beak)	Circular, lenticular, black, shiny, 3mm long (incl. beak)	Circular, lenticular, black, shiny, 3mm long (incl. beak)

Morphological character	Wied il-Ghasri, Gozo [PLA3]	Wied l-iSperanza, Malta [PSN2]	Wied il-Ghasel, Malta [PSN3]
Height of plant	80-160cm	100-180cm	70-120cm
Stem posture	Mesh network of prostrate, thick (>0mm) stems forming ascending or erect branched vegetative stems	Mesh network of prostrate, thick (>0mm) stems forming ascending or erect branched vegetative stems	Mesh network of prostrate, thick (>0mm) stems forming ascending or erect branched vegetative stems
Stem nodes	Swollen, not rooting.	Swollen, rooting at lower nodes in touch or immersed in water	Swollen, rooting at lower nodes in touch or immersed in water
Cross Section of stem nodes	Solid (unhollowed) with a thick reddish-purple border and a white spongy core. In old stems, this spongy tissue becomes hollowed	Solid (unhollowed) with a thick reddish-purple border and a white spongy core. In old stems, this spongy tissue becomes hollowed	Solid (unhollowed) with a thick reddish-purple border and a white spongy core. In old stems, this spongy tissue becomes hollowed
Leaf shape	Lanceolate	Lanceolate	Lanceolate
Leaf base	Cuneate	Cuneate	Cuneate
Leaf apex	Acuminate to acute	Acuminate to acute	Acuminate
Leaf pilosity	Lanate, densely so at the abaxial surface	Glabrous	Glabrous, scantly puberulent in few specimens.
Leaf margin	Entire, lined by tomentose hair of lamina surfaces	Entire, strigose, often sinuated	Entire, strigose, sometimes slightly sinuated
Patches on lamina	Not present	Not present	Not present
Leaf glands at abaxial surface of lamina	None observed	Yellow Sessile glands, dense, most abundant at the leaf borders of the abaxial side	Yellow-green sessile glands present at irregular distribution
Leaf ribs	Numerous, conspicuous, bulging, shallowly arched	Numerous, conspicuous, bulging, slightly arched with swell towards leaf base	Numerous, conspicuous, bulging, slightly arched with swell towards leaf base
Leaf size L x W (cm)	27-32 x 6.5 x 7.7	20-30 x 5.5-7.0	20-32 x 4.0-7.0
L : W ratio of leaves	3.8	4.5	4.4
ochreae texture	Sparsely tomentose, becoming denser at the apex	Glabrous, hyaline with a pale rusty brown apical border	Glabrous, hyaline with a pale rusty brown border (3mm long).
ochreae margin	Long pilose cilia, 5-8mm long, abundant and conspicuous	A line of sparse cilia about, 2-4mm long	A line of sparse cilia about, 1-3mm long
Inflorescences	Erect or more often nodding, stout	Erect or more often nodding, stout	Erect or more often nodding, stout
Petioles	Shortly tomentose, eglandular	Sessile yellow glands, especially in young petioles or unexposed part of petiole.	Glabrous or slightly hairy; sessile glands present in all peduncles studied
Colour of flowers	Pale pink	White	White
Nuts	Circular, lenticular, black, shiny, 3mm long (incl. beak)	Circular, lenticular, black, shiny, 3mm long (incl. beak)	Circular, lenticular, black, shiny, 3mm long (incl. beak)

Morphological character	Wied tal-Hzejjen, Malta [PGL1]	Wied l-Ort, Gozo [PGL2]	Wied tal-Grazzja, Gozo [PGL4]
Height of plant	100-150cm	70-180 cm	100-150 cm
Stem posture	Mesh network of prostrate, thick (>0mm) stems forming ascending or erect branched vegetative stems	Mesh network of prostrate, thick (>0mm) stems forming ascending or erect branched vegetative stems	Mesh network of prostrate, thick (>0mm) stems forming ascending or erect branched vegetative stems
Stem nodes	Swollen, rooting at lower nodes in touch or immersed in water	Swollen, rooting at lower nodes in touch or immersed in water	Swollen, rooting at lower nodes in touch or immersed in water
Cross Section of stem nodes	Solid (unhollowed) with a thick reddish-purple border and a white spongy core. In old stems, this spongy tissue becomes hollowed	Solid (unhollowed) with a thick reddish-purple border and a white spongy core. In old stems, this spongy tissue becomes hollowed	Solid (unhollowed) with a thick reddish-purple border and a white spongy core. In old stems, this spongy tissue becomes hollowed
Leaf shape	Narrow lanceolate	Lanceolate	Lanceolate
Leaf base	Cuneate, gradually tapering to petiole	Cuneate, gradually tapering to petiole	Cuneate, gradually tapering to petiole
Leaf apex	Acuminate	Acuminate	Acuminate
Leaf pilosity	Variably pubescent, from sparingly hairy to tomentose. More so at the lower surface.	Variable, Shortly pubescent to puberulent to glabrous, strigose on midrib and veins at abaxial surface.	Variable, Shortly pubescent to puberulent to glabrous, strigose on midrib and veins at abaxial surface.
Leaf margin	Entire and strigose. A sub-glabrous border of about 1mm thickness is present between margin and lamina's tomentum	Entire, strigose, sometimes slightly sinuated	Entire, strigose, sometimes slightly sinuated
Patches on lamina	Not present	Not present	Not present
Leaf glands at abaxial surface of lamina	Yellow-green Sessile glands which are often replaced by tomentose hairs.	Variable; colourless or yellowish-green glands half embedded in leaf tissue (pustulate). Glands exudate a slightly sticky substance	Yellowish-green glands (sometimes green) half embedded in leaf tissue (punctate). Glands exudate a slightly sticky substance
Leaf ribs	Numerous, bulging, straight and becoming curved at their ends.	Numerous, conspicuous, bulging, slightly arched with swell towards leaf base	Numerous, conspicuous, bulging, slightly arched with swell towards leaf base
Leaf size L x W (cm)	22-32 x 4.5-6.5	20-36 x 4.0 - 6.2	20-32 x 3.8 - 6.0
L : W ratio of leaves	5.0	5.2	5.1
ochreae texture	Glabrous becoming puberulent towards the top	Glabrous, hyaline with a pale rusty brown apical border	Glabrous, hyaline with a pale rusty brown apical border
ochreae margin	A line of sparse cilia about 2-3mm	A line of sparse cilia about, 1-2mm long	A line of sparse cilia about, 1-2mm long
Inflorescences	Erect or more often nodding, stout	Erect or more often nodding, stout	Erect or more often nodding, stout
Petioles	Sessile yellow glands at various densities often accompanied by sparse hairs.	Yellow sessile glands in distal parts or young petioles.	Yellow sessile glands in distal parts or young petioles.
Colour of flowers	Pale pink to rose-pink	Pale pink to rose-pink	Pale pink to rose-pink
Nuts	Circular, lenticular, black, shiny, 3mm long (incl. beak)	Circular, lenticular, black, shiny, 3mm long (incl. beak)	Circular, lenticular, black, shiny, 3mm long (incl. beak)

Figure 1: Morphological characters of *Persicaria salicifolia* found in specimens on the Maltese Islands [PSL1]. Top left: Narrow spike-form inflorescence with lax flowers; Top right: Margin of ochreae with long stiff bristles; Bottom left: Linear-lanceolate leaves; Bottom right: Trigonous, black seeds, c. 2.0-2.5mm long.

