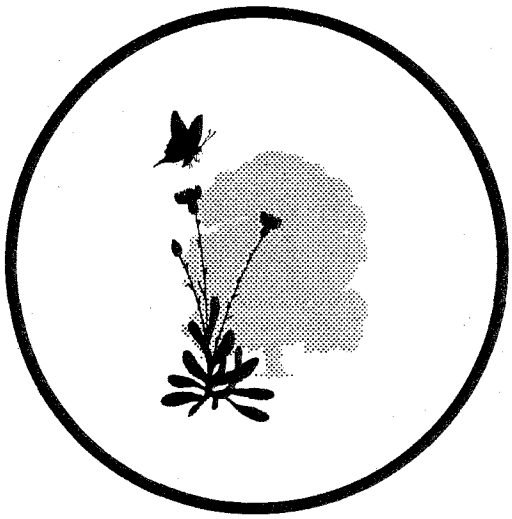
THE CENTRAL MEDITERRANEAN NATURALIST



Nature Trust (Malta)

VOLUME 3 PART 1 MALTA, JUNE 1999

THE CENTRAL MEDITERRANEAN NATURALIST

JUNE 1999

CONTENTS

Nature Trust (Malta)

During 1998, three non-Governmental organisations which shared the common aim of promoting awareness, conservation and study of Malta's natural heritage decided to join forces so as to form a single, more efficient and effective association. The organisations were The Society for the Study and Conservation of Nature (SSCN), which was founded in 1962, and the more-recently formed groups Arbor and Verde.

The merger resulted in the formation of Nature Trust (Malta), which was officially launched by His Excellency the President of the Republic on Friday, 8 January, 1999. The aims of Nature Trust (Malta) are to enhance public awareness and appreciation of the rich biodiversity of the Maltese Islands through educational campaigns, conservation schemes and research projects. Tree-planting and frog-conservation projects are already under way, and other activities planned include the protection of indigenous trees, the fostering of eco-tourism and a nation-wide campaign against illegal dumping and for the promotion of better waste management.

The first two volumes of "The Central Mediterranean Naturalist" were published as the official scientific journal of the Society for the Study and Conservation of Nature (SSCN). As from this first issue of Volume III, the journal will be the official scientific publication of Nature Trust (Malta). All papers submitted for publication therein are peer-reviewed prior to acceptance.

NATURE TRUST (MALTA) ACKNOWLEDGES WITH THANKS THE FINANCIAL CONTRIBUTION RECEIVED FROM THE ENVIRONMENT PROTECTION DEPARTMENT TOWARDS THE PUBLICATION OF THIS ISSUE.

EDITOR: DAVID DANDRIA.
TYPESETTING AND LAYOUT: DAVID DANDRIA
PRINTED AT SALESIANS PRESS, SLIEMA, MALTA.

PRICE: LM 1.50

The Central Mediterranean Naturalist	3 (1): 1 - 6	Malta, June 1999

MAERL-FORMING CORALLINE ALGAE AND ASSOCIATED PHYTOBENTHOS FROM THE MALTESE ISLANDS

Edwin Lanfranco[1], Miraine Rizzo[1] Jason Hall-Spencer[2], Joseph A. Borg[1] & Patrick J. Schembri[1]

ABSTRACT

Maerl grounds consist mainly of unattached non-geniculate coralline algae, known as rhodoliths, and their algal debris. The recent discovery of such grounds around the Maltese Islands led to the present study of rhodolith-forming species. Gross morphology of the rhodoliths was highly variable so identifications were based on microscopic examination of fertile material. Investigations using optical and scanning electron microscopy confirmed that five main species of rhodolith-forming coralline algae were present: *Lithophyllum racemus, Lithothamnion corallioides, Lithothamnion minervae, Mesophyllum alternans* and *Phymatolithon calcareum*. Two other heavily calcified species, tentatively identified as *Peyssonnelia rosa-marina* and *Neogoniolithon brassica-florida* on the basis of gross morphology, were also important contributors to Maltese maerl deposits. Seasonal monitoring of the phytobenthos associated with maerl revealed that *Flabellia petiolata* and *Womersleyella setacea* were consistently the dominant species present.

INTRODUCTION

The term maerl is used to describe biogenic sediments composed of live and dead unattached calcareous algae, mainly in the Order Corallinales. As with many seaweeds, these coralline algae can reproduce both by fragmentation and through the production of spores that settle and grow on hard substrata. Maerl is formed in both of these ways. Thus fragments that break off attached thalli may be transported by currents and form maerl through continued growth and fragmentation at the redeposition site (Freiwald, 1995). Alternatively, free-living algal nodules can form by the settlement and growth of spores on suitable sediment particles. Eventually the spores grow to form a thallus that completely encloses the original sediment grain (Bosence, 1976). Resulting unattached coralline algae typically have an inorganic core although the cores can also be of biogenic origin, such as mollusc shells (Adey, 1986).

While some authors refer to uncored algal thalli as 'maerl', and to cored algal nodules as 'rhodoliths' (e.g. Irvine & Chamberlain, 1994), here we use 'rhodoliths' to describe both types of free-living coralline algae, following the terminology of Bosence (1983b), Basso & Tomaselli (1994) and Steller & Foster (1995). Such rhodoliths show an enormous range of morphologies (Woelkerling, 1988).

Rhodoliths can have a highly irregular shape or be more or less spherical; they can also take the form of branched thalli or unbranched crustose layers enveloping a sediment particle. Branched rhodoliths show variations in branching density ranging from open to compact branching. These different morphologies have little taxonomic value since the same species can exhibit a wide spectrum of rhodolith shapes and branching densities, while different species can display a similar gross morphology.

Variations in rhodolith morphology are thought to result primarily in response to different intensities of physical disturbance, and therefore can be used as indicators of environmental conditions at the site of growth (Steneck, 1986). Bosence (1976; 1983a) related rhodolith shape and branching density with environmental parameters and concluded that sphaeroidal densely branched rhodoliths are formed in areas where water movement is significant, while open branched rhodoliths are formed in quieter waters. Because of their potential as bioindicators of environmental conditions and because rhodoliths fossilise readily, they are regarded as useful palaeoecological indicators (Basso, 1995a; Basso & Tomaselli, 1994). However, some authors dispute this view, at least in the case of rhodoliths formed by fragmentation of attached forms, suggesting that the different rhodolith shapes simply reflect different stages in their formation, being more compact or spherical when mature (Freiwald, 1995; Wehrmann *et al.*, 1995; Freiwald & Henrich, 1994).

Due to this plasticity in the gross morphology of rhodoliths within the same population, the identification of rhodolith-forming coralline algae must be based on detailed examination of microscopic characteristics such as their reproductive conceptacles (Adey & McKibbin, 1970). This generally involves optical microscopy of decalcified sections and the use of scanning electron microscopy (Woelkerling, 1988). Thus the identification of rhodolith-forming algae is time consuming, especially since diagnostic reproductive structures may occur infrequently (Adey & McKibbin, 1970). However, despite wide

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variability in external form, some species often show recognisable characteristics in gross morphology on which tentative identifications can be made (Lanfranco, 1998).

Maerl grounds in the Mediterranean are characterised by several species of coralline algae that are able to live under conditions of low light. In the Western Mediterranean maerl occurs to ca.100m while in the clearer waters of the Eastern Mediterranean it is found to ca.180m (Basso, 1996). Maerl grounds require periods of moderate water movement to overturn the algae – this allows concentric growth of the rhodoliths and prevents burial by fine particles (Bosence, 1983b; Basso & Tomaselli, 1994; Hall-Spencer, 1998). They also require a degree of shelter from wave action to avoid dispersal into non-suitable environments (Hall-Spencer, 1998).

Live rhodoliths have been collected from various sites around the Maltese Islands at depths ranging from 5m to 103m. Not all these rhodoliths come from maerl grounds; some form very sparse accumulations on soft sediments, amongst seagrass beds, and even on rock. The most extensive maerl ground known to date lies off the Northeastern coast of the islands, and covers about 20km^2 of the seabed. This maerl ground was recently discovered during a UNESCO sponsored oceanographic survey (Borg *et al.*, 1998).

The first record for a maerl-forming alga from the Maltese Islands appears to be that of Sommier & Caruana Gatto (1915) who list "*Lithothamnion polymorphum* (L.) Aresch." This taxon as represented in the Mediterranean is generally held to be synonymous with *Phymatolithon calcareum* (Woelkerling & Irvine, 1986; Cormaci *et al.*, 1997). However the authors state that it is "*..comune sulle conchilie*", which is hardly descriptive of the habitat and status of this species, which only occurs as unattached rhodoliths!

MATERIALS AND METHODS

Over a two year period (1996-1998), seasonal samples of rhodoliths were obtained from a maerl ground located at depths of between 45m and 55m off Is-Sikka l-Bajda (Borg *et al.*, 1998). On each sampling occasion 3-6 replicate 0.1m^2 van Veen grab samples and one biological dredge sample were obtained.

The phytobenthos was first removed and preserved in 10% seawater formaldehyde for subsequent identification. Maerl was then sieved over a 1mm mesh, washed to remove salt and debris, and air-dried. Preliminary sorting of the dried maerl was then carried out on the basis of gross morphology using published keys (Preda, 1908; Hamel & Lemoine, 1952; Giaccone, 1972/3). A x 40 stereo-microscope was then used to select fertile thalli for detailed examination using x 1000 optical and x 4000 scanning electron microscopes following methods given by Irvine & Chamberlain (1994).

Identifications based on these detailed observations were made by comparison with the most recent descriptions of European coralline algae (e.g. Irvine & Chamberlain, 1994; Basso, 1995b; Basso *et al.*, 1996; Cabioch & Mendoza, 1998).

RESULTS

Detailed study of the microscopic structure of Maltese rhodolith-forming algae revealed that five main species occurred at Is-Sikka l-Bajda: *Lithophyllum racemus*, *Lithothamnion minervae*, *Lithothamnion corallioides*, *Phymatolithon calcareum* and *Mesophyllum alternans*. A brief description of their gross morphology is given below:

***Lithophyllum racemus* (Lamarck) Foslie**
(Plate 1: Figure A)

This was the only rhodolith-forming species found that was attributable to the coralline subfamily Lithophylloideae. Diagnostic features included the presence of sporangia in uniporate conceptacles, a lack of cell fusions and abundant secondary pit connections. The specimens generally had short, thick, densely spaced branches broadened at the apex and conformed in every detail to descriptions of the species provided by Basso *et al.* (1996). The shape of these rhodoliths is thought to be an adaptation to high water movement: abrasion by water movement causes broadening of the branch tips but the sides of the branches remain unaffected (Basso *et al.* 1996). This species was thinly dispersed on the Maltese grounds studied, but its rhodoliths had a distinctive shape and could be quite easily recognised on the basis of gross morphology. Due to the structure of the branches, this species formed spherical rhodoliths in which the broadened apices of the thalli nearly make contact with each other and leave very few open spaces on the outer surface.

The four other rhodolith-forming species that were common at Is-Sikka l-Bajda were all attributable to the coralline subfamily Melobesioideae on the basis that sporangia were borne in multiporate conceptacles, secondary pit connections were absent, and cell fusions were abundant (see Woelkerling, 1988).

***Lithothamnion corallioides* Crouan P.L. & Crouan H.M.**
(Plate I : Figure B)

This species was also sparsely distributed on the Maltese ground studied. Several features, including flared epithallial cells, generally thin branches and multiporate conceptacles were concordant with descriptions of this species provided by Cabioch (1966, 1970, 1972), Adey & McKibbin (1970), Cabioch & Giraud (1978), Irvine & Chamberlain (1994) and Basso (1995b). Throughout southern Europe this species is most commonly found as unattached branches, or rarely as nodules enveloping pebbles or biogenic remains (Irvine & Chamberlain, 1994; Basso, 1995b). Rhodolith shape and branching density is extremely variable although the branches tend to be thin (ca.1mm diameter) and are not known to exceed 1.8mm in diameter (Basso, 1995b). On Maltese maerl grounds *L. corallioides* was present only as fragile open branched rhodoliths and was not found enveloping sediment particles. Cabioch (1966, 1970) found it useful to describe two varieties of *L. corallioides* on the French Atlantic coast; var. *minima* had narrow branches (< 1mm in diameter) and thrived on fine sandy and muddy bottoms while var. *corallioides* had thicker branches (up to 1.8mm in diameter) and thrived on coarse detritic bottoms. Both varieties of *L. corallioides* were present on the Maltese maerl ground studied, and they were

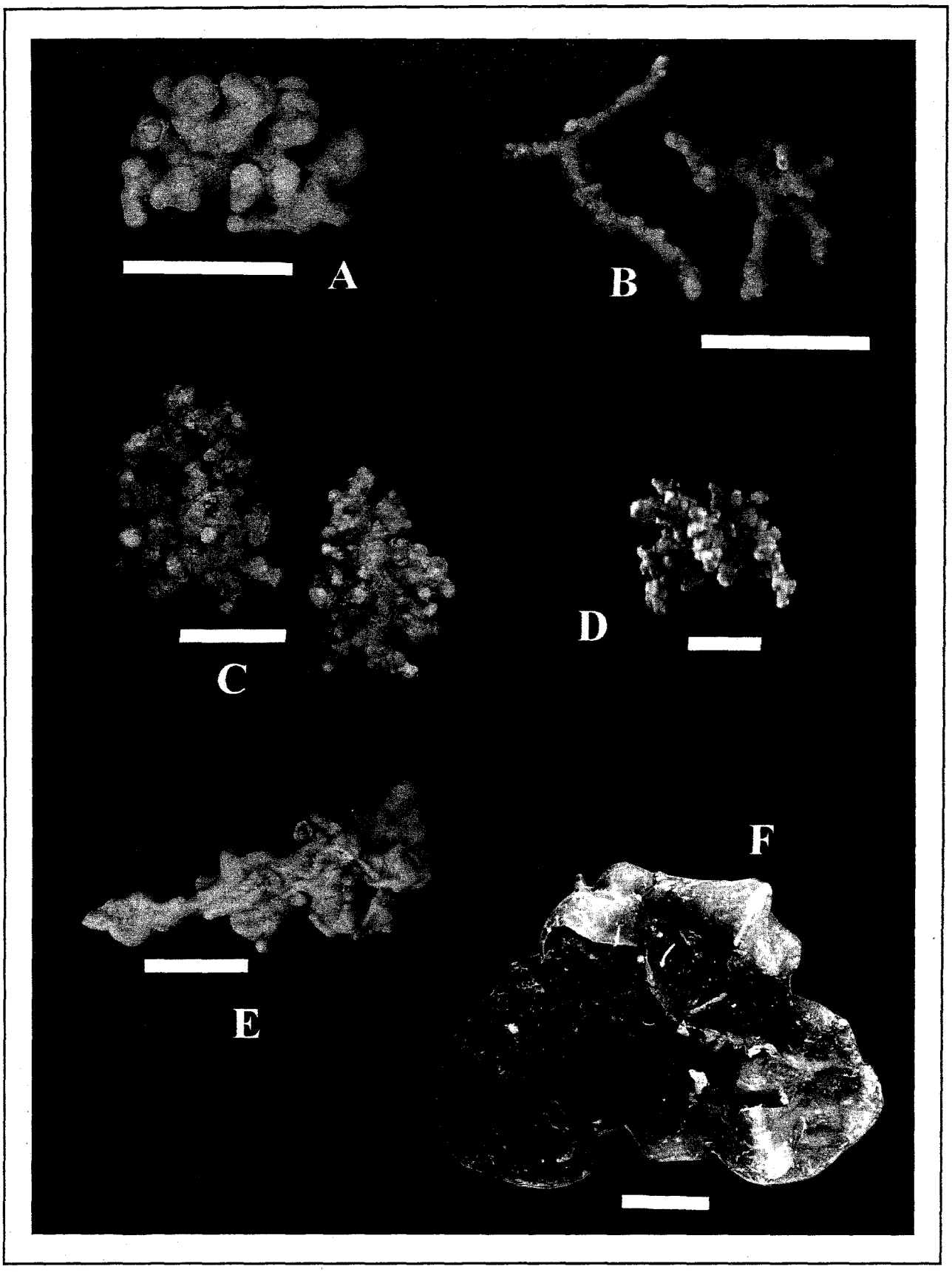

Plate I Representative examples of the main rhodolith-forming species of algae from the maerl ground off Is-Sikka l-Bajda. A: ***Lithophyllum racemus*** (Lamarck) Foslie B: ***Lithothamnion corallioides*** Crouan P.L. & Crouan H.M. C: ***Lithothamnion minervae*** Basso D: ***Phymatolithon calcareum*** (Pallas) Adey & McKibbin E: ***Mesophyllum alternans*** (Foslie) Cabioch & Mendoza F: ***Peyssonnelia rosa-marina*** Boudouresque & Denizot. (All scale bars represent 10 mm).

particularly abundant at a station that was characterised by a relatively high mud content.

***Lithothamnion minervae* Basso** (Plate I : Figure C)

This was the most abundant rhodolith-forming species present at Is-Sikka l-Bajda with specimens conforming well to descriptions given by Basso (1995b). As with *L. corallioides,* flared epithallial cells were present. A notable difference between these species was that reproductive conceptacles were abundant year-round in *L. minervae* but were infrequently seen on the other rhodolith-forming species present. These algae may occur as unattached branches or may encrust sediment or biogenic particles. The rhodoliths formed by this species are more or less densely branched, the branches having a diameter ranging from 1-3mm. On Maltese maerl grounds *L. minervae* formed very compact and more or less spherical densely branched rhodoliths, with relatively short branches. These attained quite large sizes with rhodoliths of up to 80 mm diameter.

***Phymatolithon calcareum* (Pallas) Adey & McKibbin** (Plate I: Figure D)

Specimens were attributed to this species by comparison with descriptions of the neotype specimen (Woelkerling & Irvine, 1986). Anatomical and reproductive studies led Adey & McKibbin (1970) to place this species in the genus *Phymatolithon*. Descriptions of the habit and branching pattern are given by Cabioch (1966), Irvine & Chamberlain (1994) and Basso (1996). As with all rhodolith-forming species, *P. calcareum* can be found either as unattached branches or enveloping sediment or biogenic particles. While the shape and branching density of these rhodoliths is extremely variable; the diameter of the branches tends to be thick and is typically in the range of 1.5 - 3 mm.

On Maltese maerl grounds the rhodoliths formed by this species were sparsely distributed as highly variable, irregularly branched, unattached thalli. In contrast to many Mediterranean and Atlantic maerl grounds (Jacquotte, 1962; Grall & Glemarec, 1997; Hall-Spencer, 1998), it was not one of the dominant species present. It could usually be distinguished by the naked eye on the basis of a more robust structure and a thicker branching pattern than in *Lithothamnion corallioides,* while it has a more open branching pattern than *Lithothamnion minervae.* Specimens of *P. calcareum* were easily separated from species of *Lithothamnion* on the basis of epithallial cell shape, being domed in *Phymatolithon* and flared in *Lithothamnion* (see Woelkerling, 1988).

***Mesophyllum alternans* (Foslie) Cabioch & Mendoza** (Plate I : Figure E)

This species was quite frequent on the Maltese maerl grounds studied, where it forms small irregularly shaped rhodoliths with a very characteristic lamellate structure. These lamellae overlap each other and enclose sediment particles.

Other Species

Two other species, *Peyssonnelia rosa-marina* and *Neogoniolithon brassica-florida* were tentatively identified on the basis of gross morphology. The identification of the former is almost certainly correct, but for the latter species it needs to be confirmed by microscopic examination of fertile material, which is not yet available.

***Peyssonnelia rosa-marina* Boudouresque & Denizot** (Plate 1 : Figure F)

Unlike all the other maerl-forming species, which are corallines (Order Corallinales; Family Corallinaceae), this alga is a member of the family Peyssonneliaceae (Order Gigartinales). It was quite frequent in the Maltese maerl beds studied where it formed fragile monospecific nodules made up of a series of smooth overlapping lamellae.

***Neogoniolithon brassica-florida* (Harvey) Setchell & Mason**

This species is generally found attached to hard substrata but it also encrusts pebbles or biogenic particles to form highly irregular rhodoliths.

DISCUSSION

In the Maltese maerl grounds so far examined, the dominant rhodolith-forming algae are *Lithothamnion minervae* and *Lithothamnion corallioides*. The former is a recently described species, having been formerly confused with the normally attached *Spongites fruticulosa* (Basso, 1995). Accompanying rhodolith-forming species include *Phymatolithon calcareum*, *Lithophyllum racemus* and *Mesophyllum alternans*. Other rhodolith-forming species include *Neogoniolithon brassica-florida*, which also occurs commonly in the attached state, and *Peyssonnelia rosa-marina* (Family Peyssonneliaceae; Order Gigartinales). Several rhodoliths are 'stained' with blood-red patches which have been provisionally identified as the red alga *Cruoria cruoriaeformis* (P.L. & H.M. Crouan) Denizot. Also abundant on the rhodoliths, as well as on other algae growing on the maerl, is the tiny encrusting coralline *Hydrolithon farinosum* (Lamouroux) Penrose.

The complex architecture of the rhodoliths gives rise to a very heterogeneous environment and in fact maerl beds provide a very important habitat with a high biodiversity. Apart from the species already mentioned, the maerl grounds studied support a variety of upright and creeping macroalgae. The most abundant is *Flabellia petiolata* (Turra) Nizamuddin, a species with an erect leaf-like thallus subtended by a creeping system of stolons anchored into the sediment by abundant rhizoids which permeate the whole fabric of the maerl surface. Less conspicuous but nevertheless very abundant is the creeping red alga *Womersleyella setacea* (Hollenberg) R.E. Norris, a species of recent introduction in the Mediterranean (Verlaque, 1989) and which is rapidly spreading. This employs numerous disc-shaped attachments to anchor itself to sediments, including rhodoliths and other seaweeds. The dark-green ball-shaped *Codium bursa* (L.) C. Agardh, which is attached by means of a dense system of rhizoids, *Osmundaria volubilis* (L.) R.E. Norris with dark spirally-twisted thalli, and the brown *Cystoseira corniculata* (Wulfen) Zanardini with creeping axes, are also common. Among the more notable of the other species are the red *Cryptonemia tunaeformis* (Bertolini) Zanardini, a species

which seems to occur almost exclusively on maerl, and the green net-like *Microdictyon tenuius* (C. Agardh) Decaisne. Numerous red algae of the family Rhodomelaceae, especially from the genera *Polysiphonia* and *Laurencia* (s.l.) also occur.

ACKNOWLEDGMENTS

This research has been undertaken in the framework of the BIOMAERL project. We acknowledge the support from the European Commission's Marine Science and Technology Programme (MAST III) under contract MAS3-CT95-0020. We are grateful to Professor P.G. Moore (University Marine Biological Station Millport), coordinator of the BIOMAERL project, for his encouragement and support. We also thank Mr. Oliver Cardona Ms. Yvette Rizzo and Mr. Michael Sant for providing the photographs of the rhodolith-forming algae.

This work was supported by research grants from the University of Malta and the Ministry of Education and National Culture, Malta, for which we are grateful.

(Accepted 6th April, 1999

REFERENCES

Adey, W. & McKibbin, D. 1970. Studies on the maerl species *Phymatolithon calcareum* (Pallas) nov. comb. and *Lithothamnion coralloides* Crouan in the Ria de Vigo. *Botanica Marina*, **13**: 100-106.

Adey, W.H. 1986. Coralline algae as indicators of sea-level. In: van de Plassche, O. (ed.) *Sea-level research: a manual for the collection and evaluation of data.* Geo Books, Norwich; pp. 229-280.

Basso, D. 1995a. Study of living calcareous algae by a paleontological approach: the non-geniculate Corallinaceae (Rhodophyta) of the soft bottoms of the Tyrrhenian Sea (Western Mediterranean). The genera *Phymatolithon* Foslie and *Mesophyllum* Lemoine. *Rivista Italiana di Paleontologia e Stratigrafia*, **100** (4): 575-596.

Basso, D. 1995b. Living calcareous algae by a paleontological approach: the genus *Lithothamnion* Heydrich nom. cons. from the soft bottoms of the Tyrrhenian Sea (Mediterranean). *Rivista Italiana di Paleontologia e Stratigrafia*, **101** (3): 349-366.

Basso, D. 1996. Adaptive strategies and convergent morphologies in some Mediterranean coralline algae. In: Cerchi, A. (ed.) Autoecology of selected fossil organisms: achievements and problems. *Bollettino della Società Paleontologica Italiana.* Special volume **3**, Mucchi, Modena: 1-8.

Basso, D.; Fravega, P. & Vannucci, G. 1996. Fossil and living corallinaceans related to the Mediterranean endemic species *Lithophyllum racemus* (Lamarck) Foslie. *Facies* **35**: 275-292.

Basso, D. & Tomaselli, V. 1994. Palaeoecological potentiality of rhodoliths: a Mediterranean case history. In: Matteucci R. *et al.* (eds.) Studies on ecology and paleoecology of benthic communities. *Bollettino della Società Paleontologica Italiana.* Special volume **2**, Mucchi, Modena: 17-27.

Borg, J.A., Howege, H., Lanfranco, E., Micallef, S.A., Mifsud, C. & Schembri, P.J. 1998. The macrobenthic species of the infralittoral to circalittoral transition zone off the Northeastern coast of Malta (central Mediterranean). *Xjenza* [Malta] **3** (1) : 16-24.

Bosence, D.W.J. 1976. Ecological studies on two unattached coralline algae from western Ireland. *Palaeontology*, **19** (2): 365-395.

Bosence, D.W.J. 1983a. Description and classification of rhodoliths (rhodoids, rhodolites). In: Peryt, T.M. (ed.) *Coated grains.* Springer-Verlag, Berlin and Heidelberg, 217-224.

Bosence, D.W.J. 1983b. The occurrence and ecology of recent rhodoliths - a review. In: Peryt, T.M. (ed.) *Coated grains.* Springer-Verlag, Berlin and Heidelberg, 225-242.

Cabioch J. 1966. Contribution à l'étude morphologique, anatomique et systématique de deux Mélobésiées: *Lithothamnion calcareum* (Pallas) Areshoug et *Liththamnion corallioides* Crouan. *Botanica Marina* **9**, 33-53.

Cabioch, J. 1970. Le maërl des côtes de Bretagne et le problème de sa survie. *Penn ar Bed* **7**, 421-429.

Cabioch, J. 1972. Étude sur les Corallinacées. II. La morphogenèse; conséquences systématiques et phylogénétiques. *Cahier de Biologie Marine.* **13**, 137-288.

Cabioch, J. & Giraud, G. 1978. Apport de la microscopie électronique à la comparison de quelques espèces de *Lithothamnium* Philippi. *Phycologia* **17** (4), 369-381.

Cabioch, J. & Mendoza, M.L. 1998. *Mesophyllum alternans* (Foslie) comb. nov. (Corallinales, Rhodophyta), a mediterraneo-atlantic species, and new considerations on the *Lithothamnion philippi* Foslie complex. *Phycologia* **37**: 208-221.

Cormaci, M., Lanfranco, E., Borg, J.A., Buttigieg, S., Furnari, G, Micallef, S.A., Mifsud, C., Pizzuto, F., Scammacca, B. & Serio, D. 1997. Contribution to the knowledge of benthic marine algae on rocky substrata of the Maltese Islands (Mediterranean Sea). *Botanica marina*, **40** : 203-215.

Freiwald, A. 1995. Sedimentological and biological aspects in the formation of branched rhodoliths in Northern Norway. *Beiträge zur paläontologie*, **20** : 7-19.

Freiwald, A. & Henrich, R. 1994. Reefal coralline algal build-ups within the Arctic Circle: morphology and sedimentary dynamics under extreme environmental seasonality. *Sedimentology*, **41**: 963-984.

Giaccone, G. 1972-73. *Elementi di botanica marina II.* Publicazioni Istituto Botanico Universita' di Trieste. Serie didattica, 358pp.

Grall, J. & Glémarec, M. 1997. Biodiversité des fonds de maerl en Bretagne: approche fonctionelle et impacts anthropiques. *Vie Milieu*, **47** (4): 339-349.

Hall-Spencer, J.M. 1998. Conservation issues relating to maerl beds as habitats for molluscs. *Journal of Conchology*, Special Publication No **2**: 271-286.
Hamel, G. & Lemoine, P. 1952. Corallinacées de France et d'Afrique du Nord. Archives du Museum National d'Histoire Naturelle. Septième série. Volume 1. 15-136pp, 23 plates.
Irvine, L.M. & Chamberlain, Y.M. 1994. *Seaweeds of the British Isles*. Volume 1, Part 2B. British Museum (Natural History) London, 276pp.
Jacquotte, R. 1962. Etude des fonds de maerl de Mediterranee. *Rec. Trav. Sta. Mar. End.*, **26** (41): 141-215.
Lanfranco, E. 1998. Field Identification of Coralline Algae. In: Dandria, D (ed.) *Biology Abstracts M.Sc., Ph.D. and contributions to Marine Biology*. Department of Biology, University of Malta in collaboration with the Environment Protection Department; 30-34.
Preda A. 1908. Florideae. In: *Flora Italica Cryptogama Part 2: Algae*. Roveca S. Coscione, 462pp.
Sommier, S. & Caruana Gatto, A. 1915. *Flora Melitensis Nova*. Firenze: Stab. Pellas. viii + 502pp.
Steller, D.L. & Foster, M.S. 1995. Environmental factors influencing distribution and morphology of rhodoliths in Bahía Concepción, B.C.S., México. *Journal of Experimental Marine Biology and Ecology*, **194**: 201-212.
Steneck, R.S. 1986. The ecology of coralline algal crusts: convergent patterns and adaptive strategies. *Annual Review of Ecology and Systematics*, **17**: 273-303.
Verlaque, M. 1989. Contribution a la flore des algues marine de Méditerranée: espèces rare ou nouvelles pour les cotes Francaises. *Botanica Marina*, **312**: 101-113.
Wehrmann, A., Freiwald, A. & Zankl, H. 1995. Formation of cold-temperate water multispecies rhodoliths in intertidal gravel pools from northern Brittany, France. *Senckenbergiana Maritima*, **26**: 51-71.
Woelkerling Wm.J. 1988. *The coralline red algae. An analysis of the genera and subfamilies of non-geniculate Corallinaceae*. British Museum (Natural History) and Oxford University Press. 268pp.
Woelkerling, Wm.J. & Irvine, L.M. 1986. The neotypification and status of *Phymatolithon* (Corallinaceae, Rhodophyta). *Phycologia* **25**: 379-396.

The Central Mediterranean Naturalist	3 (1): 7 - 12	Malta, June 1999

THE COMPLETE CONTENTS OF "*THE MEDITERRANEAN NATURALIST*", A PERIODICAL PUBLISHED IN MALTA BETWEEN 1891 AND 1893.

Patrick J. Schembri[1]

ABSTRACT

An account is given of the journal "*The Mediterranean Naturalist*", edited and published by John Henry Cooke (1862-1933) towards the end of the nineteenth century. The complete contents of the twenty-seven issues in three volumes are listed, with an indication of those articles concerning Malta or with a Maltese connotation.

INTRODUCTION

Between 1891 and 1893, John Henry Cooke (1862-1933), a teacher of English at the then Malta Lyceum in Valletta, founded, edited and published a journal entitled '*The Mediterranean Naturalist*'. Cooke was a keen naturalist who became particularly interested in the geology and palaeontology of the Maltese Islands and published numerous papers and articles on these subjects. A biography of Cooke, focusing especially on his activities in Malta, has been given by Zammit Maempel (1989).

The aims of '*The Mediterranean Naturalist*' were set out by Cooke in the first issue under the heading 'Programme'. In this Cooke wrote: "*The principal object, that we have in view in thus adding another publication to the already long list of periodical literature, is to provide naturalists with a paper that shall be devoted to the natural history of the Mediterranean and of its islands and shores.*" Cooke then continued to give an outline of the sort of material the journal would publish. This included original articles on Mediterranean natural history as well as reports on important results published elsewhere. Additionally the journal would include notes, discussion of scientific questions of current interest, reviews of the scientific literature, and summaries of important papers.

The first issue of '*The Mediterranean Naturalist*' was dated 1st June 1891 and the journal continued to appear until the 27th issue dated 1st December 1893. The journal seems to have been published privately by Cooke from his St.Julians residence, however, according to the title page for Volume 1, it was distributed in Malta by G.Muscat (Valletta), in Britain by W.P.Collins (London), and in the United States by B. Westermann & Co. (New York). The National Library of Malta holds a complete set of this publication (Sapienza, 1977).

At the time, this was the only local journal devoted to natural history and as such it attracted numerous papers on all aspects of Maltese natural history from a large number of naturalists, both Maltese and non-Maltese. Some of these papers are well known to present students of local natural history, however others are less so. The journal also included a vast number of short notes on local natural history, and these are virtually unknown since they are rarely, if ever, quoted. Additionally, the reports on then current research, summaries of important papers on Mediterranean natural history, correspondence, and miscellaneous other information included in the journal, provide an interesting glimpse into scientific endeavour and thinking at the time and as such are of interest to historians of natural science. In an effort to bring this important contribution to the attention of a wider audience, the present work gives the complete contents of '*The Mediterranean Naturalist*' with an indication of those items which concern local natural history.

ORGANIZATION OF THE CONTENTS LIST

In the contents list that follows, the following conventions are adopted. For each issue, the volume and number of the issue and the date are given as published, followed by the pagination for that issue. The contents of the issue are then listed in the order in which they appear, giving the author (where an article is signed) and the title, followed by the pagination. My own comments and explanations are given in square brackets. The following abbreviations are used:

Ed.	editor (that is, J.H. COOKE)
u.s.	unsigned but attributed to the editor
abs	abstract of scientific paper published elsewhere
bk. rev.	book review
rep	report either from another journal, or compiled from various sources, probably by the editor.

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Items relating to Malta are identified by the designation [**Mlt**] or **Malta** in bold. Where many short notes appear together without individual titles, individual items are not identified unless they pertain directly to Malta.

THE MEDITERRANEAN NATURALIST
– a monthly journal of natural science

As of issue 24 (Vol 3), the journal was published bimonthly and its title changed to *The Mediterranean Naturalist - a review of natural science.*

CONTENTS

VOL 1 No. 1 – June 1st, 1891 (pp 1-12)
Ed. [J.H. COOKE] Programme 1-2
CAPELLINI, G. A short history of the study of Foraminifera in Italy 2-4
u.s. A new Maltese chelonian *Trionyx melitensis* 4-5 [abs] [**Mlt**]
u.s. Manganese nodules 5 [abs + comment on **Malta**]
u.s. The subterranean treasures of Italy 5-6 [bk. rev.]
u.s. African earthworms 6 [abs]
u.s. Deep sea exploration in the Mediterranean 6-7 [rep - reference to **Malta**]
u.s. Formation of coral reefs in recent seas 7 [abs]
COOKE, J.H. Notes on the discovery of a "Pleistocene Bed" at Gozo 7-12 [**Mlt**]
u.s. Notes and news 12 [several items]
u.s. Exchange column 12

VOL 1 No. 2 – July 1st, 1891 (pp 13-28)
JERVIS, W. A. retrospective periplus of the Mediterranean Sea 13-17
u.s.The locust plague in Egypt and Algeria 17 [rep]
u.s. Recent researches of G.B. Schiaparelli made at Milan University 17-18 [rep]
u.s. Natural science in Tunis 18-19 [rep]
u.s. The oxycephalids of Carl Bovallius 19 [bk. rev.]
DRUCE, G.D. Preservation of the colour of plants 19
u.s. Phosphate beds around London 20 [rep]
u.s. Discovery of caves in Corsica 20 [rep]
u.s. The Gozo Pleistocene bed 20 [**Mlt**] [determination of fossil terrestrial shells from bed described in Vol. 1. No. 1 10]
u.s. News of the month 20-21 [several items including notice of a series of papers by Caruana Gatto on **Maltese** Lepidoptera]
JOHNSTON-LAVIS, H.J. The eruption of Vesuvius of June 7th 1891 21-22
COOKE, J.H. Observations on the geology of the Maltese islands 22-27 [part I] [**Mlt**]
u.s. Science notes 27-28 [several items]
BAKER, F. [letter] 28
u.s. Exchange column 28

VOL 1 No. 3 – August 1st, 1891 (pp 29-44)
BIDDULPH, R. Cyprus 29-33 [pt. I]
MASSEY, W.F. The culture of figs 33-34
u.s. Dr John Murray on the origin and character of the Sahara 34-36 [abs]
u.s. Notes and news 36 [several items including one on **Maltese** honey]
COOKE, J.H. Observations on the geology of the Maltese Islands 37-42 [part II] [**Mlt**]
u.s. Discovery of fossil remains at Arpino 42 [rep]
u.s. Insect plagues around the Mediterranean 43 [rep]
u.s. News of the month 43-44 [several items including one on meteorology of **Maltese Islands**]
u.s. Exchange column 44

VOL 1 No. 4 – September 1st, 1891 (pp 45-60)
MELLARD READE, T. Theories of mountain formation. Part I 45-48
COOKE, J.H. Observations on the geology of the Maltese Islands 48-50 [part III] [**Mlt**]
BIDDULPH, R. Cyprus 51-52 [part II]
CARUANA GATTO, A. Rare occurrence of *Ophrys apifera* in Malta 52-53 [**Mlt**]
u.s. Science gossip 53-54 [several items including SPCA in **Malta**]
JOHNSTON-LAVIS, H.J. The eruption of Vesuvius of June 7th, 1891 54-57 [see Vol 1 No. 2 21-22]
EARLAND, E.A. & COOKE, J.H. Notes on the Recent Foraminifera of Malta. 57-59 [**Mlt**]
u.s. News of the month 59-60
u.s. Books etc. received 60
u.s. Exchange column 60