Figure 2: Morphological characters of *Persicaria lanigera* found in specimens on the Maltese Islands. Top left: Abaxial (left) and adaxial surface of leaves from Wied Sara [PLA2], Victoria, Gozo. Lower surface is more densely hairy and has a white appearance (3-Oct-2011); Top right: Close up of wooly indumentums at the abaxial surface of lamina from Wied il-Għajn [PLA1], M'Scala, Malta (18-Sep-2011); Bottom left: ochreae lined with long shaggy cilia, about 5-6mm long from Wied Għasri [PLA3] (11-Oct-2011); Bottom right: Peduncles covered with greyish-white short tomentose hair from Wied il-Għajn [PLA1] (18-Sep-2011)

Figure 3: Morphological characters of *Persicaria senegalensis* forma *senegalensis* found in specimens on the Maltese Islands. Top left: Abaxial surface of leaf lamina from [PSN2] which is galbrous and covered with many sessile yellow glands, magnified at x40 in the inset. Top right: Peduncles from [PSN1] showing numerous yellow glands, magnified at x40 in the inset. Bottom left: ochreae from [PSN3] having 2mm long cilia at the apical margin; Bottom right: Nuts from [PSN2] some with dimpled faces.

Figure 4: Morphological characters of *Persicaria senegalensis* forma *albotomentosa* found in specimens from the Maltese Islands. Top left: Abaxial surface of lamina from [PGL1] having a shortly tomentose indumentum with a close up of the margin in the inset; Top right: Abaxial surface of lamina from [PGL1]having a sparse short hair and yellow glands, better seen in the close up shown in the inset; Centre left: ochreae from [PGL1] with a line of cilia 2mm long; Bottom left: Close up of peduncle from [PGL1] showing sessile, bulging, yellow glands. Bottom right: peduncle from [PGL1] with sessile yellow glands;

Figure 5: Morphological characters of *Persicaria senegalensis* forma *albotomentosa* found in specimens present on the Maltese Islands. Top left: Abaxial surface of lamina from [PGL2] having short white hair; Centre left: Magnified image (x40) of abaxial surface of lamina from [PGL1] showing scattered white hair, some yellow glands, and numerous translucent glands; Bottom left: same as above but material from [PGL4]; Top right: Peduncles from [PGL3] covered with sessile yellow glands; Centre right: ochreae from [PGL2] with a line of cilia 2-3mm long; Bottom right: Seeds from [PGL1] where some have dimpled faces.

Figure 6: Populations of *Persicaria lanigera* in the Maltese islands. Top left: Wied il-Għajn [PLA1] Marsascala, Malta (31-Aug-2006); Top right: Same population in 18-Sep 2011 to show its degradation down to 20-30 specimens; Centre: Wied Sara [PLA2]; Victoria, Gozo (3-Oct-2011); Bottom left: *P. senegalensis*, Wied Sara [PLA2] (3-Oct-2011); Bottom right: Whitish perianth of a metapopulation present at Wied il-Għajn [PLA1] (18-Sep-2011). Flowers of another metapopulation (1A/1B) were pink.

Figure 7: Populations of *Persicaria senegalensis* forma *senegalensis* in the Maltese islands. Top left: Wied Speranza [PSN2], Mosta, Malta (12-Dec-2009); Top right: Inflorescence from specimens at Wied Speranza [PSN2] (4-Nov-2009); Center: Wied ta' Brija [PSN1], Girgenti area, Siġġiewi, Malta (12-Nov-2008); Bottom left: Wied il-Għasel [PSN3], Mosta, Malta (22-Sep-2011); Bottom right: Basal stem submerged in water with red roots at the base of the nodes taken from Wied Speranza [PSN2] (4-Nov-2009) .

Figure 8: Populations of *Persicaria senegalensis* forma *albotomentosa* in the Maltese islands. Top Left: Wied il-Ħżejjen [PGL1], l/o Mġarr, Malta (13-Dec-2009); Top right: Close up of inflorescence from Wied tal-Ħżejjen [PGL1] (13-Dec-2009); Centre left: The only three specimens present at Wied tal-Grazzja [PGL4], Victoria Gozo (20-Jan-2008); Centre right: Same metapopulation observed almost two years later on (8-12-2009) showing the rapid colonisation of the species in shallowly flooded wetlands; Bottom: Wied l-Ort [PGL2], Għasri, Gozo (3-Oct-2011)