VOL 1 No. 5 – October 1st, 1891 (pp 61-76)
HENSLOW, G. The natural history of Malta 61-63 [**Mlt**]
VAN BENEDEN, P.J. Note on "*Dioplodon farnesinoe*" 63
T.M. [?] The climate of Cephalonia 63-64 [abs]
MILLARD READ, T. Theories of mountain building. Part II 64-67
WALMSEY, W.H. Preservation of algae 67
u.s. Sir Warington, W. Smyth, M.A., F.R.S. 67-68 [obituary of Governor of Malta]
BRUN, H.E. Vine and olive culture in Algeria 69
u.s. Deforestation of Servia 69 [rep]
FOSTER, W.G. Remarkable natural phenomenon near Cephalonia 69
COOKE, J.H. Observations on the geology of the Maltese Islands 70-73 [pt. IV] [**Mlt**]
HARTING, J.E. The Syrian greyhound 73-75
u.s. Science gossip 75-76

VOL 1 No. 6 – November 1st, 1891 (pp 77-92)
MARRAT, F.P. Notes on some natural resemblances 77-79
u.s. The mineral springs of Roumania 79 [rep]
COOKE, J.H. Diseases of the Mediterranean orange 79-82 [**Mlt**]
TAYLOR, J.E. A coral island on the Great Barrier Reef 82-83 [extract from letter]
BIDDULPH, R. Cyprus 83-85 [part III]
CARUANA GATTO, A. Notes on the Lepidoptera of Malta 85-88 [part I] [**Mlt**]
u.s. The salt mountain of Palestine 88 [rep]
COOKE, J.H. Observations on the geology of the Maltese Islands 88-90 [part V] [**Mlt**]
u.s. Science gossip 90-92
'A VISITOR' Correspondence: Our birds 92 [letter] [**Mlt**]
u.s. Exchange column 92

VOL 1 No. 7 – December 1st, 1891 (pp 93-108)
JERVIS, G. Sketch of the geology of Pantelleria, importance of its thermal springs to the Maltese 93-96 [**Mlt**]

HENSLOW, [G.] The botany and geology of Egypt 97-99 [part I]
u.s. Military pigeons 99 [rep]
MELLARD READE, T. Theories of mountain formation. Part III 99-102
COOKE, J.H. The climate of the Maltese Islands 102-106 **[Mlt]**
CARUANA GATTO, A. Notes on the Lepidoptera of Malta 106-107 [part II] **[Mlt]**
u.s. Science gossip 107-108 [including item on **Maltese** climate]

VOL 1 No. 8 -- January 1st, 1892 (pp 109-124)
SMITH, E. Remarks on the relationship of the molluscan fauna of the Red Sea and Mediterranean 109-111
u.s. The Geological Photographs Committee of the British Association and its work 111-112 [rep]
WALKER, J.J. Notes on ant's-nest beetles in Gibraltar and Tangier; with special reference to the Histeridae 112-113 [part I]
u.s. The latest theory of volcanoes 113-114 [abs]
BIDDULPH, R. Cyprus 114-116 [part IV]
u.s. The Samos fossil mammals 116-118 [abs]
J.H.C. [=J.H. COOKE ?] Occurrence of "*Chrysophrys*" in the Malta Miocene 118 **[Mlt]**
COOKE, J.H. Observations on the geology of the Maltese Islands 118-122 [part VI] **[Mlt]**
u.s. Notes and news 122-124 [several items including notice of paper by J.H. COOKE on *Stereodon melitensis* (122), on Golden Plover in **Malta** (122), earthquake in **Malta** (122); sulla and wheat in **Malta** (122); **Maltese** Pleistocene fauna (123);]
u.s. Discovery of the remains of a fossil whale near Citta' Vecchia 124 **[Mlt]**

VOL 1 No. 9 -- February 1892 (pp 125-140)
HENSLOW, [G.] The botany and geology of Egypt 125-127 [part II]
CARUANA GATTO, A The "fungus melitensis" 127-129 **[Mlt]**
COOKE, J.H. Observations on the geology of the Maltese Islands 129-133 [part VII] **[Mlt]**
DE LA GARDE, Mediterranean Lepidoptera 133-135 [part I] **[Mlt]**
MELLARD READE, T. Theories of mountain formation. Part IV 135-138
u.s. Science gossip 138-140 [including **Maltese** Miocene echinoids (138), introduction of Olive into **Malta** (139) errata (on **Malta**) (140); notice of paper by COOKE on the Scirocco wind in **Malta** (140); Golden Plover in Malta (p140); **[Mlt 139-140]**

VOL 1 No. 10 -- March 1st, 1892 (pp 141-156)
LAMBERT PLAYFAIR, R. Description of Corsica 141-143
u.s. The fossil whale from Citta Vecchia 143 **[Mlt]**
COOKE, J.H. Lampedusa and its sponge fisheries 143-146 **[Mlt]**
u.s. The poppy, its cultivation and uses 146 [rep]
DE LA GARDE, P. Mediterranean Lepidoptera 147-148 [part II]
J.E.S. Aetna and its lava streams 148
CARUANA GATTO, A. New Clausilidae from Malta 148-149 **[Mlt]**
WALKER, J.J. Notes on ant's-nest beetles at Gibraltar and Tangier; with special reference to the Histeridae 150-151 [part II]
u.s. A contribution to the moss flora of Malta 151-152 **[Mlt]**
COOKE, J.H. Observations on the geology of the Maltese Islands 152-154 (part VIII) **[Mlt]**
u.s. Notes and news 154-156 [including one item on Mediterranean weather signed "F.M."]

VOL 1 No. 11 -- April 1st, 1892 (pp 157-172)
COOKE, J.H. The Scirocco as a disintegrating agent, with special reference to its effect on the strata of the Maltese Islands 157-159 **[Mlt]**
u.s. Deep-sea exploration in the Eastern Mediterranean 159-160 [abs]
TOGETTI, T. Diseases of the Malta orange 160-161 **[Mlt]**
MELLARD READE, T. Theories of mountain formation. Part V 161-164
u.s. The soil of the Maltese Islands 164-165 **[Mlt]**
CARUANA GATTO, A. Disappearance of *Spondylus gaederopus* L. and other species from Maltese waters 165 **[Mlt]**
u.s. Science gossip 165-167
u.s. The Tunisian locust plague 167 [abs]
u.s. Samos. Its fossils and their age 167-168 [abs]
u.s. The meteorology of the Maltese Islands 168-169 [rep] **[Mlt]**
u.s. The Maltese fossil Echinoidea 169-171 [abs of paper by GREGORY] **[Mlt]**
u.s. Mummy wheat 171 [rep]
u.s. Notes and news 171-172 [including errata to p95 **[Mlt]**; Maltese climate;] **[Mlt** 171-172]
u.s. Books etc. received 172

VOL 1 No. 12 -- May 1st, 1892 (pp 173-184)
TAGLIAFERRO, C. Diseases of the **Malta** orange 173-175
J.H.C. [=J.H. COOKE ?] Fish remains in the Upper Limestone of Malta 176 **[Mlt]**
u.s. Maltese mosses 176 **[Mlt]** [addition to list (pp 151-152)]
u.s. Estivation 176 [rep]
COOKE, J.H. Notes on *Stereodon melitensis*, Owen 176-177 [abs] **[Mlt]**
u.s. Some strange plants 177-178 [rep]
u.s. The new star 178 [rep]
FLINDERS PETRIE, W.M. Wind-action in Egypt 178-180 [abs]
u.s.Exploration in the Black Sea 181 [abs]
u.s. Notes and news 181-184 [including donation of **Maltese** fossil Echinoidea to University Museum] **[Mlt** 182]
u.s. Notes on books, etc. 184
Index to Vol 1 (185-186)

VOL 2 No. 13 -- June 1st, 1892 (pp 187-202)
WALKER, J.J. A year's insect-hunting in Gibraltar 187-189 [part I]
u.s. Why we should teach geology 189-190 [abs]
u.s. The sulphur mines of Sicily 190 [rep]
JOHNSTON LAVIS, H.J. The relationship of the structure of rocks to the conditions of their formation 190-194 [part I]
u.s. Subterranean waters in the Sahara 194 [rep]

J.H.C. [=J.H. COOKE ?] The Malta potato disease 194-195 [**Mlt**]
MOORE, R. On the meadow of Nysa in Asia Minor 195-197 [part I]
u.s. Vanishing forms 197 [rep]
u.s. Algerian oases 197-198 [rep]
u.s. Prehistoric man in the Mediterranean 198-199 [rep]
u.s. Fossil birds of Corsica and Sardinia 199 [bk. rev. of LYDEKKER's monograph]
u.s. Notes and news 200-202 [including spring migration in **Malta**; gloves made from *Pinna* byssus] [**Mlt** 201-202]

VOL 2 No. 14 -- July 1st, 1892 (pp 203-218)
BRYAN, G.H. The recent discovery of skeletons in the caves at Mentone 203-205
COOKE, J.H. The phosphate beds of the Maltese Islands and their possibilities 205-209 [**Mlt**]
u.s. Changing climate 210 [rep]
u.s. The hope of France 210 [rep]
u.s. Prehistoric man in Italy 210-211 [bk. rev.]
u.s. The fathomed depths of the ocean 211 [rep]
JOHNSTON LAVIS, H.J. The relationship of the structure of rocks to the conditions of their formation 211-213 [part II]
u.s. The great African cataract 213 [rep]
u.s. The tunny fishery in Sicily and Sardinia 214-215 [abs]
TWELVES, H. The vine diseases in Sicily 215-216 [letter and note]
u.s. Notes and news 216-218 [including diseases of Maltese vines] [**Mlt** 218]

VOL 2 No. 15 -- August 1st, 1892 (pp 219-234)
COOKE, J.H. Eruption of Etna 219-221
u.s. The sponges of Tripoli 211 [rep]
MOORE, R. On the meadow of Nysa in Asia Minor. II 221-223
u.s. An ancient birdland 223-225 [rep]
u.s. Geology of the Nile Valley 224 [abs]
JOHNSTON LAVIS, H.J. The relationship of the structure of rocks to the conditions of their formation 224-226 [part III]
u.s. Tools of the pyramid-builders 226 [rep]
CARUANA GATTO, A. Maltese Caecilianellae. A contribution to the study of Maltese land shells 226-227 [**Mlt**]
u.s.The Sahara 228 [rep]
WALKER, J.J. A year's insect-hunting at Gibraltar. II. 228-230
CAMERANO, L. The serpents and chelonians of Italy. 230-232
BEYNON, R. The depths of the Mediterranean and Black Sea. part I. 231-232
u.s. Notes and news 232-234 [including diseases of Maltese vines; earthquake felt in **Malta**] [**Mlt** 232]

VOL 2 No. 16 -- September 1st, 1892 (pp 235-250)
HENSLOW, G. Phosphate nodules 235-239
CARUANA GATTO, A. On the extraordinary abundance of *Deiopeia pulchella* Beis in Malta. 239 [**Mlt**]
J.H.C. [=J.H. COOKE ?] The eruption of Etna 239-240 [rep]
u.s. A marketable commodity 240-241 [abs]
COOKE, J.H. The *Peronospora* among the Malta vines 241-244 [**Mlt**]
MOORE, R. The meadow of Nysa in Asia Minor 244-245 [pt. III]
CARUANA GATTO, A. *Assiminea littorina* Delle Chiaie in Malta 245 [**Mlt**]
JOHNSTON LAVIS, H.J. The relationship of the structure of rocks to the conditions of their formation 245-248 [part IV]
WALKER, J.J. A year's insect-hunting in Gibraltar. Part IV 248-249
u.s. Notes and news 249-250 [including thunderstorms in **Malta**; introduction of tobacco and *Opuntia* into **Malta**] [**Mlt** 250]

VOL 2 No. 17 -- October 1st, 1892 (pp251-266)
JERVIS, G. Supposed Quaternary and since submerged volcano of Mergellina, at Naples 251-253
u.s. On *Tryonx ragusensis* and *T. melitensis* 253 [abs] [**Mlt**]
u.s. The Phoenicians in the Mediterranean 254-255 [rep]
COOKE, J.H. On the occurrence of a black limestone in the strata of the Maltese Islands 255-257 [**Mlt**]
u.s. Fighting mice with a bacillus 257 [abs]
u.s. Teeth food 257 [abs]
JOHNSTON LAVIS, H.J. The relationship of the structure of rocks to the conditions of their formation 257-259 [part V]
u.s. A strange march to the sea 259-260 [rep]
u.s. "Left handed" snails 260 [rep]
BEYNON, R. The depths of the Mediterranean and Black Seas 260-263 [part II]
u.s. Prehistoric items 263-264 [rep]
u.s. Notes and news 264-266 [including notice of a paper on **Malta** by COOKE; representation of **Malta** at Botanical Congress; correspondence in **Maltese** newspaper on birds and insects; figs in **Malta**] [**Mlt** 264-266]
HUGHES, W.L. [letter] 266

VOL 2 No. 18 -- November 1st, 1892 (pp 267-282)
COOKE, J.H. On the occurence of *Ursus arctos* in the Malta Pleistocene 267-269 [**Mlt**]
u.s. The silkworm in Malta 269 [rep] [**Mlt**]
u.s. Mantidae 269-270 [rep]
u.s. An under valued product 271 [rep]
HUGHES, [W.L.] Insects in biscuits 271-272 [**Mlt**]
TCHERAZ, M. Armenia 272-273
JOHNSTON LAVIS, H.J. The relationship of the structure of rocks to the conditions of their formation 273-276 [part VI]
CARUANA GATTO, A. Albinism and colour variation in Maltese wild flowers 276-277 [**Mlt**]
u.s. Exploration of the Black Sea 277-278 [abs]
J.H.C. [=J.H. COOKE ?] On the vine and potato disease in Malta 278-279 [**Mlt**]
WALKER, J.J. A year's insect-hunting at Gibraltar. IV 279-281
u.s. Notes and news 281-282 [including notice of paper by CARUANA GATTO] [**Mlt** 281]

VOL 2 No. 19 -- December 1st, 1892 (pp 283-298)
JOHNSTON LAVIS, H.J. The relationship of the structure of rocks to the conditions of their formation 283-285 [part VII]
u.s. The birds of Malta 285-286 [rep] [**Mlt**]
u.s. The late eruption of Pantelleria 286-287 [rep]

A.C.G. [= A. CARUANA GATTO ?] Entomological notes 287 [**Mlt**]
u.s. Science gossip 287-291 [including **Maltese** fossil echinoids; marine biological station in **Malta**] [**Mlt** 290-291]
R.N.C.[?] The Italian Geographical Congress of 1892 295-296 [rep]
GODFREY, M.J. Botanical notes 296-297 [**Mlt**]
u.s. Notes and news 297-298 [including diseases of tomatoes in **Malta**; vine diseases in **Malta**; protection of **Maltese** fisheries; notice of paper by COOKE; marine biological station in **Malta**; correspondence on birds and insects in **Maltese** newspapers] [**Mlt** 297-298]
JERVIS, A. Birds v. insects 298 [letter]

VOL 2 No. 20 -- January 1st, 1892 [sic! = 1893] **(pp 299-314)**
HUGHES, M.L. The natural history of certain fevers occurring in the Mediterranean 299-300 [part I] [**Mlt**]
WELSCH, J. On the Miocene beds of Western Algeria 301-302
J.H.C. [=J.H. COOKE ?] A ramble through Emtahleb 302-205 [**Mlt**]
u.s. The flora of Northern Germany during the Middle Ages 305 [abs]
u.s. Science echoes 305-309 [items subtitled]
JOHNSTON LAVIS, H.J. The relationship of the structure of rocks to the conditions of their formation 309-311 [part VIII]
HALKYARD, E. The collection and preparation of Foraminifera 311-312 [part I]
PLATANIA, G. Geological notes of Acireale 312-313 [part I]
u.s. Notes and news 313-314 [including setting up a commission on the "Bird Question" in **Malta**; disease of sulla in **Malta**; fishing industry in **Malta**] [**Mlt** 313-314]

VOL 2 No. 21 -- February 1st, 1892 [sic! = 1893] **(pp 315-330)**
COOKE, J.H. Some evidence of the occupation of the Maltese Islands by prehistoric man 315-320 [**Mlt**]
u.s. The Malta Potato Disease 320 [abs; not clear if work reported was done in **Malta**]
JOHNSTON LAVIS, H.J. The relationship of the structure of rocks to the conditions of their formation 320-322 [part IX]
A.C.G. [= A. CARUANA GATTO ?] Notes for the month: Botany [pp 322-323]; Conchology [p 323] [**Mlt**]
HALKYARD, E. The collection and preparation of Foraminifera 323-325 [part II]
HUGHES, M.L. The natural history of certain fevers occurring in the Mediterranean 325-327 [part II] [**Mlt**]
u.s. Science gleanings 327-329 [including census of cultivated land in the **Maltese Islands**; **Maltese** lace and filigree; archaeological discoveries in **Malta**] [**Mlt** 328-329]
SCIORTINO, J.C. Maltese Lepidoptera 329-330 [letter] [**Mlt**] [with comments by "A.C.G." (= Alfredo Caruana Gatto) 330]

VOL 2 No. 22 -- March 1st, 1893 (pp 331-346)
JERVIS, G. The fourth allotropic form of carbon 331-332
HUGHES, M.L. The natural history of certain fevers occurring in the Mediterranean 332-334 [part III] [**Mlt**]
u.s.The latest from Mars 334 [rep]
u.s. Meteorological report for 1892 334-335 [rep] **Mlt**
PLATANIA, G. Geological notes of Acireale 335-336 [part II]
u.s. Animal plagues 336 [rep]
u.s. Notes and news 337 [including capture of shark off **Gozo**] [**Mlt** 337]
JOHNSTON LAVIS, H.J. The relationship of the structure of rocks to the conditions of their formation 337-340 [part X]
u.s. The lands of volcanoes 340 [rep]
u.s. The geology of Arabia Petrea and Palestine 340-341 [abs]
CARUANA GATTO, A. The vegetation of the house terraces of Malta 341-342 [**Mlt**]
u.s. Science gossip 342-345 [including fibres from *Pinna* in **Malta**] [**Mlt** 344]
SCOLES, J. Meteorological report. St. Ignatius' College Malta, January 1893 345-346 [**Mlt**]

VOL 2 No. 23 -- April 1st, 1893 (pp 347-362)
FORSTER, W.G. The recent earthquakes in Zante 347-354
u.s. The future of the races 354 [rep]
u.s. Variation in skin colour 354 [rep]
COOKE, J.H. The marls and clays of the Maltese Islands 355-357 [part I] [**Mlt**]
u.s. Science gossip 358-360 [including note on changes in the *Mediterranean Naturalist*; damage by **Maltese** snails; bees, sulla and rheumatism in **Malta**; species of fig in **Malta**; trade in archaeological items, lace, filigree and dogs; **Maltese** dog] [**Mlt** 358-359]
TOPLEY, W. The Sandgate landslip 360-362
SCOLES, J. Meterological report. St. Ignatius' College, Malta. February, 1893 362 [**Mlt**]

VOL 3 No. 24 -- June 1st, 1893 (pp 363-386)
AYSCOGHE FLOYER, E. La botanique du Nord-Etbai 363-366
TAGLIAFERRO, N. "*Falco punicus*" in Malta 366 [**Mlt**]
u.s. Animal plagues 367 [rep]
u.s. The Malta potato disease 367-368 [rep] [**Mlt**]
BURNS, G.J. [with a note by COOKE, J.H.] The effect of pressure in causing a thinning in soft strata 368-369 [**Mlt**]
u.s. The world's coal supply 369-370 [rep]
CARUANA GATTO, A. The street of duels 373-374 [**Mlt**] [rep]
u.s. Diamond making 374 [rep]
COOKE, J.H. The marls and clays of the Maltese Island 374-378 [part II] [**Mlt**]
u.s. City dust 378-379 [rep]
PLATANIA, G. Geological notes of Acireale. part III 379-380
u.s. The "Pola" deep-sea explorations 380 [rep]
TAGLIAFERRO, N. On the occurrence of lignite in the Globigerina bed of Malta 380-381 [**Mlt**]
u.s. Science gossip 381-385 [including *Peronospora* in **Malta**; aphids in **Malta**; ladybirds in **Malta**; archaeological site at **M'Xlokk**; earthquakes in **Malta**;] [**Mlt** 382-383]
SCOLES, J. Meteorological report. St. Igantius' College Malta 1893 386 [March & April 1893] [**Mlt**]

VOL 3 No. 25 -- August 1st, 1893 (pp 387-410)
u.s. A museum for Malta 387-389 [**Mlt**]
u.s. Artificially coloured flowers 389 [rep]

u.s. Petroleum theories 389 [rep]
BALBI, E. & CARUANA GATTO, A. Resoconto di una escursione fatta alle grotte di Isoverde in Liguria 389-391 [written by a **Maltese** Naturalist]
TAGLIAFERRO, N. On *Fuligula rufina* in Malta 391-392 [**Mlt**]
u.s. City dust 392 [rep]
AYSCOGHE FLOYER, E. La botanique du Nord-Etbai. part II 392-394
BAIRSTOW, S.D. The orange diseases in Cape Colony 394-399 [part I]
u.s. Colours of ancient Egypt 399-400 [rep]
COOKE, M. [= Minnie COOKE] A modern Golgotha 400-401 [**Mlt**]
HALKYARD, E. The collection and preparation of Foraminifera. part III 401-402
u.s. Deep sea explorations in the Eastern Mediterranean 402-403 [abs]
COOKE, J.H. On the occurrence of concretionary masses of flint and chert in the Maltese limestones 403-405 [**Mlt**]
u.s. Notes and news 405-409 [including on the museum of the **Malta** University] [Mlt 406]
SCOLES, J. Meteorological report. St. Ignatius' College Malta, 1893 410 [March & April 1893] [**Mlt**]

VOL 3 No. 26 -- October 1st, 1893 (pp 411-434)
COOKE, J.H. The utilization of the waste lands of Malta. A new industry for the Maltese - a suggestion 411-414 [**Mlt**]
u.s. Plant extremes 414-415 [rep]
u.s. Egyptian horses 415 [rep]
OYSCOGHE FLOYER, E. Notes sur la geologie de l'Etbai nord ou desert Est Egyptian 415-417 [part I]
u.s. The mystery of the moon 417 [rep]
A.C.G. [= A. CARUANA GATTO ?] Local notes 418-419 [various items on **Maltese** natural history] [**Mlt**]
WALKER, A. Starlings 419-421
TAGLIAFERRO, N. On the occurrence of *Echeneis naucrates* in Maltese waters 421 [**Mlt**]
u.s. A novel industry 421-422 [rep]
POLLONERA, C. Sui limacidi dell'Algeria 422-425
u.s. Method of taking plaster casts of objects of natural history 425 [rep]
BAIRSTOW, S.D. The orange disease of Cape Colony 425-428 [part II]
u.s. Hints for young collectors 428-429 [rep]
u.s. Notes and news 429-433 [including grape harvest in **Malta**; Medlycott's drawings of **Maltese** birds and fishes; archaeological remains in **Malta**; **Maltese** agriculture; **Maltese** snakes; tapeworms in **Malta**; cultivation of sulla in **Malta**] [**Mlt** 430-432]
SCOLES, J. & DOBSON, J.F. Meteorological report. St. Ignatius' College Malta, 1893. 434 [August & September 1893] [**Mlt**]

VOL 3 No. 27 -- December 1st, 1893 (pp 435-458)
W.K.R.B. [?] The tapestries of St. John's Church Valletta. 435-438 [**Mlt**]
A.C.G. [= A. CARUANA GATTO ?] On the orange fly in Malta 438 [**Mlt**]
u.s. Recent exploration of the Maltese and Sicilian caverns 438-440 [unsigned but reprinted from "Natural Science Dec. 1893"] [**Mlt**]
HEY, W.C. Stray notes on the natural history of Spain 440-441
COOKE, J.H. Vestiges of the Phoenicians in the Maltese Islands 441-446 [**Mlt**]
u.s. Stray thoughts 446-447 [a collection of quotations]
CARUANA GATTO, A. Common beetles of the Maltese Islands 447-451 [**Mlt**]
J.H.C. [= J.H.COOKE ?] The Victoria Cavern 451-453 [**Mlt**]
BAIRSTOW, S.D. The orange disease in Cape Colony 453-455 [part III - "to be continued"]
COOKE, J.H. The utilization of the waste lands in Malta and Gozo 455-458 [**Mlt**]
u.s. Notes and news 458

ACKNOWLEDGEMENTS

I am grateful to Alfred E. Baldacchino for help received in the preparation of this paper and to Ms Michelle Spiteri for typing the manuscript.

(Accepted 3rd March 1999)

REFERENCES

Sapienza, A. F. (1977) *A checklist of Maltese periodicals.* Msida, Malta: Malta University Press; [unpaginated]
Zammit Maempel, G. (1989) *Pioneers of Maltese geology.* B'Kara, Malta: Dr G. Zammit Maempel; 302pp.

The Central Mediterranean Naturalist	3 (1): 13 - 14	Malta, June 1999

RIELLA HELICOPHYLLA (MONT.) HOOK., A NEW ADDITION TO THE MACROPHYTIC WETLAND FLORA OF THE MALTESE ISLANDS (BRYOPHYTA, MARCHANTIOPSIDA, RIELLACEAE)

Sandro Lanfranco[1], Edwin Lanfranco[2]

ABSTRACT

The freshwater liverwort *Riella helicophylla* (Mont.) Hook. is recorded for the first time from the Maltese Islands. A number of individuals were cultured following hydration of desiccated sediment collected from Ghadira s-Safra, a saline marshland situated on the north-eastern coast of Malta. Subsequent fieldwork has not revealed any field occurrences of the species in the Maltese Islands, indicating that this record may be due to a chance occurrence of viable spores in the sediment, possibly as a consequence of transport by means of migrating waterfowl. The apparent absence of the species in the wild may also be due to habitat degradation and to a sub-optimal physico-chemical environment.

INTRODUCTION

The macrophytic flora of wetlands of the Maltese Islands is made up mainly of angiosperms. Non-angiospermous groups recorded from Maltese wetlands include chlorophytes, charophytes, and a moss, while no aquatic liverworts have hitherto been recorded. The occurrence of *Riella helicophylla* therefore represents the first such record for the Maltese Islands. The genus *Riella* comprises twelve species, all of which are halophytic and restricted to regions of arid climate (Allorge, 1947). Five of these species [*R. affinis, R. cossoniana, R. helicophylla, R. notarisii* (= *R. reuteri*) and *R. parisii*] are of Mediterranean or peri-Mediterranean provenance (Duell, 1983). The distribution of *R. helicophylla* follows a Mediterraneo-atlantic pattern (Casas *et al.*, 1981), having been recorded from Tunisia, Algeria, Egypt, Southern France, Southern Portugal, mainland Spain and the Balearic Islands. It is interesting to note that this species has hitherto only been recorded from one island locality in the Mediterranean (Cros, 1982). The nearest records to the Maltese Islands, in terms of geographical proximity, are from Tunisia (Trabutr, 1911) and from Thau, Southern France (Dubois and Hebant, 1968), while there are no recorded occurrences of the species in nearby Sicily (Dia *et al.*, 1985).

METHOD AND RESULTS

The species appeared following hydration of desiccated sediment taken from Ghadira s-Safra, a seasonally flooded coastal wetland situated on the north-eastern coast of Malta (UTM grid reference 502787; Fig. 1). A brief overview of the habitat at Ghadira s-Safra has been given by Lanfranco and Schembri (1995). Dry sediment samples were collected on 15 July 1990 and stored in dry paper bags pending hydration. Sediment samples were placed in steam-sterilised 250ml glass measuring cylinders and hydrated with deionised water on 16 July 1990. The sediment in the cylinders was thoroughly homogenised by vigorous agitation at the beginning of the experiment. The apparatus was subsequently maintained in the laboratory, next to an east-facing window. Water in the measuring cylinders was topped up regularly in order to offset losses from evaporation. The mean electrical conductivity of the water, based over five samples with five replicates each was $1382 \pm 156\ \mu Scm^{-1}$. The first appearance of *R. helicophylla* was recorded on 13 August 1990 and the specimens were maintained in culture for several months, attaining lengths of 5cm – 9cm. The plants were subsequently harvested for identification. Identification was carried out by one of the authors (EL) and confirmed by Dr Montserrat Brugues of the Universitat Autonoma de Barcelona. Voucher specimens were deposited at the University of Malta, at the Universitat Autonoma de Barcelona and in the private herbarium of E. Lanfranco (Malta).

DISCUSSION

Subsequent fieldwork in different years has not revealed any field occurrences of *Riella helicophylla*. The apparent absence of *Riella helicophylla* in the wild may be a consequence of a number of factors, operating in isolation or in synergy:

Habitat disturbance: Ghadira s-Safra has experienced frequent anthropogenic disturbance throughout the past decade, reducing the water-retention capability of the habitat. Mean hydroperiod duration has consequently also reduced, minimising the probability of successful germination and reproduction of species comprising the ephemeral freshwater taxocene. Such degradation has exerted negative effects on locally-rare taxa recorded from this habitat, including the notostacan crustacean *Triops cancriformis* (Lanfranco and Schembri, 1995).

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Chance: Since Ghadira s-Safra is a coastal habitat, the possibility of visits by migratory waterfowl is increased. The mud adhering to the feet of birds is known to be an important source of amphipod propagules (Swanson, 1984), while resting stages of freshwater invertebrates can survive passage through the gut of waterfowl (Thiery, 1991). Viable spores of *Riella helicophylla* may therefore have been transported to Ghadira s-Safra following sporadic visits by waterfowl.

Unfavourable physico-chemical conditions: Salinity is an important factor in the germination and maturation of Riella helicophylla, where relatively high salinities, such as those characteristic of saline marshlands, inhibit germination but promote maturation (Marin Velasquez, 1982). In a temporary Mediterranean marshland, salinity would initially be low, but would progressively increase as dissolution of salts and evaporation of water proceed. Inhabitants of such marshes would therefore be adapted to respond to such conditions, germinating as soon as flooding occurs (low salinity) and maturing as water levels recede (high salinity). The salinity at Ghadira s-Safra is lower than that recorded in similar coastal habitats in the Maltese Islands (Lanfranco, 1990). This lower salinity would provide a physiological trigger for germination but may inhibit maturation. As such, individual plants may be overlooked as a consequence of small size. This may be rectified by effort-intensive sampling. Such a sampling programme is in progress.

CONSERVATION AND LEGISLATION

R. helicophylla is listed in Appendix 1 of the Berne Convention (Strictly Protected Flora). It is also legally protected in the Maltese Islands (Legal Notice 49/1993).

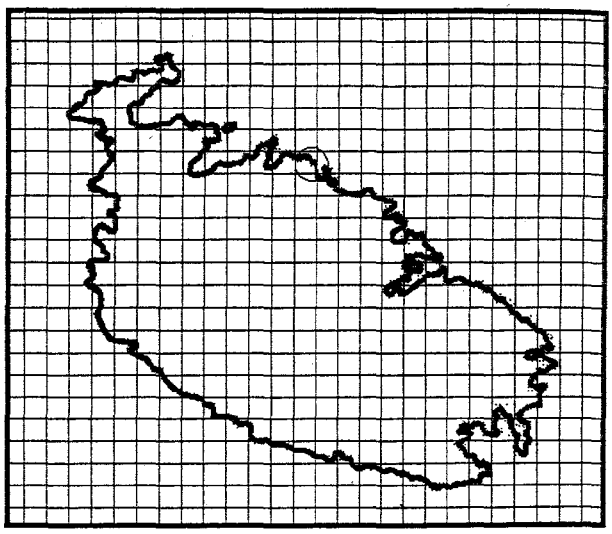

Fig. 1 Outline map of Malta. The approximate position of Ghadira s-Safra is circled.
Area of grid squares = 1 km^2. North is at top.

ACKNOWLEDGEMENTS

The authors thank Dr Montserrat Brugues (Department of Botany, Autonomous University of Barcelona, Barcelona, Spain) for identification of specimens and provision of key literature.

(Accepted 10th March, 1999)

REFERENCES

Allorge, P. (1947) Essai de Bryogeographie de la Peninsule Iberique. 1: 48 – 54. Paris: Paul Lechevalier.

Casas C., Brugues, M. & Cros, R.M. (1981) Contribucio al coneixement de l'area geografica d'alguns briofits. *Treb. Inst. Cat. Hist. Nat.* **9**, 169-178.

Cros, R.M. (1982) Algunos briofitos interessantes para la flora balear. *Acta Botanica Malacitana* 7, 141 – 150.

Dia, M.G., Miceli G. & Not, R. (1985) Check-list delle Epatiche note in Sicilia. *Webbia* **39**, 163-177.

Dubois, A. and Hebant, Ch. (1968) Un *Riella* nouveau pour la France. *Naturalia Monspeliensa* **19**, 43-46.

Duell, R. (1983) Distribution of the European and Macaronesian liverworts (Hepaticophytina). *Bryologicae Beitraege* **2**, 1-114

Lanfranco S. (1990) The Ecology of Freshwater Rockpools in Malta. University of Malta, Faculty of Education. 195pp. Bachelor of Education (Honours) Thesis. (Unpublished)

Lanfranco S. & Schembri P.J. (1995) Ghadira s-Safra: a threatened coastal wetland with and endangered biota. **34**: 127 Monaco: CIESM (1995).

Marin Velasquez, J.A. (1982) Aparicion de *Riella helicophylla* en cultivo de Barro. Influencia de la salinidad en su desarollo. *Collectanea Botanica* **13**, 195 – 200.

Swanson, G.A. (1984) Dissemination of amphipods by waterfowl. *Journal of Wildlife Management* **48**, 988-991.

Thiery, A. (1991) Multispecies coexistence of Branchiopods (Anostraca, Notostraca & Spinicaudata) in temporary ponds of Chaouia plain (Western Morocco): sympatry or syntopy between usually allopoatric species. *Hydrobiologia* **212**, 117-136.

Trabut, M.L. Sur la presence de deux *Riella* en Tunisie: *Riella helicophylla* et *Riella reuteri*. *Bull. Soc. Bot. France* **58**, 171-175

The Central Mediterranean Naturalist | 3 (1): 15 - 16 | Malta, June 1999

A PRELIMINARY LIST OF THE LEUCOSPIDAE OF THE MALTESE ISLANDS (HYMENOPTERA, CHALCIDOIDEA)

Charles Farrugia[1]

ABSTRACT

Four species of Leucospidae are recorded from the Maltese Islands; three of these, *Leucospis brevicauda* Fabricius, 1804, *L. dorsigera* Fabricius, 1775 and *L. intermedia* Illiger, 1807, are recorded for the first time.

INTRODUCTION

The Leucospidae comprise a small hymenopteran family with about 120 species worldwide. It includes many of the largest Chalcidoidea and the species are known to develop as parasites of solitary aculeate Hymenoptera. Boucek (1974) recognized four genera, of which only *Leucospis* is present in Malta. *Leucospis* contains more than 100 species distributed in all continents.

I have had the opportunity to collect and identify several specimens of Leucospidae from the Maltese Islands. In addition, I have examined material deposited in Dr. Martin J. Ebejer's (MJE) private collection. Identifications are based on Boucek (1974).

All specimens have been collected by the author except where indicated. Representative specimens have been deposited at the Natural History Museum, London (NHML) and at the National Museum of Wales (NMW) as indicated. Otherwise the material examined is in the author's private collection.

SPECIES LIST

Leucospis brevicauda Fabricius, 1804

Material examined

Malta: Ghajn Hadid (on *Foeniculum vulgare*) 9.viii.1997, 1♀. Gozo: Ramla Bay, 12.ix.1997 (on *Eryngium maritimum*) 3 ♀♀ (NHML), 1♀ (NMW), 1♂.

Distribution: Portugal, Spain, Southern France, Italy (including Sardinia and Sicily), Turkey, Morocco, Algeria Tunisia, (Boucek, 1974).

Notes: A new record for the Maltese Islands.

Leucospis dorsigera Fabricius, 1775

Material examined

Malta: Wied Babu, 14.vi.1997, 1 ♂; Wied Qannotta, 25.vii.1998, 1♀ (NMW); Wied Babu, 24.viii.1996, 1♂; Wied il-Ghasel, 25.viii.1997 (on *Foeniculum vulgare*) 1♀ (NHML), 1♂ (NHML); Ghajn Tuffieha, 30.viii.1997, 1♀, (NHML); Buskett, 29.viii.1997, 1♂; Slugs Bay, 1.ix.1997, 1♂. Gozo: Ghasri, 27.viii.1995, 1♀ (on *Foeniculum vulgare*) (NMW); Ramla Bay, 12.ix.1997 (on *Eryngium maritimum*), 1♀ (NHML), 1♂.

Distribution: France, Germany, Czechoslovakia, Moldavia, Ukraine, Daghestan, Transcaucasia, Kazakhstan, Turkmenia, Uzbekistan, Tadzhikistan, Morocco, Algeria, Tunisia, Libya, Egypt, Turkey, Syria, Lebanon, Israel, Iraq, Iran, Afghanistan, (Boucek, 1974).

Notes: A new record for the Maltese Islands.

Leucospis gigas Fabricius, 1793 (Fig. 1)

Material examined

Malta: Wied Has-Saptan, 27.iv.1997, 1♀; 20.v.1997, 1♀; 3.vi.1997 [reared from final instar larvae collected on 17.i.1997 from the mud nest of a *Chalicodoma* sp. (Hymenoptera, Megachilidae)], 2♀♀ (NHML), 1♀ (NMW); Marfa Ridge, 10.vii.1987, leg. M.J. Ebejer, 1♀ (MJE), 1♀ (NMW); Marfa Ridge, 12.vii.1987, leg. M.J. Ebejer, 1♀ (MJE).

Distribution: Southern Europe up to Central France, Vienna, Morocco, Algeria, Tunisia, Libya, Egypt, Israel, Turkey, Iran, Afghanistan, Pakistan, Turkmenia, Uzbekistan, Tadzhikistan, Northen China.