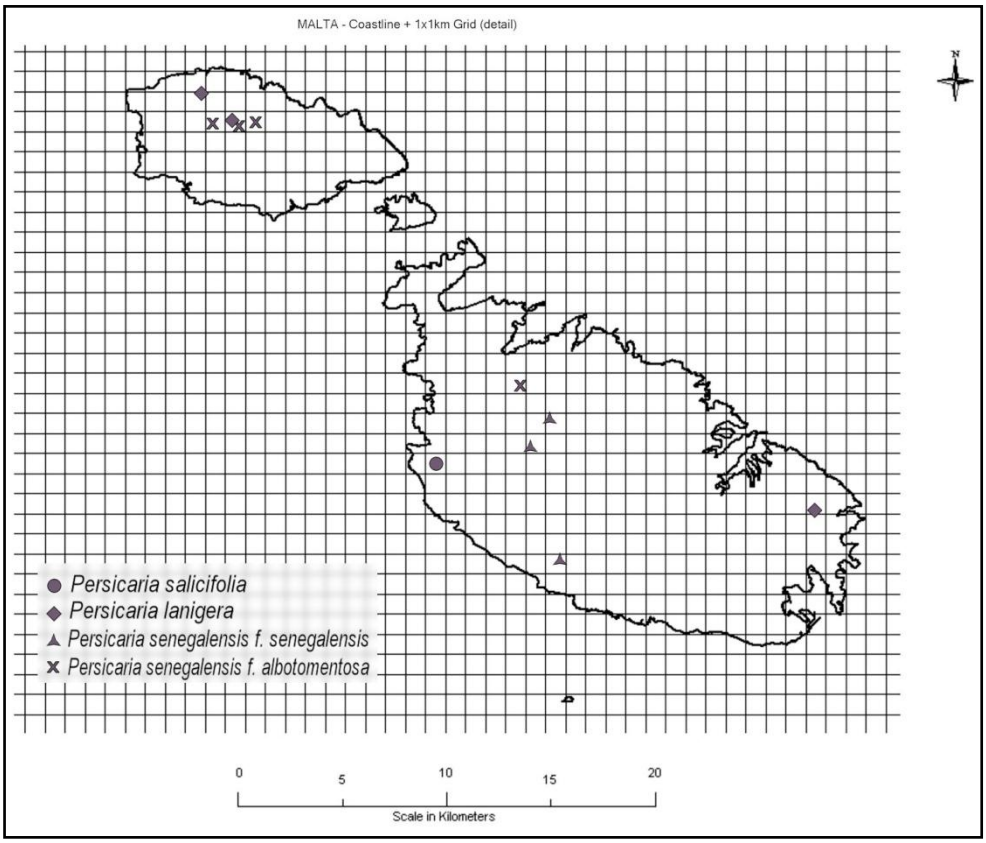

Figure 9: Distribution of *Persicaria* species in the Maltese Islands.

All photographs in this article were taken by the author (Stephen Mifsud).

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The author found great help from Mr. Michael Briffa and Mr. Edwin Lanfranco who supplied useful and detailed information about their own records of *Persicaria* spp.

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MARASMIUS CORBARIENSIS (ROUM.) SINGER (FAMILY MARASMIACEAE ROZE EX KÜHNER) - A NEW FUNGAL SPECIES FOR MALTA

Stephen MIFSUD[1]

ABSTRACT

A population of *Marasmius corbariensis* (Roum.) Singer was found in an olive grove at ix-Xewkija, Gozo. Being a new agaric for the Maltese Islands, details on this population and habitat is given in this communication.

KEYWORDS: *Marasmius corbariensis*, Agaricales, Marasmiaceae, fungi, Malta.

Marasmius Fr. (1838) is a genus of fungi in the family of Marasmiaceae Roze ex Kühner 1980 (Order: Agaricales Underw. 1899) which comprises about 500 species (Kirk *et al.*, 2008). Elias Fries, the author of the genus, classified species which produced white or pale spores, have a stiff and thin stipe, and, most importantly, have the property of marcescence, in this genus (WIKI). A marcescent fungus is one which can dry and remain alive in temporary periods of draught, and gains back its original stature and turgidity when environmental moisture is restored. Nowadays, this biological character is no longer considered a valid criterion for taxonomical classification but, still, many of the *Marasmius* spp. have this property (WIKI).

Needlepin-shaped fungi were observed and collected from Ta' Blankas olive grove situated at ix-Xewkija, Gozo on the 30th January 2011 (Figure 1: left). With the aid of Mr Edwin Lanfranco who identified the genus, the species was identified as *M. corbariensis* (Roum.) Singer (syn. *Agaricus corbariensis* Roum., 1880). This species differs from the closely related *M. androsáceus* Fr. (syn. *Agaricus androsáceus* L.; *Marasmius olivetorum* Thüm. (Andres Cantero, 1975)) by having whitish or pale gills (*vs.* reddish brown in *M. androsáceus*) and by having bicoloured pileus; a central dark brown disk and yellowish/beige margin (Courtecisse & Duhem, 1994, 2000) as illustrated in Figure 1 (centre and right). Interestingly, many authors credit the description of this taxon to Singer, but a few others, such as MYCB puts Saccardo as the author, with Singer being illegitimate.

In the list of fungi, Sommier & Caruana Gatto (1915) list only *M. olivetorum* as a member of this genus, reporting it on fallen leaves of olive trees at San Anton Gardens. Mr Michael Briffa and Mr Edwin Lanfranco, who studied local mycology for long, have not encountered *M. corbariensis*. Therefore, *M. corbariensis* represents a new record for the Maltese Islands, unless the species identified as *M. olivetorum*, by Sommier & Caruana Gatto (ibid.) was the same species.

Figure 1 (left): Specimens on fallen leaves of olive trees, Ta' Blankas, ix-Xewkija, Gozo (7 February 2011); (centre): Cap of *Marasmius corbariensis*. Ta' Blankas, 31 January 2011; (right): Gills of *M. corbariensis*. Ta' Blankas (31-Jan-2011).
Photos: Stephen Mifsud.

[1] Flat 5, Busy Bee, Triq tal-Konti, iz-Zebbug, Gozo. E-Mail: info@maltawildplants.com

M. corbariensis is listed as a parasite of olive trees by Andres Cantèro (1975), but Zervakis *et al.* (2004) specified that *M. corbariensis* grows on dead leaves of *Olea europaea* L. in Greece. In Europe, the species is also found in Italy, including Sicily (Lantieri *et al.*, 2009) and Spain (GBIF). The Maltese station lies within the distributional range of the species, although, based on just one population, it is still questionable if its presence at Ta' Blankas is indigenous or if it was introduced with the plantations of the olive trees in that site, which took place some 40 years ago (Xewkija Local Council, pers. comm.)

Hundreds of specimens were found on several fallen olive leaves (Figure 1 left) in the aforementioned site but not on living foliage. Most of the host leaves were lying either in damp, superficial leaf mould formed by prolonged leaf drop while some were found on moist bare rock, often covered with patches of mosses such as *Ptychostomum* (*Byrum*) *donianum* (Grev.) Holyoak & Pederson. All leaves were in the shade. The author has not searched thoroughly for other metapopulations on the site, and this report is based on one small zone (10m x 10m) of the olive grove. Owing to the fact that *M. corbariensis* is only a saprophytic fungus on dead leaves of olive trees (Lantieri *et al.*, 2009; Zervakis *et al.*, 2004), myrtle and holm oak (Lantieri *et al.*, 2009), it offers no particular threats to such hosts or to the environment; at least no report has been found to state this.

ACKNOWLEDGEMENTS

The author would like to express gratitude for the correspondence with Mr Michael Briffa and Mr Edwin Lanfranco about this species, the latter also supplying identification aid and literature. Thanks also to Mr Stephan Mifsud who confirmed the identification of the moss *Bryum donianum.*

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PITHYA CUPRESSINA (ASCOMYCOTA: PEZIZOMYCETES, SARCOSCYPHACEAE): A NEW ADDITION TO THE MALTESE MYCOBIOTA

Carmel SAMMUT[1]

ABSTRACT: The cup fungus *Pithya cupressina* is recorded for the first time from the Maltese Islands where it has been found associated with cypress leaf-litter.

KEYWORDS: *Pithya cupressina*, Sarcoscyphaceae, Mycobiota, Malta.