Notes: *Leucospis gigas* is known to occur in two forms (Boucek, 1974). One form has yellow and the other orange markings, and they are referred to by Bytinski-Saltz (1963) as form *typica* (yellow) and form *rufonotata* (orange). All specimens examined in the present work belong to the yellow f. *typica*. Schembri (1847) first recorded this species from Malta when he described it as *Leucospis costae*. It is evident that he described the species from male and female specimens of the orange-marked f. *rufonotata*. This points to the occurrence of both forms in the Maltese Islands. Further evidence is provided by Bytinski-Saltz (1963) who

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stated that he had examined specimens of f. *rufonotata* from Malta.

Nikolskaya (1960) also refers to the occurrence of *L. costae* in Malta.

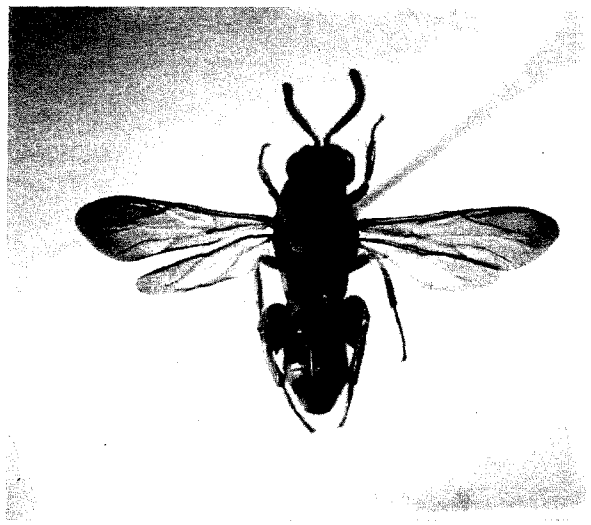

Fig. 1 *Leucospis gigas* f. *typica* Fabricius, ♀. (x 2.5)

Leucospis intermedia Illiger, 1807

Material examined

Gozo: Ramla Bay, 15.viii.1998 (on *Eryngium maritimum*), 1♀ (NMW); Ramla Bay, 12.ix.1997 (on *Eryngium maritimum*), 2♀♀ (NHML), 1♀.

Distribution: Southern France, Southern Switzerland, Austria, Southern Czechoslovakia, Moldavia, Southern Ukraine, Algeria, Libya, Egypt, Israel, Lebanon, Turkey, Iran, Transcaucasia, Turkmenia, Uzbekistan, Tadzhikistan, Northern Afghanistan, (Boucek, 1974).

Notes: A new record for the Maltese Islands.

DISCUSSION

All four species recorded during the present study have a typical West Palaearctic distribution (Boucek, 1974). I have observed *Leucospis dorsigera*, *L. brevicauda* and *L. intermedia* to be abundant on the sand dunes at Ramla Bay in Gozo. *L. intermedia* appears to be restricted to the latter site only and may therefore be considered a threatened species due to the precarious state of the sand dunes.

ACKNOWLEDGEMENTS

I am grateful to Dr. Martin J. Ebejer for allowing me to examine material in his private collection. I also thank Dr. Zdenek Boucek (NHML) for providing me with literature and for his valuable comments. Dr. John S. Noyes kindly allowed me to use the collection at the NHML, while Dr. John Deeming made it possible for me to examine specimens at the NMW. I would also like to thank Mr. David Mifsud for providing me with literature, Mr. David Dandria (Biology Dept., University of Malta) for reading and correcting the manuscript, and Mr. Antoine Zammit (Department of Agriculture, Malta), who took the photograph of *Leucospis gigas*.

(Accepted 15th March, 1999)

REFERENCES

Boucek Z. (1974). A revision of the Leucospidae (Hymenoptera: Chalcidoidea) of the world. *Bulletin of the British Museum (Natural History) Entomology*, London. Supplement **23**, 241pp.

Bytinski-Salz, H. 1963. Geographical variation and sex-ratio in *Leucospis gigas* (Hymenoptera: Chalcidoidea). *Acta Entomologica Musei Nationalis*, Prague. **35:** 527-530.

Nikolskaya, M.N. (1960). Chalcids of fam. Chalcididae and Leucospidae [In Russian] *Fauna SSSR*, 7, 5, 221pp. Moscow & Leningrad.

Schembri, A. (1847). Description d'une nouvelle espece de *Leucopsis*. (sic) *L. costae. Ann. Soc. Ent. Fr. Ser 2. 1847. T. 5. Bull.* p87.

The Central Mediterranean Naturalist	3 (1): 17 - 22	Malta, June 1999

A SURVEY OF BLENNIIDAE, CLINIDAE, AND TRIPTERYGIIDAE (PISCES) IN MALTESE WATERS (CENTRAL MEDITERRANEAN), INCLUDING FOUR PREVIOUSLY UNRECORDED SPECIES

Mark-Anthony Falzon[1]

ABSTRACT

The results of field research undertaken during summer 1998 are reported. Three new species of Blenniidae and one new species of Tripterygiidae are recorded for the first time from the Maltese islands. A fourth species of Blenniidae is recorded for the first time in 150 years. Information on local status, occurrence, and previous records is given for 20 species belonging to the mentioned families of fishes.

INTRODUCTION

This paper reports on the occurrence and status in Maltese waters of twenty species of fish belonging to the families Blenniidae, Clinidae, and Tripterygiidae. It is the result of research conducted during the period June to September 1998.

Compared to other groups, the ichthyology of the Maltese islands has been well studied, with no fewer than seven publications covering the period 1838 to 1993. All authors deal with the family Blenniidae, and all but one with the families Tripterygiidae and Clinidae. Table 1 summarises the literature, and includes only entries based on direct observation and/or examination of specimens by the respective authors. Entries listed explicitly on the authority of previous workers are not included.

The major shortcoming of most previous work was a reliance on specimens found in fishermen's catches and/or randomly taken by the researcher operating a hand net from shore. This has resulted in major omissions: *Lipophrys canevai*, for instance, is a species which tends to spend most of its time hiding in holes and is consequently difficult to take.

METHODS

A great deal of valuable information on the behaviour, ecology, and distribution of individual fish species can be obtained by observing fishes in the wild. Numerous methods for direct observation and recording of fishes in the wild have been developed and the actual techniques used depend on the objectives of the study in question (Gibson 1999: 8).

The present work is based on direct observation. Since most species belonging to the three aforementioned families tend to occur in relatively shallow water, often in very shallow water in the mediolittoral and infralittoral zones, snorkelling was found to be a perfectly adequate means of observation. Observations were carried out at 15 sites around the Maltese coast (Fig 1) and were spread over 34 sessions of approximately one hour each. Notes on physical characteristics, habits, and habitat were taken in the field. Special care was taken in recording structure of tentacles and fins. Various identification keys were used, notably Whitehead *et al.* (eds.) (1986), Bath (1977), Lythgoe & Lythgoe (1991), and Šoljan (1968). Riedl (1991) and Miller & Loates (1997) were useful as general reference works.

RESULTS

Information on the occurrence and status in Maltese waters of twenty species of fish is given. Unless otherwise stated, all descriptions of structure, colour, size, habitat and occurrence are based on the present author's field notes.

BLENNIIDAE

The present work records 12 species of Blenniidae, 3 of which are new to the Maltese islands and a fourth is recorded for the first time in 150 years. A further 4 species and 1 unidentified species were recorded by previous authors and are included at the end of the list. Maltese names, except when underlined, are given as in Lanfranco (1993); the underlined names were coined by the present author.

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Aidablennius sphynx Valenciennes, 1836
Malt: Budakkra lewn iz-zebbug

Common but localised, occurring exclusively in rocky (especially Globigerina limestone platforms), very shallow (generally < 0.5m) bare areas where algal growth is sparse.
Observed characteristics: Characteristic steep, almost vertical, forehead, one pair of fleshy threadlike orbital tentacles, high spiny dorsal fin, and small eyes set well up in head, almost protruding. Basic colour a light yellowish-grey to a light brown, with brown vertical bars edged bluish. There is a conspicuous grey (sometimes bluish) spot edged red behind the eye. Some individual males with a pinkish-orange edge to very high spiny dorsal. Size range 35 to 65 mm.
Distribution: The species is recorded from around the Mediterranean, the Atlantic coast of Morocco, and the Black Sea (Whitehead *et al.* 1986: 1097).

Coryphoblennius galerita Linnaeus, 1758
Malt: Budakkra tal-blat

This species was last recorded in Malta by Trapani in 1838. In this survey, six individuals were noted clinging to the rock face in extremely shallow water, frequently being exposed above water level by wave action. The frequency status of this species is still to be determined.
Observed characteristics: Rather steep forehead and very small eyes. One pair of fleshy orbital tentacles and a very few (compare especially to *Scartella cristata*) filamentous tentacles over nape. Basic colour a light brown with darker vertical bars on body. Conspicuous white upper lip in some specimens. Size range 40 to 70 mm.
Distribution: Mediterranean, Black Sea and from southern Ireland, Cornwall and Brittany southwards to Guinea; also occurs off the Azores and the Canaries (Whitehead *et al.* 1986: 1099).

Lipophrys canevai (Vinciguerra, 1880)
Malt: Budakkra tat-tikki

Recorded for the first time for the Maltese islands. The fact that previous authors fail to record this species is probably due to the lack of direct observation. It is one of the commoner Blenniidae species, occurring in shallow water (generally < 1m) in a variety of rocky habitats, usually to be found hiding in holes (sometimes upside down) with only the head protruding.
Observed characteristics: Body relatively laterally flattened. No observable tentacles. Soft dorsal fin noticeably higher than spiny dorsal fin. Squarish head with very steep forehead and small eyes set high up in head. Colour variable, generally a chocolate brown with darker spots and ill-defined vertical streaks. Sometimes a row of ill-defined white spots along back, just below dorsal fin. Males much darker, with almost black head and yellow red-spotted cheeks and reddish-brown opercula. Size range 55 to 85 mm.
Distribution: Mediterranean and off southern Portugal (Whitehead *et al.* 1986: 1102).

Lipophrys pavo (Risso, 1810)
Malt: Budakkra tal-ghalla

The species is very common but limited to rock pools on the shore.
Observed characteristics: Body laterally flattened. No observable tentacles. Colour a light yellowish-brown with light brown vertical bars edged blue. A dark spot with bluish margin behind eye. Males with rounded, high crest. Size range 40 to 100 mm.
Distribution: The species is recorded in the Mediterranean, Black Sea and Atlantic coasts, from Morocco to mouth of Loire, France. It is also present in the Suez canal (Whitehead *et al.* 1986: 1104).

Lipophrys trigloides (Valenciennes, 1836)
Malt: Buzullieqa

Regular but not common, in very shallow water (< 0.5 m), generally clinging motionless to vertical rock faces in the zone immediately below the waterline.
Observed characteristics: Angular indented head somewhat recalling a Gurnard (family Triglidae). Large eye and well-defined, rounded orbital. No observable orbital tentacles. Basic colour a light olive with dark vertical bars. Size range 40 to 100 mm.
Distribution: Mediterranean, Sea of Marmara and from Brittany southwards to Senegal. Also off Madeira and the Canaries (Whitehead *et al.* 1986: 1105).

Lipophrys basilicus (Valenciennes, 1836)
Malt: Budakkra tal-fond

Not found in the present study. Recorded as common in Maltese waters by Jennings (1979), and considered doubtful by Cilia (1990) and Lanfranco (1993).
Distribution: Western Mediterranean, Adriatic Sea and Izmir (Whitehead *et al.* 1986: 1102).

Parablennius gattorugine (Brünnich, 1768)
Malt: Budakkra tal-qawwi

Regular but not common, generally in shallow water around 0.5 m, but often at greater depths of up to 2.5 m. Tends to prefer rocky areas with substantial algal growth, preferably brown algae such as *Cystoseira* spp. against which the species is well camouflaged.
Observed characteristics: Single pair of orbital tentacles, featherlike in structure, and up to 15 mm in length. Large eyes. Colour a chocolate brown or olive-brownish, with darker vertical bars on body. Size range 50 to 150 mm.
Distribution: To be found in the Mediterranean, Sea of Marmara, and the Atlantic coast from Ireland to Morocco (Whitehead *et al.* 1986: 1107)..

Parablennius incognitus (Bath, 1968)
Malt: Budakkra tal-faxxi

Regular but not common, inhabiting rocky areas, generally in shallow water up to 1 m deep.

TABLE 1. Blenniidae, Clinidae and Tripterygiidae species from Maltese waters hitherto recorded in the literature.

Species	Trapani 1838	Gulia 1861	Despott 1919	Baldacchino 1935	Lanfranco 1958	Jennings 1979	Cilia 1990
Aidablennius sphynx					•		•
Blennius ocellaris	•	•	•		•		•
Coryphoblennius galerita	•						
Lipophrys basilicus						•	
Lipophrys pavo		•	•		•		•
Lipophrys pholis	•	•			(1)		
Lipophrys trigloides					•		•
Parablennius gattorugine		•	•		•		•
Parablennius incognitus							•
Parablennius sanguinolentus				•	•		
Parablennius tentacularis	•		•		•		
Parablennius zvonimiri						•	
Scartella cristata							•
Blennius sp.						•	
Clinitrachus argentatus		•	•		•		(2)
Tripterygion tripteronotus		•			•		(2)

(1) Included in 1958 edition but corrected (omitted) in 1993 edition.
(2) Cilia (1990) does not consider Clinidae and Tripterygiidae.

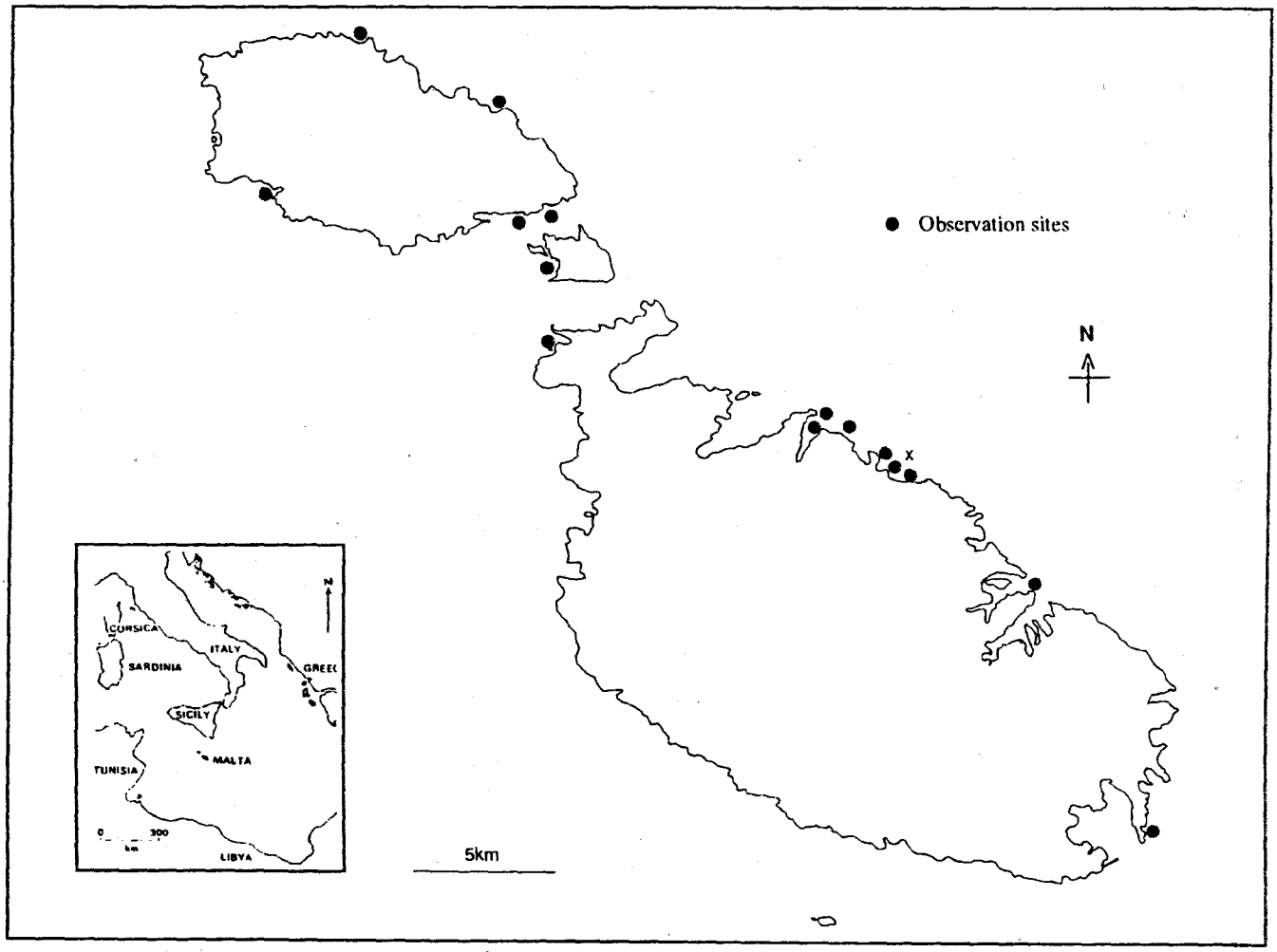

Fig. 1 Sites where observations were carried out.

The species was previously known locally from a single specimen taken in 1972 (Cilia 1990: 6).
Observed characteristics: Single pair of branched (but not featherlike) orbital tentacles. Noticeable notch between spiny and soft dorsal fins. Basic colour a darkish olive-greyish, with darker vertical bars on body. Some specimens (territorial males?) are more colourful, having reddish orbits and a bluish fringe to dorsal fins. Size range 40 to 65 mm.
Distribution: Recorded in the Mediterranean, Black Sea and off Iberian Peninsula to Morocco and the Canaries (Whitehead *et al.* 1986: 1107).

Parablennius pilicornis (Cuvier, 1829)
Malt: Budakkra safra

Recorded for the first time for the Maltese islands. A single record. One individual fish was observed several times in exactly the same spot (Site X on Fig 1, White Rocks, l/o Bahar ic-Caghaq) in August and September 1998. Algal growth in the area, which was rocky, was relatively sparse, and the depth was 1.5 m. The species was noted to be very approachable and was photographed on one occasion.
Observed characteristics: Conspicuous single pair of antler-like orbital tentacles and filiform appendages around nostrils visible at very close range. Large eyes set high in head within well-defined orbitals. Body slim but not laterally compressed, very slightly pot-bellied. No noticeable notch between spiny and soft dorsal fins. Colour a dull golden, making the fish very conspicuous at any distance and unlike any other species of Blenniidae. At very close range, a scattering of reddish-brown small blotches is apparent on lower half of body. Size 85 mm.
Distribution: The species is recorded from the Western Mediterranean, namely southern Spain, Morocco, Algeria. Also occurs in the eastern Atlantic from Portugal to South Africa and off Brazil (Whitehead *et al.* 1986: 1109).

Parablennius rouxi (Cocco, 1833)
Malt: Budakkra tar-rig

Recorded for the first time for the Maltese islands. Two individual fish were observed at White Rocks on one occasion in August 1998. Both were observed at a depth of ca. 5 m, over a sand and soft residue bottom interspersed with outcrops of rock and *Posidonia*.
Observed characteristics: Two sets of orbital and nasal tentacles. Colour unmistakeable, white with dark brown (jet black at distance) stripe from base of caudal fine to eye. Size 70 mm.
Distribution: Northern Mediterranean and off Portugal (Whitehead *et al.* 1986: 1109).