During a survey of macrofungi in Malta, the author came across a small disc-shaped ascomycete growing on cypress leaf litter but its identity remained undetermined. Recently a similar specimen was collected from the exact same area (figure 1). The specimen was examined microscopically (figure 2) and was eventually identified as *Pithya cupressina* by comparison with Phillips (1893), Seaver (1942) and Benkert (2008).

Pithya cupressina appears restricted to this area, as searches in other stations have been negative. However although the apothecia are brightly coloured their miniscule size renders them inconspicuous to the casual observer. Furthermore this species prefers shaded areas in contrast with open areas favoured by other cup fungi.

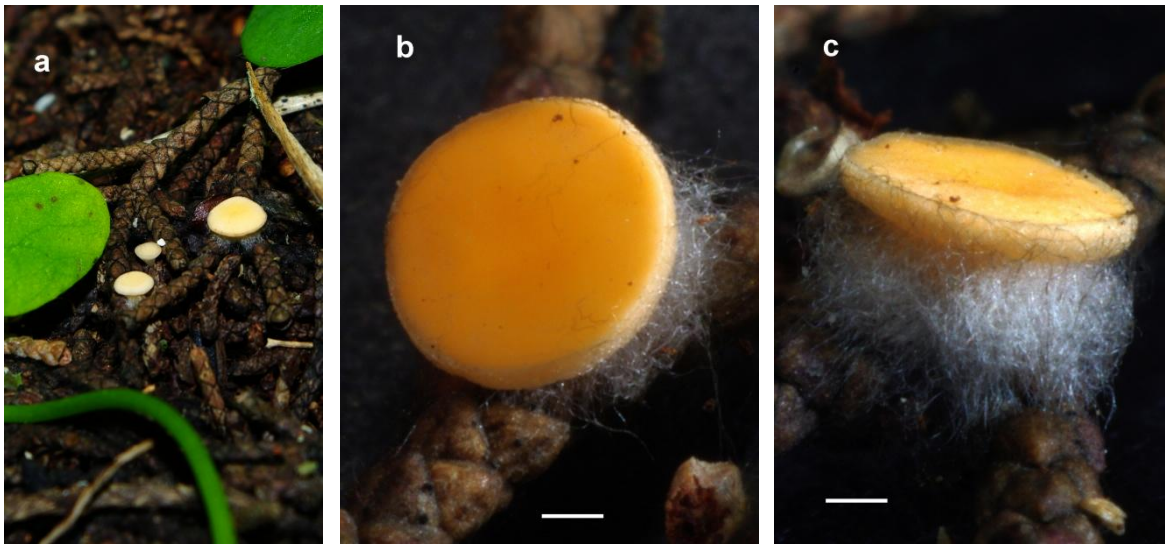

Figure 1. (a) *Pithya cupressina* on leaf litter; (b) frontal view; (c) lateral view. Scale 0.5mm.

Order: Pezizales
Family: Sarcoscyphaceae
Pithya cupressina (Batsch) Fuckel
Malta: il-Buskett (Verdala) gregarious on *Cupressus* leaf litter, 7/1/11 (CS189); il-Buskett (Verdala) gregarious on *Cupressus sempervirens* litter, 16/12/11 (CS302).

Ascocarp initially 'cup' shaped flattening to a disc on maturation, yellow-orange to orange on the upper surface but a pale yellow on the underside, size range 0.5 – 3mm in diameter, shortly stipitate to sessile, glabrous around the margin but villous on the underside, particularly in mature specimens where the stipe is obscured by the white hairs.

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Microscopically the asci are cylindrical, operculate, 8-spored, 140-215µm x 10-13µm bulging at each spore location, thinning gently towards the base. The paraphyses are filiform, 100-220µm x 2-5µm, slightly inflated at the tips occasionally splitting into two (central to basal split). Spores in fresh material are globular, aseptate, smooth and hyaline, 10-11µm in diameter. In dried material there is a tendency for the spores to become distorted to a slightly ellipsoid shape. Melzer's reagent: negative all tissues.

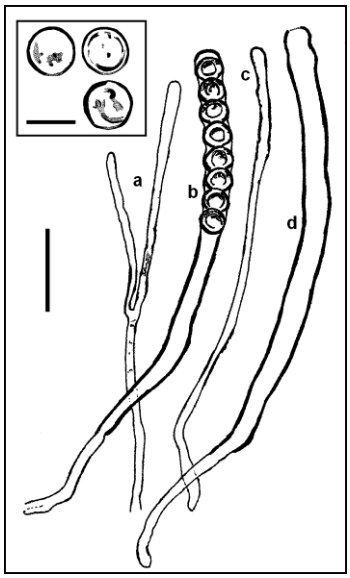

Figure 2. (a) Paraphysis splitting into two;(b) ascus with spores;(c) paraphysis; (d) empty ascus. Inset: spores. Scale 10µm.

Pithya cupressina is associated with conifer leaf litter, most commonly on *Cupressus* & *Juniperus* (Seaver, 1942) and is distinguished from the related *Pithya vulgaris* by the latter's larger size (Benkert, 2008), association with *Abies* leaf litter (Benkert, 2008) or *Pinus* leaf litter (Breitenbach & Kränzlin, 1984) and the larger ascospores (Saccardo, 1889) of the latter. *Scutellinia* species are easily distinguished from this species by the presence of marginal hairs, whilst *Aleuria aurantia* is larger, darker in colour (orange-red) and terrestrial.

It is relevant to note that Edwin Lanfranco states that he had first encountered and identified this species on the 7th February 1982, also from il-Buskett and growing on *Cupressus sempervirens* litter (Lanfranco, pers. comm. 25th April 2012).

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ANOTHER RECORD OF *AGLAIS URTICAE* (LINNAEUS, 1758) (LEPIDOPTERA: NYMPHALIDAE) IN THE MALTESE ISLANDS

Arnold SCIBERRAS[1]

ABSTRACT

Another specimen of *Aglais urticae* (Linnaeus, 1758) in the Maltese Islands is reported in this work. Such a specimen represents the third Maltese record, and it is presumed to be a casual immigrant species. All previous records are discussed.

KEYWORDS: *Aglias urticae*, Lepidoptera, Nymphalidae, Malta.

INTRODUCTION

In the Maltese archipelago the Nymphalidae family is represented by six species; only two of these, namely *Vanessa cardui* (Linnaeus, 1758) and *Vanessa atalanta* (Linnaeus, 1758), are regular migrants and sometimes resident. Both of these species also breed locally. *V. cardui*, the commonest nymphalid species on the islands, migrates by the thousands and this phenomenon is well documented (Valletta, 1952, 1972; Sammut, 1989, 2000; Falzon, 2003).Some very rare species occasionally arrive in the archipelago along *V.cardui*. However, rare species are capable of migrating solitarily (Sciberras, 2004a). *V. atalanta* is also common, but much less so than *V.cardui* (Sciberras 2006). *Polygonia egea* (Cramer, 1775) is represented by only two records (Valletta, 1948 a, b, 1980; Sammut, 2000; Sciberras & Schembri, 2005a). *Nymphalis polychlorus* (Linnaeus, 1758) is represented by a single record (Schembri,1986; Sammut, 2000; Sciberras & Schembri, 2005a).) *Inachis io* (Linnaeus, 1758) was recorded from four specimens which are all regarded as accidentals (Aquilina, 1980; Valletta, 1981; Sammut 2000; Sciberras & Schembri, 2005a:, Cachia & Sciberras, 2010).

PREVIOUS RECORDS

Aglais urticae was mentioned the first time in literature for the Maltese islands by Fletcher (1904-1905, 1905). He mentions that Matthew informed him (*in litt*.) that he noticed one specimen on March 23rd 1892. Caruana Gatto (1925) in his work repeats the same observation. Borg [P.] (1932) lists it as rare and Borg [J.] (1939) mentions that among other very rare species, some specimens of the latter were found locally in a battered condition and presumed that they arrived by strong winds. Both De Lucca (1950) and Valletta (1966, 1972) mention that in their long years of collecting, they never encountered this species. Sammut (2000) simply omits this species from the local list and presumed, due to the lack of findings, that this species was probably included in the Maltese list as a misidentification. On May 14th 1985 Emanuel Cardona captured a specimen of *Aglais urticae* at Wied Ħanżir, Qormi and in his collection it was misidentified as another species. It was in late 2002 that the specimen was identified correctly by Sammut as the latter. On November 23rd 2003 the author was collecting a number of *Vanessa cardui* specimens on a *Lantana camara* at Marsa (Malta racing course) for reference collection and while the specimens were on the setting boards Jeffrey Sciberras noted the different specimen. When deposited in the collection box it became obvious that the specimen belonged to *Aglais urticae*. The 1985 and the 2003 specimens are the only confirmed specimens to date (Sciberras, 2004b; Sciberras & Schembri, 2005 b).

The new record of *Aglais urticae*

Information for the third record for Malta: Malta: 23August 2011. An almost complete specimen was collected by the author from an electric fly killer machine in a factory, limits of l-Imrieħel.

DISCUSSION

Following the 2003 record every *Vanessa cardui* and *Pieris* spp. migration was followed carefully by the author because the rare species records seemed always to link with these migrations. From November 13th to December 4th 2003 there was the possibility that more specimens of this species might have arrived with the migration, but since

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these are not fully confirmed, they were not listed (Sciberras & Schembri, 2005 b). Since then, except for this record, no specimens were ever found. The remains of the specimen (Figure 1) were collected carefully due to its battered state. Along the butterfly specimen in question, specimens of *Musca domestica*, Cercopidae sp., Chrysopidae sp. specimens were also collected being attracted to this UV light trap. Although in such a battered state, this species was easily identifiable when compared to other local species. A search was also made in the nearby vegetation surrounding the establishment on the *Urtica* spp., but proved fruitless in finding any other specimens, larvae or eggs of the latter species. On the same day of the find, including the whole previous week , many *Vanessa cardui* specimens were noticed and when counting their numbers in various localities, this indicated that another migration of this species was about to take place.

Figure 1 : *Aglais urticae* from l-Imriehel, 23/viii/2011.(Left): as found, and (right) as assembled sideways.
Photographs by A. Sciberras, 2011.

DISTRIBUTION AND TAXONOMY

This species is widespread from the Atlantic coast of Europe through to the pacific coast of Asia. The distribution in Europe is stable. The wingspan is generally 45-62mm. The sexes look very similar but males are often smaller than females. The upper side is dark red with black and yellow stain like markings . The slightly scalloped wings have a series of blue spots close to the side and hind margins. The undersides are less colourful, the pattern on the forewing being a duller reflection of the upper-side. In this species eggs are laid in large clusters with numbers ranging from 30 to 200. These are pale, glassy-green with 8 or 9 ribs running from top to base These can be found on young tender nettle leaves, sometimes hidden deep within the main clump. The eggs will hatch within 12 days. The caterpillars feed on *Urtica dioica* and *U. urens*. As a result of this, *Aglais urticae* inhabits a huge range of habitats, wherever the food plant occurs (Gooden, 1971).

CONCLUSION

It is very difficult to assess the presence of this species locally. It is more probable that the specimen arrived with a *V.cardui* migration as in the case of other previous records, rather than considering it a rare resident species. It is quite a large species to go unnoticed for such long periods of time. It is unlikely that the specimen arrived by human intervention, however, especially, that nowadays many species of ornamental plants are being imported in considerable quantities, one cannot exclude that introduction is a possibility.

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TWO SPECIMENS OF *HYPOLIMNAS MISIPPUS* (LINNAEUS, 1764) (LEPIDOPTERA: NYMPHALIDAE) IN THE MALTESE ISLANDS

Arnold SCIBERRAS[1] and Jeffrey SCIBERRAS[2]

ABSTRACT

Two specimens of *Hypolimnas misippus* (Linnaeus, 1764) are reported in the Maltese islands.

KEYWORDS: *Hypolimnas misippus*, Lepidoptera, Nymphalidae, Malta.

INTRODUCTION

Hypolimnas misippus is a widespread species of nymphalid, throughout its distribution range in Africa, Asia and Australia. This species is well known for its degree of polymorphism and mimicry. Males are blackish with distinctive white spots that are fringed in blue. Females are polymorphic and come in multiple varieties that include male-like forms while others mimic the toxic *Danaus chrysippus* (Linnaeus, 1758) and *Danaus plexippus* (Linnaeus, 1758).

Local reports and observations

On 31 October 2010, one of the authors (JS) was walking on a hill (known as il-Ħotba) at Mellieħa, overlooking Wied il-Miżieb. On the way he disturbed an unfamiliar Lepidoptera specimen which was resting on a rock; it then flew away a few meters ahead of him on the same pathway, eventually landing on an inflorescence of male flowers of *Ceratonia siliqua.*
It started feeding immediately. One way to identify the specimen was to collect it, but prior to this, the author chose to take two pictures with his mobile phone at 3.15p.m, just in case it flew away.The specimen was approachable enough that it was collected by hand leaving an iridescent blue colouration on his hand as it was being handled. It was later taken to Mr Ray Vella (a keen ornithologist) to examine the specimen for further identification. During handling, the specimen managed to escape.