Parablennius sanguinolentus (Pallas, 1811)
Malt: Budakkra hamra

Common. Rather localised, occurring in significantly larger numbers in shallow (< 1 m), completely bare, rocky areas with pebbles and/or medium-sized stones. Often in deeper water, up to ca. 3m. The species is sometimes taken by anglers.
Characteristics: Rudimentary pair of orbital tentacles. No noticeable notch between spiny and soft dorsal fins. Body shape diagnostically pot-bellied. Colour a light greyish-brown with small darker spots on body. Behaviour characteristic, swimming away with a swaying motion rather than hiding when approached. A ca. 170 mm individual (probably a breeding male) with dark purple coloration, dark bluish iridescent pectorals, whitish fleshy tips to anal finrays and a single pair of red orbital tentacles was observed on one occasion in September 1998. Size up to 200 mm.
Distribution: Occurs throughout the Mediterranean, Black Sea, and Atlantic coast from Morocco to Loire, France (Whitehead *et al.* 1986: 1110).

Parablennius zvonimiri (Kolombatovic, 1892)
Malt: Budakkra tal-qroll

Common. Occurs in several types of habitats, but mostly in rocky, shallow areas (ca. 1 m) with short brown algae. Rock faces with red encrusting algae are also favoured. The species is recorded locally to be frequent by Jennings (1979), and of doubtful occurrence by Cilia (1990).
Observed characteristics: Complex orbital and nasal tentacles; most tentacles thin and filamentous, but conspicuous branching set over orbits. Pronounced notch between spiny and soft dorsal fins. Colour variable from a light brown to a chocolate-brown, generally with a row of 5 - 7 yellowish-white spots along back, at base of dorsal fins. Size range 50 to 70 mm.
Distribution: Recorded from several areas around the Mediterranean and Black Sea (Whitehead *et al.* 1986: 1111).

Parablennius tentacularis (Brünnich, 1768)
Malt: Budakkra kannella

Not found in the present study. Recorded by Trapani (1838), noted to be very scarce by Despott (1919), and recorded again by Lanfranco (1958). An unconfirmed sighting was made by the present author in 1995; a single specimen was observed over boulders and sand at a depth of ca. 3 m.
Distribution: Occurs in the Mediterranean, Black Sea, and Atlantic coast from Spain to Senegal and the Canaries (Whitehead *et al.*1986: 1111).

Scartella cristata (Linnaeus, 1758)
Malt: Budakkra tal-frenza

The commonest species of Blenniidae found in Maltese waters. Occurs in rocky areas and tends to hide in holes, occasionally two fish (male and female?) to a hole, in shallow water, (< 0.75 m). In the Honduras and Belize, out of 7 specimens taken in one study, all were taken in less than 3m and 5 were taken in less than 1.5m (Greenfield and Johnson 1981: 72-3). Previously known locally from one specimen taken in 1982 and another in 1987 (Cilia, 1990: 5).
Observed characteristics: Tentacle structure diagnostic - a row of several (>10, often around 20) thin, short, filamentous tentacles on nape from top of orbits to base of dorsal, often somewhat longer in orbital region. Eyes small. Highly variable in colour, from a light olive-brown

to a dark greyish-purple in larger specimens. Darker thin diagonal bars and blotches often present. Size range 60 to 130 mm, generally around 75 mm.
Distribution: Widespread. Occurs in the southern and eastern Mediterranean and from Biscay southward to Congo. Also off the Canaries, Bermuda, Florida, Cuba and Brazil (Whitehead *et al.* 1986: 1112), and from the Honduras and Belize (Greenfield and Johnson 1981: 72-3).

Blennius ocellaris Linnaeus, 1758
Malt: Budakkra tal-Ghajn

Not found in the present study. Recorded by Trapani (1838), Gulia (1861), Despott (1919), Lanfranco (1958), and Cilia (1990). Most authors record it as common. The species is known to occur at moderate depths from 30 m (Whitehead *et al.* 1986: 1098); this presumably explains its absence in the present study.
Distribution: Mediterranean, Black Sea and the Atlantic coast from Morocco to the English Channel (Whitehead *et al.* 1986).

Blennius pholis Linnaeus, 1758
Malt: Buzullieqa

Not recorded in the present study. Recorded by Trapani (1838), Gulia (1831) and Lanfranco (1958). Cilia (1990) attributes these records to *Lipophrys trigloides*, a somewhat similar species; in his 1993 revised edition, Lanfranco adopts this view. Note that in Maltese usage, 'Buzullieqa' often refers to Blenniidae in general and *Parablennius sanguinolentus* in particular.
Distribution: Restricted to the western Mediterranean where it occurs off Southern Spain and the Balearics; found along Atlantic coasts from southern Norway to Morocco and Madeira (Whitehead *et al.*: 1990). Recorded in the Adriatic, but Šoljan (1963) attributes these records to *Parablennius sanguinolentus*, a somewhat similar species.

Blennius sp.

Not recorded in the present study. Jennings (1979) describes a *Blennius* sp. closely resembling *Lipophrys pavo*, with similar body shape and fin structure, no orbital tentacles, no black spot behind eye characteristic of *L. pavo*, and a less pronounced or absent body hump. It is reported to be common in southeastern Maltese waters. Cilia (1990) proposes that this description possibly refers to *Lipophrys fluviatilis* Asso, 1881.

CLINIDAE

One species is recorded.

Clinitrachus argentatus (Risso, 1810)
Malt: Budakkra tal-fidda

This species was observed twice, in very shallow water among dense *Cystoseira* spp. growth. Difficult to observe, and as such frequency status still undetermined.
Observed characteristics: Dorsal fin with very pronounced incision after first few anterior spines. Colour grey-brown with silvery white patches along sides of body. Behaviour diagnostic, 'walking' on ventral fins and clinging to rocks and algae in very shallow water. Size around 85 mm.
Distribution: Mediterranean, Sea of Marmara, Bosphorus and Atlantic coast of Morocco and Portugal (Whitehead *et al.* 1986: 1117).

TRIPTERYGIIDAE

Tripterygion melanurus melanurus (Guichenot, 1845)
Malt: Bzaru sekond

First records for the Maltese islands. The nominate race occurs, as evident from the black spot edged white on the caudal peduncle. Frequent. Generally over rocky / hard substrate areas. Occurs on the vertical sides of boulders at 2 to 5 m depth, favouring dimly lit situations. Encrusting red algae favoured; this species in fact often associates with *Parablennius zvonimiri*.
Observed characteristics: Dorsal fin in three parts. Anterior spiny part dark and conspicuous, often 'flicked' when fish is approached. Eyes large and set in well-defined orbits. Colour red of varying intensity, with dark head appearing marbled at close range. Variable presence of small white spots along back, just below dorsal fin. Easily confused with *Lipophrys nigriceps portmahonsis* Castanos 1933, but fin structure diagnostic. Size generally < 40 mm.
Distribution: The nominate race occurs in the Balearic islands, southern Sardinia, Algeria, Tunisia, Israel, Lebanon, Cyprus, and southern Turkey. *Tripterygion melanurus minor* occurs in France, Tyrrhenian Sea, eastern Sicily, Adriatic Sea, and Aegean Sea. Hybrid populations are known off northern Sicily, Marmaris and Rhodes (Whitehead *et al.* 1986: 1120).

Tripterygion tripteronotus (Risso, 1810)
Malt: Budakkra rasha sewda

Common. Young fish inhabit very shallow areas (< 1 m) over rocky bottoms where algal growth is relatively sparse. Adults generally in deeper water (1.5 - 4 m), near stones and boulders over rocky bottoms. Adult males with black and red coloration rarely recorded after July; colour is probably linked to territoriality, but this needs further investigation.
Observed characteristics: Dorsal fin in three parts. Anterior spiny part dark. More sturdy appearance than *T. melanurus melanurus*. Colour: red body and solid (not marbled) black head in some (territorial?) males and otherwise greenish-brown with ill-defined darker vertical bars. Young specimens greenish with lighter bars, sometimes appearing almost translucent; reddish orbits frequent.
Distribution: Mediterranean and Black Sea (Whitehead *et al.* 1986: 1121).

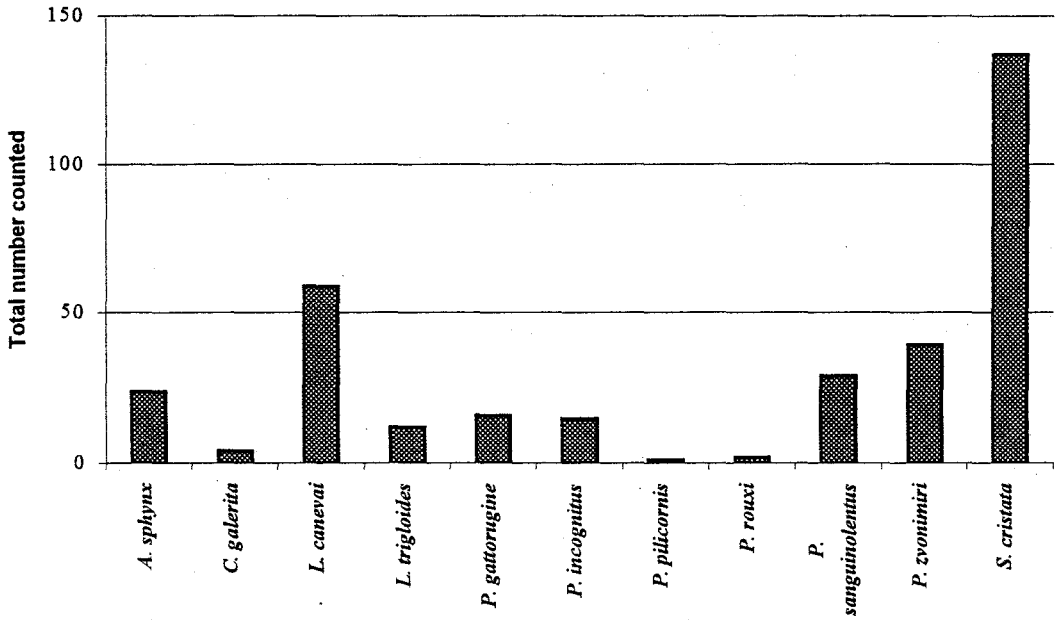

Fig. 2 Frequency of 11 species of Blennidae in a selected area.

DISCUSSION

The relative frequency of species depends to a large extent on the type of habitat where observations are carried out. Site X, the coastal area known as 'White Rocks' on the East coast of Malta (Fig. 1) consists of a variety of microhabitats concentrated in a small area. Data gathered over 8 observation sessions at this site in August 1998 were combined in order to illustrate the relative frequency of species. The results, shown in Fig. 2, are only a rough indication of the status of each species.

ACKNOWLEDGEMENTS

Thanks are due to Dr. David Aldridge of the Department of Zoology, University of Cambridge, for reading an earlier version of this paper, and to Victor Falzon for his help with the figures.

(Accepted 23rd February, 1999)

REFERENCES

Bath, H. 1977. Revision der Blennini (Pisces: Blenniidae). *Senckenbergiana Biologica* 57 (4/6): 167 - 234.

Cilia, J.L. 1990. On Some Previously Unrecorded Blennidae and Gobiidae from Maltese Waters. *The Central Mediterranean Naturalist* Vol. 2 (1): 5-13.

Despott, G. 1919. *The Ichthyology of Malta*. Malta: Critien's Press.

Gibson, R.N. 1999. Methods for Studying Intertidal Fishes. In *Intertidal Fishes: Life in Two Worlds*. M.H. Horn, K.L.M. Martin & M.A. Chotkowski (eds.), pp 7-25. San Diego: Academic Press.

Greenfield, D.W. & Johnson, R.K. 1981. The Blennioid Fishes of Belize and Honduras, Central America, with comments on their Systematics, Ecology, and Distribution (Blenniidae, Chaenopsidae, Labrisomidae, Tripterygiidae). *Fieldiana Zoology* New Series, 8: 1-106.

Gulia, Gavino 1861. *Tentamen Ichthyologiae melitensis sistens methodo naturali stripum objectis nonullis observationibus genera ac species, a recentoribus de re zoologica scriptoribus admissas piscium insularis Melitae*. Malta: Tipographia Anglica.

Jennings, G.H. 1979. *Mediterranean Fishes*. London: Calypso.

Lanfranco, G. 1993. *The Fish around Malta (Central Mediterranean)* (revised edition; first published 1958) Malta: Progress Press.

Lythgoe, J. & Lythgoe, G. 1991. *Fishes of the Sea: the North Atlantic and Mediterranean*. London: Blandford.

Miller, P.J. & Loates, M.J. 1997. *Fish of Britain and Europe*. London: Harper Collins.

Riedl, R. 1991. *Fauna e Flora del Mediterraneo*. Padova: Franco Muzzio.

Šoljan, T. 1963. *Fishes of the Adriatic (Ribe Jadrana)* [originally published in Serbo-Croatian by Nakladi Zavod Hrvatske, Zagreb, 1948]. Belgrade: NOLIT.

Trapani, G. 1838. *A Catalogue of the Different Kinds of Fish of Malta and Gozo, with their Maltese, Latin, Italian, English and French Names, as well as their season*. Malta: Government Press.

Whitehead, P.J.P., Bauchot, M.L., Hureau, J.C., Nielsen, J & Tortonese, E. (eds.) 1986. *Fishes of the North Eastern Atlantic and the Mediterranean*. 3 vols. UNESCO: London.

The Central Mediterranean Naturalist | 3 (1): 23 - 26 | Malta, June 1999

TENEBRIONIDS ASSOCIATED WITH SANDY SHORES IN THE MALTESE ISLANDS (COLEOPTERA, TENEBRIONIDAE)

David Mifsud[1]

ABSTRACT

The tenebrionids associated with sand dune beaches in the Maltese Islands are reviewed. Eleven species are included of which *Xanthomus pallidus* (Curtis) and *Nalassus aemulus* (Küster) are here recorded for the first time. For each species local and global distribution data are provided.

INTRODUCTION

Sandy shores and dunes in most parts of the world support characteristic specialised faunas in several insect groups. Some of the beetle species are herbivores living on plants specific to this type of habitat, but many are carnivores, saprophages, or fungivores (Crowson, 1981). Burrowing is a characteristic habitat of many of the species, both as adults and larvae. Some of the sand dune beetles, notably among the Tenebrionidae, show affinities to species of sandy semi-desert areas inland. For a general overview of coastal sand dunes the work edited by Gimingham *et al.* (1989) should be consulted.

Sandy shores constitute only 2.4% of the Maltese Islands' coastline and are under high pressure from recreational and touristic development. Due to this, most of the entomofauna associated with this type of habitat has almost disappeared. This remarkable decrease in the insect fauna associated with such habitats was already noted during the earlier part of this century (Caruana Gatto, 1925), when a number of previously common beetles were reported as decreasing in number, or even as completely absent. Perhaps the only locality in the Maltese Islands which currently still supports a relatively good assemblage of faunistic and floristic species associated with sand dunes is found at Ramla in Gozo.

The tenebrionid fauna of the Maltese Islands has been recently studied by Mifsud & Scupola (1998) who reported a total of 56 species. Since then, two previously unrecorded tenebrionids were collected from sand dunes at Ramla in Gozo. A complete account of the tenebrionid beetles associated with sand dune beaches in the Maltese Islands is here provided, including ecological, local and general distributional data. Local distributions are mainly reported from Grimm (1986) and Mifsud & Scupola (1998). Some of the tenebrionid species recorded here were included in the Red Data Book for the Maltese Islands (Schembri & Sultana, 1989) and it would probably be appropriate to include the remaining species in future updates.

Material has been deposited in the following institutions and private collections:

DDM David Mifsud private collection, Malta

SMNS Staatliches Museum für Naturkunde, Stuttgart, Germany

MCSN Museo Civico di Storia Natural 'Giacomo Doria', Genova, Italy

NHMB Naturhistorisches Museum Basel, Switzerland

SPECIES LIST

Erodius siculus melitensis Reitter, 1914
[DDM; MCSN; NHMB]

Local distribution. MALTA: Armier Bay, Mellieha Bay, Ghadira, White Tower Bay, Golden Bay. GOZO: Ramla.

E. siculus melitensis is a frequent species in the Maltese Islands. It is often found at the base of sand dune plants. The nominate form occurs on Egadi and Lipari Islands, Central and Southern Italy, Sicily, Dalmatia, Albania, Corfù and Greece.

Cheirodes brevicollis (Wollaston, 1864)

Local distribution. MALTA: Armier Bay.

Only one specimen of *C. brevicollis* has so far been collected from the Maltese Islands (Grimm, 1986). It is a widely distributed species known from the Canary Islands up to Western Pakistan.

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Ammobius rufus Lucas, 1849 [Fig.1]
[DDM; MCSN; NHMB]

Local distribution. MALTA: Armier Bay, Ghajn Tuffieha Bay, Ghadira, White Tower Bay, Golden Bay. GOZO: Ramla. COMINO: Santa Marija Bay.

A. rufus is a frequent species in the Maltese Islands. It is often found under stones embedded in sand or associated with roots of sand dune plants. In Italy it was collected at the base of *Tamarix* and *Ammophila* (Bonometto & Canzoneri, 1970). It is distributed throughout the Mediterranean Basin (Morocco, Corsica, Italy, Sardinia, Sicily and circumsicilian Islands, Santorini Islands and Cyprus) extending to the Black Sea.

Clitobius ovatus (Erichson, 1843)
[DMM; MCSN; NHMB; SMNS]

Local distribution. MALTA: Armier Bay, Ghajn Tuffieha Bay, Mellieha Bay, Marsaskala, M'Xlokk (Balluta). GOZO: Qbajjar (around Qolla l-Bajda).

C. ovatus is a frequent species in the Maltese Islands. It is often found associated with halophytic plants in coastal marshlands especially where such marshes interact with sandy beaches. *Phtora crenata* (Germar) was observed in this same type of habitat, but it is restricted to marshes and never found on sandy beaches. Recently (18.I.1999), in Gozo, hundreds of specimens of *C. ovatus* were observed at the base of *Inula crithmoides* growing in a sandy substratum (coastal). *C. ovatus* is a widely distributed species known from Senegal, Angola, Sahara, throughout North Africa, Turkey, Sicily, Lampedusa, Tchad and Cape Verde Islands.

Trachyscelis aphodioides Latreille, 1809
[DDM; MCSN; NHMB]

Local distribution. MALTA: White Tower Bay, Armier Bay, Paradise Bay, Mellieha Bay, Golden Bay, Ghajn Tuffieha Bay, Gnejna Bay. GOZO: Ramla. COMINO: Santa Marija Bay.

T. aphodioides is a frequent species in the Maltese Islands. It is often found under stones embedded in sand or associated with roots of sand dune plants. It is distributed throughout the Mediterranean Basin, Black Sea, North Africa, Canary Islands and Cape Verde Islands. *T. aphodioides lopadusae* is known from Lampedusa (Koch, 1935).