On 12 November 2010, Mr. Marco Bugeja (gardener and an amateur naturalist) phoned one of the authors (AS) and recounted a sighting of an unfamiliar lepidopteran specimen that came flying a few meters in front of him at Ġnejna Bay on the same day at 4.15 pm. The description matched the specimen collected and photographed by (JS). Identification was made by (AS) and Mr. Aldo Catania, based on the detailed description and images (Fig. 1).

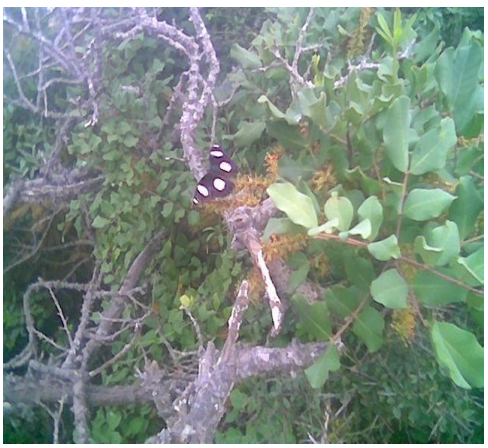

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Figure 1. *Hypolimnas misippus* taken at Mellieha on the 31 October 2010. Photographs by Jeffrey Sciberras.

The specimen's upper-side matched Bingham's description of a male of this species (Bingham, 1905). The male has dark velvety brownish-black upper-wings. The forewing has a broad white oval spot between the veins 3 and 7 (or between the 3rd and 7th vein). A smaller spot near the apex is also present. These spots are crossed by the black veins and bordered in iridescent blue that is visible only at certain angles. The hind wing has a larger white spot but the veins crossing it are yellowish and not as prominent as those on the forewing. There are some white specks along the tornus and the margin is edged with white and black.

CONCLUSION

It is beyond doubt that both these specimens are a result of introductions by man. The Maltese Islands are quite out of its natural range. The closest occurrence of this species to our islands is Saudi Arabia, which is still too far away. It naturally occurs in: Angola; Lokoli Swamp Forest - Benin; Botswana; Burkina Faso; Burundi; Cameroon; Central African Republic; Chad; Comoros; Congo; Democratic Republic of the Congo; Equatorial Guinea; Ethiopia; Gabon; Gambia; Ghana; Guinea; Guinea-Bissau; Ivory Coast; Kakamega forest - Kenya; Lesotho; Liberia; Madagascar; Malawi; Mali; Rodrigues - Mauritius; Mozambique; Namibia; Niger; Nigeria; Oman; Reunion; Rwanda; Saudi Arabia; Senegal; Seychelles; Sierra Leone; Somalia; South Africa; Sudan; Swaziland; Tanzania; Togo; Uganda; United Arab Emirates; Yemen; Zambia; Zimbabwe (Vane-Wright & Ackery,1984). To back this assumption both AS and Catania were informed that there have been local sales for pet trade of both *Hypolimnas misippus* and *H. bolina* (Linnaeus, 1758) for captive breeding, the latter species being more readily available for purchase. These sightings are somewhat troubling because the main food plants for this species are *Asystasia lawiana* and *Portulaca oleracea* (Kunte, 2006), the latter being a common summer ruderal species in the Maltese Islands. It may thus become an adequate food source for this species. Although *Hypolimnas misippus*, being a tropical species, may not thrive under present climatic conditions in Malta, the trend towards increasing temperatures may, in the future, favour this and other such species. It is therefore imperative that a close watch be kept for these potentially invasive aliens.

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The authors wish to thank Marco Bugeja for his detailed description of the sighting, Esther Sciberras, and Romario Sciberras for their assistance in literature research and comments on the initial draft of the work. Aldo Catania's assistance in identification has also been invaluable.

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OBSERVATIONS ON THE LIFE HISTORY OF *SYNCLISIS BAETICA* RAMBUR 1842 (NEUROPTERA: MYRMELEONTIDAE) AT THE RAMLA L-ĦAMRA SAND DUNES IN GOZO (MALTA, CENTRAL MEDITERRANEAN)

Arnold SCIBERRAS[1], Jeffrey SCIBERRAS[2] and Alan DEIDUN[3]

ABSTRACT

Although the neuropteran species *Synclisis baetica* was recorded in the Maltese Islands (Central Mediterranean) way back in 1996, and is the largest neuropteran species on the Islands, no research on the local ecology of this species has ever been conducted. This study summarises the observations on the behaviour of the species made in the wild within the sand dune remnants of Ir-Ramla l-Ħamra (Gozo, Maltese Islands) over the 2003-2009 period, as well as observations on the life cycle of the same species made on a number of captive-bred individuals.

KEYWORDS: *Synclisis baetica*, Neuroptera, Myrmeleontidae, Malta.

INTRODUCTION

Very little research has been published to date on the neuropteran species of the Maltese Islands. The first works that mention these insects are those of Borg (1932) and Ħepple (1954), with the latter recording two species. Aspok & Holzel (1980) recorded four species. Valletta (1984, 1985), in turn, lists 10 neuropteran species, most of which were new records and Duelli's visit in 1990 revealed 7 additional species for the Islands (Duelli, 1992). The observational study of Plant & Schembri (1996) is the most recent work, as they reviewed the existing literature and came up with a total number of 29 confirmed neuropteran species in addition to a number of other species which were not fully identified.

Synclisis baetica was previously recorded from the Maltese Islands by Plant & Schembri (1996), who collected a larva of this species from Ramla l-Ħamra on the 29th May 1988, with an adult female eventually emerging from the pupa in August 1988. Practically no research has been conducted locally on the ecology of this species, such that reference had to be made by the authors of the present study to the few foreign works on the ecology of different neuropteran species which exist. One such comprehensive work is that by Stange & Miller (1985), which, although is a study of the family Myrmeleontidae, still provides interesting information on the ecology of the genus *Synclisis*.

The aim of the current work is to document the life cycle observations made for *Synclisis baetica* made at Ramla l-Ħamra (Gozo, Maltese Islands) throughout the 2003-2009 period. Although most of the observations match published records, some behaviour seem not to tally and this is suspected to be due to the specific local microhabitat, lack of specimens available for study and that this species is characterised by a very high variability in the population parameters.

MATERIALS AND METHODS

Adult individuals of *Synclisis baetica* were located in the field by means of ultra-violet (UV) lamps deployed after sunset; individuals of the same species were taken from the wild from late July till early October, over the 2003-2009 period. Larvae of the species were observed *in situ* in 'observation posts', which were demarcated by placing cane sticks in the sand to mark the area. Some specimens of the species were raised in captivity to calculate the life span of the species from egg stage (or early larval stages) to adulthood.

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RESULTS AND DISCUSSION

Synclisis baetica, in spite of being the largest Neuroptera species in the Maltese islands, is rather inconspicuous. It is quite a rare species and its distribution is restricted only to the Ramla l-Ħamra sand dune remnants in Gozo (Figure 1). A few (<10) larvae of the species were recorded (2005-2007) in a 10m^2 pocket within such dune remnants, situated ca. 50m away from the shoreline (location is demarcated by a circle in Figure 2), while 60 individuals at the last larval stage were recorded in the spring of 2007, in a different part of the dune remnants, ca. 30m further inland than the previous location (location is demarcated by a box in Figure 2).

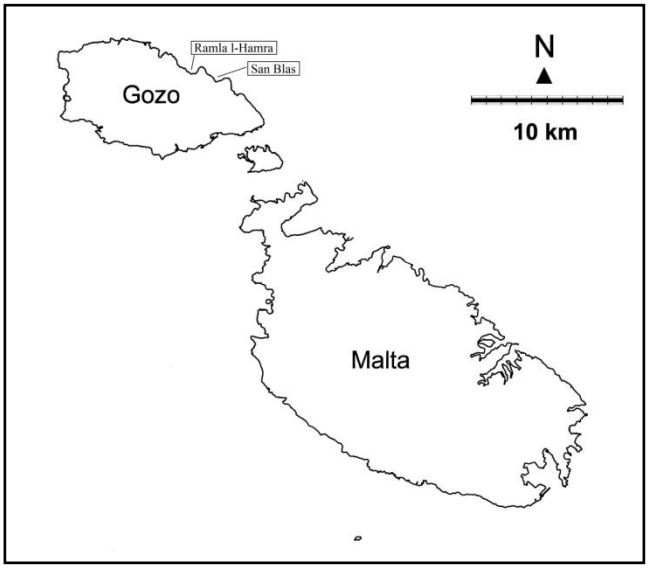

Figure 1. Location of the two sandy beaches where *Synclisis baetica* was recorded in the present study.

Figure 2. The two locations at the Ramla l-Ħamra sandy beach (Gozo, Maltese Islands) where the two larval cohorts of *Synclisis baetica* were collected.

Sporadic additional sightings of individuals of the species (amounting to 7 larvae) were made during the 2003-2009 period, within the same dune remnants. On one occasion (4th September 2004), a single adult female of *Synclisis baetica* was collected from San Blas Bay, also in Gozo (Figure 1).This individual is the largest adult specimen known of the species ever to be collected locally with a wingspan of 105mm. This specimen was found dead. It is unlikely that the latter locality is supporting a breeding population of the species due to the absence of favourable habitat conditions; this consists of dry sandy, sloping areas, sheltered along the upper rim by vegetation. Most of the larvae of the species were located on the slope just below the vegetation rim. Adult specimens of the species were only observed in the field when UV light was deployed, in twilight-pitch black conditions from late July till early October. It is interesting to note that no individuals of *S. baetica* were ever collected under conditions of bright moonlight. The highest number of adults collected and released back into the wild during a single night at Ramla l-Ħamra was 8 specimens, on the 23rd August 2006. Other observations made in the field at Ramla l-Ħamra on the behaviour of *Synclisis baetica* include the following:

(i) larvae 'hunted' at distances of less than 10cm away from each other;
(ii) individuals at early stages of development fed mainly on micro-Coleoptera, Hymenoptera (Order: Formicoidea) and small Diptera individuals;
(iii) on only one occasion an arachnid (Order: Opiliones) was predated upon by *Synclisis baetica*, with two individuals at an early stage of development collaborating to entrap the opilionid;
(iv) the highest larval mortality rate was observed during the first and second instar stages;
(v) cannibalism was also observed, especially in individuals bred in captivity, which also readily accepted dead material as long as it could be wielded by their pincers.
(vi) foraging rates observed were prodigious – for instance, on one occasion a mature (final instar larva) *Synclisis baetica* individual consumed 5 dipteran individuals and 1 *Talitrus* sp. individual, over a period of 4 hours. Many individuals, especially in their final instar, were observed to be incessant feeders and required a fairly high sand surface temperature to pupate;
(vii) Stange & Miller (1985) stated that this genus does not construct pitfalls; this is only partly true, since for the mature stages, the authors observed gently-sloping pitfall traps with diameters of 20mm and a maximum depth of 11mm;
(viii) forward and backward movements by individuals of the species were observed, but when threatened by predators or when searching for prey, individuals performed backward movement only;
(ix) the larvae were generally encountered on relatively open tracts of sand, where sand depth was considerable and was ideal for temperature regulation, protection of the large cocoon, escape and concealment from predators, as well as providing space for hunting prey;
(x) the cocoon was observed to be constructed in a single day and the period from construction of the cocoon to the emergence of the adult spanned between 54-60 days, a length of time which is almost equivalent to that in cited in Stange & Miller (1985). However, there were instances in the field were individuals emerged from the cocoon later, after 90 days, and these were the ones which encountered scarce food resources. It was observed that the larvae rarely moved from their post, even when food resources were very low;
(xi) individuals embarked on feeding as soon as the sand temperature was warm enough (at around 8:00 am during the summer months), but extremely low or high sand surface temperatures were avoided with individuals burrowing deeply in the sand;
(xii) individuals were most active on the sand surface during mid-morning, late afternoon, and during very warm nights.

The different development stages observed are shown in Figure 3 below.