Phaleria acuminata Küster, 1852
[DDM; MCSN]

Local distribution. MALTA: Ghajn Tuffieha Bay, White Tower Bay, Mellieha Bay. GOZO: Ramla.

P. acuminata is a frequent species in the Maltese Islands. It is distributed in Southern Spain, Balearic Islands, Corsica, Sardinia, Italy, Sicily, Dalmatia, Turkey, Lebanon, Palestine, Egypt, Tripolitania, Tunisia, Algeria and Morocco.

Phaleria bimaculata (Linnaeus, 1767)
[DDM; MCSN; NHMB]

Local distribution. MALTA: Armier Bay, Paradise Bay, Mellieha Bay, Ghadira, Mgiebah Bay, Gnejna Bay, Dragonara, M'Xlokk Bay, Manoel Island. GOZO: Ramla. COMINO: Santa Marija Bay, Blue Lagoon. COMINOTTO: Blue Lagoon.

P. bimaculata is a common species in the Maltese Islands widely distributed in Southern Spain, France, Italy, Elba, Sardinia, Sicily, Lampedusa, Yugoslavia, Albania, Greece, Bulgaria, Rumania, Crimea, Rhodes, Crete, Egypt, Tripolitania, Tunisia, Tangier and Alboran.

Pseudoseriscius cameroni (Reitter, 1902) [Fig. 2]
[DDM; MCSN; SMNS; NHMB]

Local distribution. GOZO: Ramla.

P. cameroni is a rare species endemic to the Maltese Islands, often associated with roots of sand dune plants such as *Pancratium maritimum*. It was previously reported from Mellieha Bay in Malta (Cameron & Caruana Gatto, 1907), where it now seems to be extinct.

Gunarus parvulus (Lucas, 1849)

Local distribution. MALTA: Mellieha Bay.

Only one specimen of *G. parvulus* was so far collected (on *Acacia*) from the Maltese Islands (Grimm, 1986). *G. parvulus* is known from Morocco, Tunisia, Balearic Islands, Spain (Andalusia), Sardinia, Adriatic Italy, Sicily and Ionian Islands.

Xanthomus pallidus (Curtis, 1830)

Local distribution. GOZO: Ramla.

Material examined. GOZO, Ramla, 18.I.1999, 2 exs., Leg. D. Mifsud (DMM).

X. pallidus is a new record for the Maltese Islands and could be a rare species. The two specimens were found under sand, possibly associated with roots of *Ammophila arenaria*. The ecology of *X. pallidus* and the closely related *X. pellucidus* (Mulsant) was discussed in detail by Binaghi & Ghidini (1957). Future work could also reveal the presence of *X. pellucidus* and *Halammobia pellucida* (Herbst), since all the above mentioned species often occur together. In Italy these two latter species are found in more protected sand dune systems where colonisation by *Euphorbia paralis* begins (Binaghi & Ghidini, 1957). *X. pallidus* is known from Holland, United Kingdom, France, Spain, Madeira, Italy, Sicily, Lampedusa, Corsica, Algeria and Morocco. Canzoneri (1959) described *X. pallidus residuus* from Northern Italy (Venezia) and *X. pallidius ghidinii* from coasts along Southern Italy.

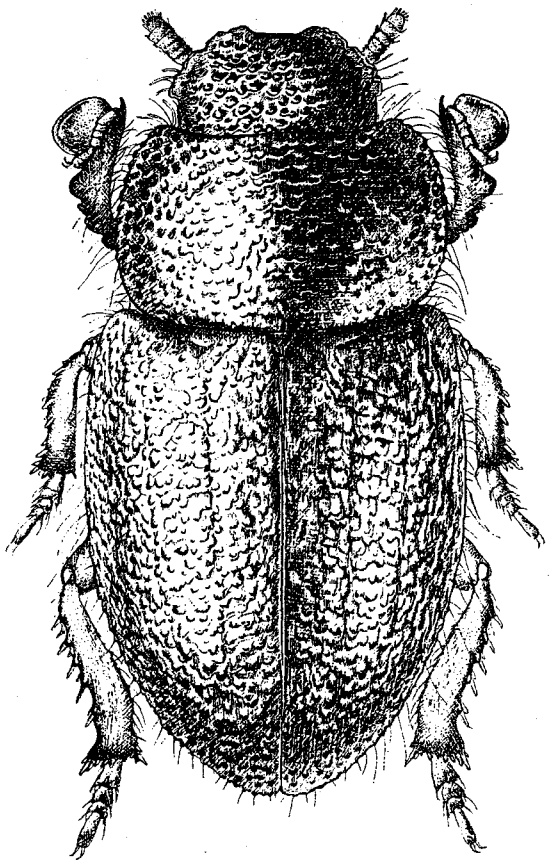

Fig. 1 *Ammobius rufus* Lucas (after Bonometto & Canzoneri, 1970).

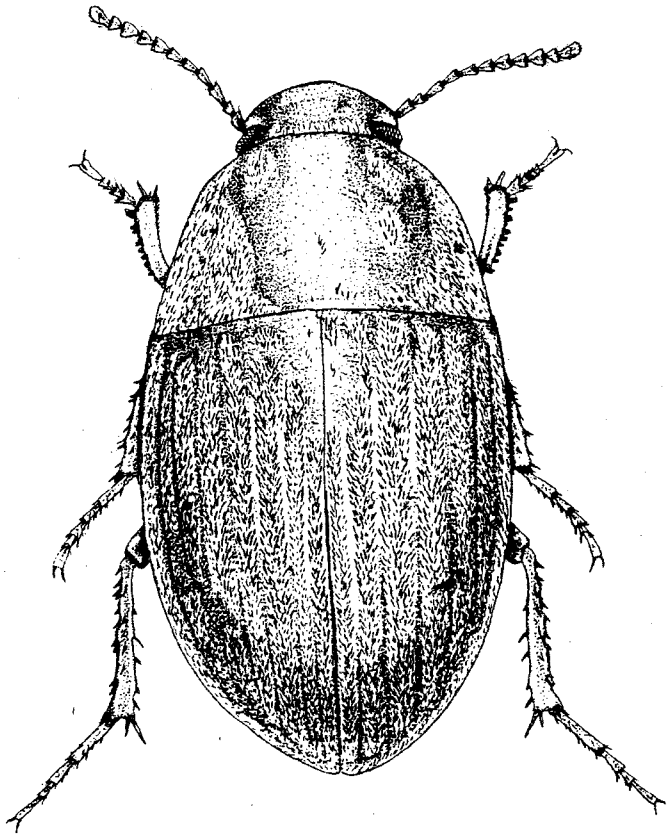

Fig. 2 *Pseudoseriscius cameroni* (Reitter) (after Mifsud & Scupola, 1998).

Nalassus aemulus (Küster, 1850)

Local distribution. GOZO: Ramla.

Material examined. GOZO, Ramla, 18.I.1999, 10 exs., Leg. D. Mifsud (DMM; NHMB; SMNS).

N. aemulus is a new record for the Maltese Islands and like the preceding species could be locally rare. The population found in Gozo was in close association with the basal parts of *Ononis natrix ramosissima*. *N. aemulus* is known from Central Italy, Sicily, Tripoli, Tunisia, Pelagic Islands, Linosa, Algeria, Southern Spain and Balearic Islands. *N. aemulus calaritanus* was recently described from Sardinia (Leo, 1985).

ACKNOWLEDGEMENTS

I would like to thank a number of colleagues who in some way or other helped me during the preparation of this work. I am grateful to Dr Wolfgang Schawaller (Stuttgart) and to Dr Richard Heinertz (Basel) for their help and assistance in identifying the new material collected. I also thank Dr Andrea Liberto (Rome) for providing me with important information.

(Accepted 10th April, 1999)

REFERENCES

Binaghi, G. & Ghidini, G. M. (1957) Sui *Cylindronotus (Xanthomus) pallidus* Curt. e *pellucidus* Muls. del Litorale Toscano (Coleopt.:Tenebrionidae). *Bollettino della Società Entomologica Italiana*, Genova, **87** (5-6): 87-90.

Bonometto, L. & Canzoneri, S. (1970) I Tenebrionidae delle spiagge e dune del litorale di Venezia. *Bollettino del Museo Civico di Storia Naturale di Venezia*, **20-21**: 223-231.

Cameron, M. & Caruana Gatto, A. (1907) A list of the Coleoptera of the Maltese Islands. *Transactions of the Entomological Society of London*, **59** (3): 383-403.

Canzoneri, S. (1959) Note sugli *Xanthomus* Muls. (Coleoptera, Tenebrionidae). *Bollettino della Società Entomologica Italiana*, Genova, **89** (9-10): 145-148.

Caruana Gatto, A. (1925) Sulla straordinaria diminuzione della entomofauna nella spiaggia delle baie di Marsa, Marsascala, e San Giorgio di Birzebbugia. *Archivum melitense*, Malta, **6** (4): 161-164.

Crowson, R. A. (1981) *The Biology of the Coleoptera*, London, Academic Press, 802 pp.

Gimingham, C. H., Ritchie, W., Willetts, B. B. & Willis, A. J. (1989) Coastal Sand Dunes. *Proceedings of the Royal Society of Edinburgh*, **96** (Sec. B), 1-314.

Grimm, R. (1986) Tenebrionidae vom Maltesischen Archipel (Insects: Coleoptera). *Stuttgarter Beiträge zur Naturkunde*, (Serie A), **392** (17S): 1-17.

Koch, C. (1935) Wissenschaftliche Ergebnisse der entomologischen Expedition Seiner Durchlaucht des Fuersten A. della Torre e Tasso nach Aegypten und auf die Halbinsel Sinai VII. Tenebrionidae (Coleoptera). *Bulletin de la Société Royale Entomologique d'Egypte, Le Caire*, **19**: 2-111.

Leo, P. (1985) Le popolazioni Italiane di *Nalassus aemulus* (Küster) e descrizione di una nuova razza della Sardegna (Coleoptera Tenebrionidae Helopinae). *Bollettino del Museo Civico di Storia Naturale di Verona*, **12**: 141-148.

Mifsud, D. & Scupola, A. (1998) The Tenebrionidae (Coleoptera) of the Maltese Islands (Central Mediterranean). *Annali del Museo Civico di Storia Naturale "G. Doria"*, Genova, **XCII**: 191-229.

Schembri, P.J. & Sultana, J. [Eds.] (1989) *Red data book for the Maltese Islands*, Department of Information, Valletta, Malta, viii + 142 pp., 8 pls.

The Central Mediterranean Naturalist | 3 (1): 27 - 28 | Malta, June 1999

NOTES ON THREE CARABIDS COLLECTED FROM THE MALTESE ISLANDS (COLEOPTERA, CARABIDAE)

David Mifsud[1] & Augusto Vigna Taglianti[2]

ABSTRACT

Following the recent work on the carabid fauna of the Maltese Islands (Magrini & Schembri, 1997), *Campalita olivieri* Dejean and *Somotrichus elevatus* (Fabricius) are here recorded for the first time. The record of *Ocydromus andreae* (Fabricius) by Magrini & Schembri is incorrect and should refer to *Ocydromus atlanticus* (Wollaston).

INTRODUCTION

The carabid fauna of the Maltese Islands has been recently studied by Magrini & Schembri (1997) who reported a total of 125 species. The occurrence of seven additional species was indicated as doubtful for the Maltese Islands. It is outside the scope of the present note to provide new collecting data on previously recorded species or to supply new information on species cited by previous authors (eg. Cameron & Caruana Gatto, 1907) which were not confirmed by the recent study of Magrini & Schembri (1997). In the present work, data on three interesting carabids will be provided. Material has been deposited in the following institutions and private collections:

AVTI Augusto Vigna Taglianti, Università di Roma 'La Sapienza', Italy

DMM David Mifsud private collection, Malta.

SPECIES LIST

Campalita olivieri Dejean, 1831

Material examined. MALTA, Valletta, 24.XII.1997, 1 ex., Leg. C. Farrugia & D. Mifsud (DMM).

One live female specimen was collected in a rather busy street in the capital city of Valletta. The specimen was only slightly damaged, probably due to human activity. Only two records of this carabid beetle have so far been reported from Europe. One dead specimen in a good state of preservation was found on Lampedusa (Vigna Taglianti, 1993, 1995) and another record was reported from Southern Spain (Zaballos & Jeanne, 1994). Both these records are probably accidental and Vigna Taglianti (1995) suggested that *C. olivieri* could occasionally and irregularly fly from North Africa to Europe, or be transported there through the agency of wind or predators. *C. olivieri* is distributed in the desertic and sub-desertic regions from the Atlantic Islands up to North Western India.

Ocydromus (Peryphus) atlanticus (Wollaston, 1854)

Material examined. GOZO, Qbajjar (around Qolla l-Bajda), 15.VI.1991, 3 exs., Leg. D. Mifsud (DMM; AVTI).

[One of these three specimens was given on loan for study and to be included in the work of Magrini & Schembri (1997). This specimen was unfortunately destroyed through insect infestation, as was most of the other carabid material (Schembri, S., *personal communication*, 1999)]

The three specimens of *O. atlanticus* were collected under a large stone near brackish water pools. Unfortunately, this species was misidentified by Magrini & Schembri (1997) as the somewhat similar *O. andreae* (Fabricius, 1787).

O. atlanticus was originally described from material collected in Madeira and was subsequently reported from the Canary Islands (Machado, 1992). We ascribe the Maltese specimens to the subspecies *megaspilus* (Walker, 1871), described from Sinai: it is widely distributed in Northern Africa, known from Mauritania, Morocco, Algeria (Hoggar), Egypt and Ethiopia (Antoine, 1955), and from Saudi Arabia and Yemen (Basilewsky, 1979). It is also known from the Eastern Mediterranean area, in Jordan, Syria and Black Sea (from Bulgaria it had been described as *serdicanus* Apfelbeck, 1904, synonym of *megaspilus*) (Hieke & Wrase, 1988). In their checklist of the Carabidae of Russia and adjacent lands, Kryzhanovskij *et al.* (1995) recorded this species from Crimea, Ciscaucasia, Caucasus, Kazakhstan, Turan, Kopetdagh, Tian-Shan and mountains of SE Middle Asia.

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O. atlanticus is frequent and typically found in small springs, on muddy, often brackish soils, while *O. andreae*, a South-European riverine species, is associated with sandy streams and rivers of low and medium altitude.

Somotrichus elevatus (Fabricius, 1787)

Material examined. MALTA, Msida (Tal-Qroqq), 20.VI.1995, 1 ex., Leg. C. Farrugia (AVTI); Marsa (Ghammieri), 4.XI.1996, 1 ex., Leg. D. Mifsud (DMM).

Both specimens were attracted to light. In Italy, (Binaghi, 1948), *S. elevatus* is known from a single record collected at the port of Genova while searching through remains of imported grains infested with weevils and tenebrionid beetles. The same author reports that *S. elevatus* has been introduced in several territories and is currently almost cosmopolitan in distribution. It was reported as common in Eastern Africa and South East Asia. In Eastern Africa (Tanzania), *S. elevatus* was collected in caves on bat guano ("grottes du Kulumuzi près Tanga"- Alluaud, 1916).

ACKNOWLEDGEMENTS

We would like to thank a number of colleagues who in some way or other helped us during the preparation of this note. We thank Dr Richard Heinertz (Basel) for identifying *Campalita olivieri* and for providing important information, Dr Charles Huber (Bern) for providing useful information and Mr. Charles Farrugia (Malta) for donating his carabid material.

(Accepted 22nd April, 1999)

REFERENCES

Alluaud, C. (1916) Coléoptères des iles Mascareignes et Séchelles. Cicindelidae et Carabidae. *Annales de la Société entomologique de France*, **85**: 37-90.

Antoine, M. (1955) Coléoptères Carabiques du Maroc (Première partie). *Mémoires de la Société des Science Naturelles et Physiques du Maroc*, Nouvelle Série, Zoologie, **1**: 177 pp.

Basilewsky, P. (1979) Insects of Saudi Arabia Coleoptera: Fam. Carabidae. *Fauna of Saudi Arabia*, **1**: 141-146.

Binaghi, G. (1948) Note di Caccia (III) (Coleoptera). *Bollettino della Società Entomologica Italiana*, Genova, **78** (7-10): 77-79.

Cameron, M. & Caruana Gatto, A. (1907) A list of the Coleoptera of the Maltese Islands. *Transactions of the Entomological Society of London*, **59** (3): 383-403.

Hieke, F. & Wrase, D.W. (1988) Faunistik der Laufkäfer Bulgariens (Coleoptera, Carabidae). *Deutsche entomologische Zeitschrift*, (n.f.) **35** (1-3): 1-171.

Kryzhanovskij, O. L., Belousov, I. A., Kabak, I. I., Kataev, B. M., Makarov, K. V. & Shilenkov, V. G. (1995) A Checklist of the Ground-Beetles of Russia and Adjacent Lands (Insecta, Coleoptera, Carabidae) *Series Faunistica* No. 3. Pensoft Publishers, Sofia-Moscow. 271 pp.

Machado, A. (1992) Monografia de los Carabidos de las Islas Canarias (Insects, Coleoptera). *Instituto de Estudios Canarios*, La Laguna, 734 pp.

Magrini, P. & Schembri, S. (1997) A topographic catalogue of the Carabidae of the Maltese Islands (Coleoptera). *Bollettino della Società Entomologica Italiana*, Genova, **129** (3): 213-234.

Vigna Taglianti, A. (1993) *Coleoptera Archostemata, Adephaga 1 (Carabidae).* In: Minelli, A., Ruffo, S. & La Posta, S. [Eds.] Checklist delle specie della fauna italiana, **44**. Calderini, Bologna.

Vigna Taglianti, A. (1995) Coleoptera Carabidae. In: Massa, B. [Ed.]. Arthropoda di Lampedusa, Linosa e Pantelleria (Canale di Sicilia, Mar Mediterraneo). *Naturalista siciliano*, Palermo, **19** (Suppl.), 357-421.

Zaballos, J. P. & Jeanne, C. (1994) Nuevo Catalogo de los Carabidos (Coleoptera) de la penunsula iberica. *Monografias Sociedad Entomológica Aragonesa*, Zaragoza, **1**: 159 pp.

The Central Mediterranean Naturalist | 3 (1): 29 - 34 | Malta, June 1999

INTRODUCED SAP-FEEDING INSECT PESTS OF CROP PLANTS IN THE MALTESE ISLANDS

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ABSTRACT

Sap-feeding insects within Hemiptera and Thysanoptera are some of the most important crop pests world-wide. Apart from the loss of yield they cause by sap depletion, saliva toxicity and soiling of the leaves, some species transmit serious plant virus diseases. Important sap-feeding species that have been introduced to the Maltese Islands include the whitefly *Bemisia tabaci*; the scale insects *Pseudococcus longispinus*, *Planococcus citri* and *Icerya purchasi*; the aphids *Aphis gossypii*, *Aphis spiraecola*, *Myzus persicae* and *Viteus vitifoliae*; and the thrips *Frankliniella occidentalis* and *Heliothrips haemorrhoidalis*. For each of these pests information is provided on area of origin, present distribution, host-plant range and virus disease transmission. Control strategies undertaken in the Maltese Islands are described where relevant. Some general considerations on quarantine measures are discussed.