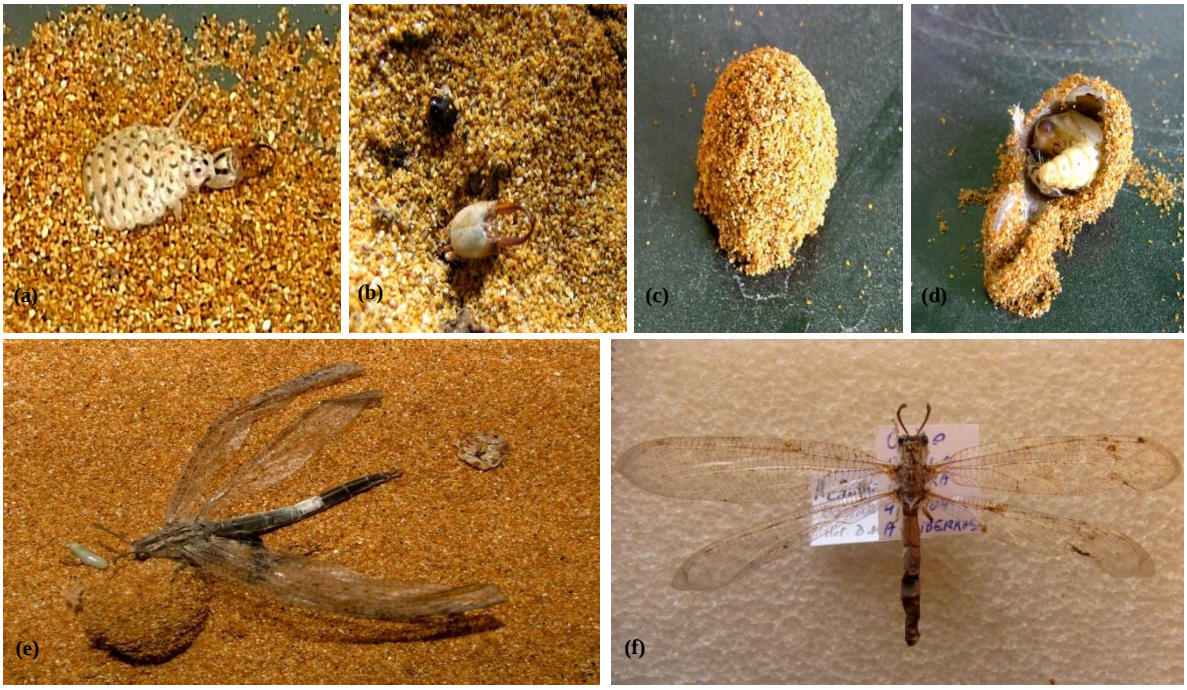

Figure 3: Different developmental stages of *Synclisis baetica*: (a) second instar stage as observed in captively bred individuals; (b) last instar stage as observed in captively bred individuals; (c) cocoon stage; (d) pupal stage as observed in captively bred individuals; (e) fully-developed adult, with cocoon, larvae shedding and meconium; (f) the specimen found dead in the field on the 04.9.04 at the beach of San Blas (Gozo, Maltese Islands).

Photographs by A. Sciberras.

Only two specimens were observed laying eggs. As soon as the female expelled the eggs, she coated them with sand, using the posterior gonapophysis. The eggs were buried at shallow depths. The other female caught just after dusk still had egg material at the end of its abdomen, some of which had been broken. Her abdomen was devoid of eggs. One female emerged in captivity along with 3 males. They were fed on *Tenebrio molitor* but only one specimen was observed feeding on a larva of this species. At a later stage, one of the adult females laid 23 eggs. The latter was large (varying from 4-6mm) and oblong and hatched in 26 days. The 'free' larvae (not developing within the cocoon nor inside the egg) went through three larval instars, and a diapause stage. The silken cocoon, with sand grains covering the surface, was constructed beneath the sand surface,. The mobile pupae dug their way to the surface of the sand, with the adult emerging and then climbing on wrack material before expanding its antennae, wings, and abdomen. The observed complete morphological transformation (from the shedding of the pupal skin to the fully-formed adult) took around 2.5-3 hours before the insect was ready to fly and during this period they egested volumes of a semi-liquid substance constantly (about 15-17 times) and along this process a dry coated meconium substance was also produced. 10 adult specimens of *Synclisis baetica* were later released back to Ramla l-Ħamra dune remnants.

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BROMUS CATHARTICUS VAHL (FAM. POACEAE), A NEW RECORD FOR THE MALTESE ISLANDS

Timothy J. TABONE[1], Alex CASHA[2] and Stephen MIFSUD[3]

ABSTRACT

The discoveries of the first 4 known populations of the alien *Bromus catharticus* from the Maltese Islands are reported. Notes on the species' distribution range, local habitat and invasive potential are also given.

KEYWORDS: *Bromus catharticus*, Malta, alien flora, watercourses.

Bromus catharticus Vahl [= *B. unioloides* (Willdenow) Kunth; *B. willdenowii* Kunth; *Ceratochloa cathartica* (Vahl) Herter; *C. unioloides* (Willdenow) P. Beauvois] was first found in the Maltese Islands by one of the authors (TJT) during March 2000 on a muddy substrate permeated by a semi-permanent watercourse at Għajn Istas, overlooking the Pwales graben in the North of the island of Malta. The watercourse in question flows across the soft Blue Clay formation (early to mid-Miocene), intersecting intensively cultivated land and thus subject to much anthropogenic disturbance, with the accompanying phytocoenosis mainly consisting of field weeds and relictual stands of specialised stream vegetation. The dominant species was *Helminthotheca echioides* (L.) Holub, with *Verbena officinalis* L. and *Panicum repens* L. as sub-dominant species. Important accompanying species present: *Beta maritima* L.; *Parietaria judaica* L.; *Galium aparine* L.; *Convolvulus arvensis* L.; *Ipomoea indica* (Burmann) Merrill; *Avena* sp. pl.; *Lolium perenne* L.; *Phalaris minor* Retzius; *Polypogon monspeliensis* (L.) Desfontaines; *Schedonorus arundinaceus* (Schreber) Dumortier.

Another three populations have since been found at the following localities, all on permanently wet substrates among cultivated fields adjacent to roadsides: Triq il-Manikata (at the western extremity of the Pwales graben), discovered by TJT on the 15th April 2008 along irrigation canals; population consisting of 2 clumps; Wied tal-Mistra (limits of Mellieħa and Xemxija), discovered by AC on the 14th April 2011 among vegetation dominated by *Arundo donax*, this being the most extensive population; and Tal-Imbordin (overlooking the Pwales graben), discovered by SM on the 20th April 2012 among vegetation dominated by *Arundo donax*, with the *Bromus catharticus* population consisting of isolated clumps. The sites from which this species has been found so far are all at an altitude of between 0-150m.

Bromus catharticus is native to Central and South America (GRIN; Stace 1991) and occurs as a naturalised alien on all main continents: North America, South and East Tropical Africa, Australia, New Zealand, China (USDA; GRIN). It has also been recorded from the following European territories: Lithuania (LISD); Ukraine (CABI); UK (where it is rarely cultivated for fodder and has become naturalised and also occurs as an accidentally introduced grain- and wool- casual alien, found on rough ground, roadsides and field margins, scattered in Central and South Britain), the Channel Islands and the Scillies (Cope and Gray 2009; Stace 1991); Italy, where it was similarly introduced as a forage plant and wool-alien and became naturalised in a number of localities, but today persisting solely within the Latium province (Pignatti 1997); Sicily (Pignatti 1997), where it has become established at Messina and in good numbers "at Marina di Cottone and Mascali in the Catania area", showing a preference for wet habitats (Giardina *et al.*, 2007) .

It is unlikely that *Bromus catharticus* will turn out to be an invasive species with a negative impact on native vegetation. It has clearly failed to become widely established within the Central Mediterranean: most populations in Italy have disappeared (Pignatti 1997) and is still "rare" in Sicily, despite the fact that a century has passed since the first sighting on that island by Sommier (Giardina *et al.*, 2007). The first-known Maltese population at Għajn Istas has already declined considerably to a mere 4 clumps within the 12 years that have lapsed since the original discovery date.

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