INTRODUCTION

Sap-feeding insects include true bugs, cicadas, whiteflies, jumping plant-lice, scale insects, aphids and thrips. Not all members of these mentioned insect groups are sap-feeding; some exceptions include bed-bugs and assassin bugs which are either adapted to suck the blood of vertebrates or are predators of other insects.

Sap-feeders are usually small insects and reliable identification requires expert knowledge. They are also difficult to detect at quarantine points and are therefore easily introduced to new territories. Their feeding damage can be troublesome to agricultural crops in various ways:

- They pierce and injure plant tissues while feeding, and damage plants by sap depletion thus reducing productivity by direct consumption of carbohydrates and other nutrients transported in the phloem. Sometimes injected saliva may cause leaf drop, stunting or distortion of growth or even galling, debilitating the plant and making ornamental plants unsaleable;
- Adults of mobile sap-feeding insects can carry a number of important plant virus diseases from one plant to another;
- Some sap-feeding insects, particularly members of the Sternorrhyncha (i.e. aphids, scale insects, jumping plant-lice and whiteflies) excrete sugary honeydew which coats nearby surfaces and provides a substrate for growth of unsightly sooty moulds. These deposits and growths block light and air from the leaves, impairing photosynthesis and reducing produce quality and quantity. Severe fouling may make plants and produce unmarketable.

Most of these insect groups favour humid, warm and dry conditions, while excessive heat or dryness is avoided. Cold climate and heavy rainfall causes high mortality by washing the insects off the plant. Most sap-feeding insect pests are spread from one country to another through human transport of infested plant material. Inherently, small islands have fewer insect pests than continental countries, but their small agricultural industries are more vulnerable to the impact of any introduced pest. Small island states often do not have appropriate records of insects already present, so that new introductions often go unnoticed until it is too late to take control measures for eradication of the introduced pests.

There are very few published works which mention introduced insect pests in the Maltese Islands. Saliba (1963) provided a comprehensive list of insect pests on crop plants in the Maltese Islands but did not mention introduced species. Other works (Borg, 1922, 1932; Mifsud, 1995, 1997) provided brief information on some introduced insect pests. More recently, a number of introduced insects were cited (Schembri & Lanfranco, 1996) in the work edited by Baldacchino & Pizzuto (1996) on alien species of flora and fauna of the Maltese Islands.

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The following account is intended to present data on some of the most important introduced sap-feeding insect pests in the Maltese Islands.

Thrips or Thunder-flies (Thysanoptera)

Thrips are very small insects; both immature and adults can crawl about but the adults also fly actively. Thrips are gregarious and lacerate plant cells to feed on their contents, often causing distinctive brown or silver patches in lines on leaves and petals, disfiguring or distorting the plant and sometimes reducing productivity and fruit set. Distinctive specks of faeces are often left on leaf surfaces, but no honeydew is produced. Plant virus diseases are sometimes transmitted via the mouthparts of thrips. Predators such as ladybird beetles, anthocorid bugs, ants, spiders and predatory thrips are often effective in keeping thrips populations low. Almost nothing has been published on the thrips fauna of the Maltese Islands; however, this group is currently under study. Two economically important species known to have been introduced to the Maltese Islands are *Frankliniella occidentalis* and *Heliothrips haemorrhoidalis* (Mifsud, 1997; Watson & Ismay, 1994).

Frankliniella occidentalis Pergande – Western Flower Thrips

This species originated in North America (Canada, Mexico and continental USA) (Anon., 1992a). It began spreading internationally in the early 1980s and has now reached all continents, spreading across north-western Europe (particularly on Chrysanthemums) and reaching Africa in 1989 (CIE, 1993). It is not known when it was introduced in the Maltese Islands. The Western Flower Thrips is a polyphagous species; it often attacks flowers, causing serious damage to seed crops, cut flowers, nursery stock, peaches, plums, nectarines, strawberries, sweet peppers, grapes, cotton and many other crops. In Malta it is a particular problem in flower nurseries, causing discoloration and scarring of open blooms, especially in carnations. Tomato Spotted Wilt Virus (TSWV) is one of the most important diseases of tomatoes, causing losses up to 100%. The rate of spread of TSWV greatly increased during the 1980s (Roselló *et al.*, 1996), about the same time as the arrival of the Western Flower Thrips, which is now regarded as the most important vector of this virus. TSWV has so far been recorded in greenhouses on *Dahlia* and *Gerbera* in the North-western parts of Malta (Mgarr and St. Paul's Bay) (Wheeler, 1958, 1994).

Heliothrips haemorrhoidalis Bouché – Greenhouse Thrips

The Greenhouse Thrips is a native of tropical America but now has a virtually cosmopolitan distribution, occurring out of doors between 45 degrees North and 40 degrees South, and under glass in more temperate regions (CIE, 1964). Probably the species arrived in the Maltese Islands only recently. It is highly polyphagous, attacking leaves with a relatively low nitrogen content, causing bleached patches and leaving black faecal spots on the lower leaf surface (Watson *et al.*, 1995). The impact of this pest in the Maltese Islands is still being investigated. Large populations have been found on cultivated *Viburnum* sp. grown in the open in the Southern parts of Malta (Zabbar).

Whiteflies (Hemiptera, Aleyrodoidea)

Adult whiteflies resemble minute moths about 1 mm long, having two pairs of wings normally coated with white powder, but occasionally darkly pigmented. Adults fly very actively when disturbed. The immature stages are immobile (except for the first instar larvae commonly referred to as crawlers) and are usually found on the lower leaf surfaces, sometimes surrounded or covered by transparent or whitish waxy secretions. The last larval instar, the 'pupal case', is used for identification purposes. Most whitefly species (nymphs) excrete sugary honeydew droplets that tend to coat surrounding surfaces, encouraging sooty moulds to grow. Heavy infestations may cause leaf-drop and yellowing due to sap depletion and saliva toxicity. Adults of some species are efficient vectors of serious plant virus diseases. Populations may be successfully regulated by natural enemies such as parasitic wasps, neuropteran larvae and ladybird beetles. The whitefly fauna of the Maltese Islands totals 13 species and is well documented (Mifsud, 1995; Mifsud & Palmeri, 1996; Rapisarda *et al.*, 1996). Probably, four species are relatively recent introductions to the Maltese Islands. *Aleurothrixus floccosus* (Maskell) and *Dialeurodes citri* (Ashmead) are mainly associated with citrus trees, which are not cultivated on a large scale, so their agricultural importance locally is limited. *Trialeurodes vaporariorum* (Westwood), the greenhouse whitefly, is also of moderate importance. The most economically important pest species is *Bemisia tabaci*. Mifsud *et al.*, (1995) mentioned naturally occurring whitefly parasites found in the Maltese Islands.

Bemisia tabaci Gennadius (*s.l.*) – Sweetpotato or Silverleaf Whitefly

The origin and identity of this damaging pest is uncertain and controversial. Possibly, *B. tabaci* originated in India (Fishpool & Burban, 1994), but it has been present in several parts of the world for at least 100 years and it may be indigenous in some places, e.g. the Mediterranean basin. Early damage by the insect was reported initially from India, Sudan and Israel. Two significant events are worth mentioning. During 1970-79, the insect caused outbreaks first in Sudan, then in the Middle East and later in southwestern America. Another outbreak occurred in 1986 in Florida; there has since been a worldwide epidemic. Today, the geographic range of the pest ranges from temperate countries like Japan, Canada and the Netherlands (on greenhouse crops), throughout most of the world's subtropical and tropical countries (Anon., 1992b; CIE, 1986). Recently, even Australia has reported greenhouse problems with *Bemisia*. Biochemical and biological evidence suggests that what was regarded as a single species is actually a complex of biotypes or separate species (De Barro, 1995; Brown *et al.*, 1995). A pesticide-resistant biotype, biotype B, which causes silvering of cucurbit leaves in high infestations, was first recognized in

the mid 1980s as particularly damaging, due to its high polyphagy, high fecundity and efficiency as vector of plant geminivirus diseases. Originally recorded in Israel, it soon spread to the Caribbean, Africa and India and is now present on all temperate and tropical continents. It causes crop losses globally worth hundreds of millions of dollars every year, and is extremely difficult to control. This biotype B, commonly referred to as the silverleaf whitefly or ponsietta strain, has been recently described as a separate species *B. argentifolii* (Bellows *et al.*, 1994); however, this population cannot be identified reliably except by specialist biochemical methods, and most workers are continuing to refer to it as biotype B (De Barro, 1995).

B. tabaci is considered as the most common and important whitefly vector of plant viruses throughout the world. It is the only known whitefly vector of geminiviruses (Brunt, 1986; Dufus, 1987; Harrison, 1985).

In the Maltese Islands, the species has been known as a pest of tomatoes since 1993 and was recorded on several crops (Anon., 1993; Mifsud, 1995; Saliba, 1993). So far, the major damage was reported in tomato crops, due to the spread of the Tomato Yellow Leaf Curl Virus (TYLCV). In addition to the use of pesticides, control of this pest in greenhouses has involved introduction of natural enemies (Mifsud, 1997) and exclusion of adults from greenhouses by covering the vents with fine mesh.

Scale Insects (Hemiptera, Coccoidea)

The pest scale insects discussed below are all soft-bodied insects coated with white waxy secretions, up to 12 mm long. They feed on plant sap, occurring singly or in colonies on plant stems, leaf undersides and sometimes on developing fruit. Honeydew is often excreted and sooty mould may develop on nearby plant surfaces. Plants may be damaged by sap depletion or by the effects of fouling with honeydew and sooty mould. Local dispersal is by locomotion of the smallest immature stage or by transport by wind or animals. Scale insects are not normally vectors of plant virus diseases. Populations may be regulated by parasites or through predation by ladybird beetles, birds and neuropteran larvae.

The scale insect fauna of the Maltese Islands was studied quite extensively (Borg, 1919, 1932) with some 60 species recorded. No further work was done on this economically important group until the present authors made recent surveys, and an updated list is currently being prepared (Mifsud & Watson *in prep.*). A number of scale insect pests were introduced to the Maltese Islands with citrus cultivation. These include species such as *Ceroplastes floridensis* Comstock, *Saissetia coffeae* (Walker), *Aonidiella aurantii* (Maskell), *Lepidosaphes* spp. and *Parlatoria* spp. These are not discussed further here, as they are mostly confined to citrus. More information on these pests is available in Borg (1919, 1922, 1932) and Mifsud (1997). The scale insects discussed below attack commercial crops in the Maltese Islands.

Icerya purchasi Maskell – Cottony Cushion Scale

This insect originated in Australia but reached California in 1868 (Bartlett, 1978a) and has since spread around the world to become virtually cosmopolitan, occurring in greenhouses in many temperate countries (CIE, 1971). Cottony Cushion Scale is polyphagous but is noted as a pest of fruit trees including citrus. Heavy infestations can kill branches by sap depletion and sooty mould damage. *I. purchasi* entered the Maltese Islands on some ornamental plants from Sicily in 1907/8 and was first observed in a few gardens at St. Julian's from where it spread to Sliema and Msida and then throughout the islands in less than three years (Borg, 1919, 1922). The ladybird beetle *Rodolia cardinalis* (Mulsant) was introduced during this time as a biological control agent and is still a means of control against this pest (Mifsud, 1997). Cottony Cushion Scale is a common pest of fruit trees, especially citrus, in the Maltese Islands. The most common control measure used in the islands involves surface oil sprays mixed with insecticides.

Planococcus citri (Risso) – Citrus Mealybug

This species is probably the most economically important and cosmopolitan species of mealybug; its origin is obscure but may possibly have been in China (Bartlett, 1978b). There are very few parts of the world where it does not occur, either in the field in warm climates or on protected crops in temperate regions (CIE, 1969a). The species is polyphagous, especially in protected cultivation, but in field conditions it shows a strong preference for citrus and is only rarely found on other hosts, e.g. grapevines in the Mediterranean region (Cox, 1989). In the Maltese Islands, *P. citri* attacks mainly citrus but is also occasionally found on vines. However, most damage observed on grapevines in the Maltese Islands is due to a probably native species, *P. ficus* (Signoret), which is also known to attack other crops. These two mealybug species are extremely difficult to separate even with the aid of microscope slide mounts (Cox, 1989). Control measures against Citrus Mealybug in Malta are similar to those for the Cottony Cushion Scale. In other countries, Citrus Mealybug in protected crops is often controlled using parasites.

Pseudococcus longispinus (Targioni Tozzetti) – Long-tailed Mealybug

This species differs from the *Planococcus* species discussed above, in having the marginal white wax projections much longer at the posterior end than on the sides, hence the name. The origin of this species is unknown; it is almost cosmopolitan, occurring in the field in warm countries and in greenhouses in temperate regions (CIE, 1984). The Long-tailed Mealybug is highly polyphagous, frequently occurring on ornamentals, citrus and other fruit trees; heavy infestations of branches can cause fruit drop due to sap depletion (Bartlett, 1978b). *P. longispinus* is a virus vector on grapevines. It transmits viruses associated with leafroll symptoms (Petersen & Charles, 1997) and stem pitting (Rosciglione & Gugleri, 1986). In the Maltese Islands, large populations of this mealybug have been recorded causing extensive damage to

several crops including *Citrus* spp., *Ficus* spp., *Prunus* spp. and others. Control measures are similar to the previously mentioned species. Populations in open fields can be regulated by natural enemies.

Aphids or Plant-lice (Hemiptera, Aphidoidea)

Aphids are small, soft bodied insects about 1-5 mm long. They often form dense colonies on the growing points of plants, either on shoots or underground on the roots, and feed on plant sap. They excrete sugary honeydew, often causing sooty mould growth and sometimes attracting ants to attend them. Plants may be damaged by sap depletion (causing wilting), saliva toxicity (causing leaf yellowing and death or galling) or through the effects of sooty mould growth. Many aphids reproduce asexually in warm dry conditions, giving birth to live young, so minimising the time between generations. All stages are capable of walking short distances; the adults may be wingless or winged. Dispersal over long distances is by flight of winged adults assisted by winds. Aphids, particularly the mobile winged forms, are important vectors of plant virus diseases. Populations are regulated by natural enemies such as parasitic wasps and by predators such as ladybird beetles and syrphid, cecidomyiid and neuropteran larvae. Very little has been published on the aphid fauna of the Maltese Islands. Some species causing plant galling have been recorded by Caruana Gatto (1926), while Saliba (1963) gave a list of aphid pests occurring in the Maltese Islands. In recent years, the present authors have collected numerous aphids and estimate that over one hundred species occur locally.

Aphis spiraecola Patch – Green Citrus Aphid

The species probably originated in the Far East but has spread widely in citrus-growing parts of the world during this century, arriving in North America in the early 1900s, Australia in 1926, New Zealand in 1931, the Mediterranean region around 1939 and in Africa in 1961 (CIE, 1969b). The aphid is polyphagous but prefers woody hosts, including ornamentals and citrus. In the Maltese Islands it was collected on apple, pomegranate and citrus. Colonies on young shoots often cause curling of the leaves, which may protect the aphids from heavy rain. Green Citrus Aphid is an inefficient vector of the important citrus virus disease, Citrus Tristeza Virus, and is known to transmit at least six other virus diseases (Blackman & Eastop, 1984).

Aphis gossypii Glover – Melon or Cotton Aphid

There is uncertainty about the area of origin of this aphid, which is now virtually cosmopolitan (CIE, 1968). It is particularly abundant in tropical countries; in colder climates it is confined to greenhouses, where it can be a major pest. It is highly polyphagous, feeding on the leaf undersides of mostly herbaceous host-plants including vegetables and other crops; it is particularly damaging to cucurbits and cotton. The species is known to transmit over 50 plant virus diseases (Blackman & Eastop, 1984), some affecting a number of important crops. In the Maltese Islands, it is an important pest on several crops including potatoes, marrows, cut flowers, aubergines, cucumbers and citrus. Most local control measures still involve application of various insecticides.

Myzus persicae (Sulzer) – Green Peach or Peach-Potato Aphid

This species is probably of Asian origin but now occurs world-wide (Blackman & Eastop, 1984). In temperate climates it usually overwinters in the sexual form on its primary host, peach and related *Prunus* species and hybrids; during summer, it is highly polyphagous on secondary hosts in over forty plant families, including many important crop plants. *M. persicae* is known to transmit over one hundred plant virus diseases (Kennedy *et al.*, 1962). Persistent viruses transmitted include beet mild yellowing, pea leaf roll, potato leaf roll and others. In the Maltese Islands, it is commonly found on both outdoor and greenhouse crops such as kohlrabi, cabbage, potato and aubergines, where severe damage is often reported. Four species of braconid parasites were recorded from this aphid pest (Mifsud, 1997).

Viteus vitifoliae (Fitch) – Grape Phylloxera

This serious pest of grapes originated in North America, where the local vines evolved with it and are not severely damaged by its feeding. It was accidentally introduced to Europe around 1860 (when it devastated the wine industry), then to the Mediterranean region, the Middle East, Africa, Korea, Australia, New Zealand and parts of South America (CIE, 1975). Grape Phylloxera feeds on species of *Vitis* including grape vines. Foliar attack does not seem to be unduly damaging, but asexual forms attacking roots all year round can kill plants that did not originate from North America. Grafting European vines onto North American root stocks has successfully solved this problem in the past, but concern has increased in recent years because this resistance has broken down in some parts of the world as new biotypes of Grape Phylloxera have evolved (King & Rilling, 1985; Strapazzon & Girolami, 1985). *V. vitifoliae* was first introduced in Italy in 1879 and one year later was reported from Sicily. For a long time, the Maltese Islands remained free from this insect pest. However, in July 1919, a considerable infestation of the insect was found at Ramla in Gozo as well as other localities on the same island (Borg, 1922). Vines grafted on American rootstock are nowadays used in this important industry as the pest does not attack such rootstock. The pest is still occasionally met with on wild, non grafted vines in the Maltese Islands.

DISCUSSION

Agriculture on small islands (such as the Maltese Islands) often has a restricted crop selection. Thus the accidental introduction of a harmful pest can have serious effects on the agricultural community in both economic and social terms. Sap-feeding insects are small, cryptic and can easily be imported accidentally on plant material from other countries. The examples discussed were all accidentally

introduced to the Maltese Islands, and have caused serious damage or yield reduction in a number of crops. The Maltese agricultural export sector is not very strong, the most important crop in this respect being potato. Export crops can become economically non-viable as a consequence of a serious pest or disease, because other countries will refuse to accept produce unless it is guaranteed pest-free. In the early 1970s, Malta had a strong export industry of Chrysanthemum flowers and cuttings. However, this industry came to an end because of the accidental introduction of the leafminer, *Liriomyza trifolii* (Burgess). This dipteran pest was intercepted in England and Wales on plants originating from Kenya and Malta in 1977/8 (Bartlett & Powell, 1981) and soon afterwards Chrysanthemum imports from these countries were banned.

The introduction of insect pests can have even wider implications. Many small islands rely heavily on tourism as a source of foreign exchange. Agriculture is often mainly responsible for maintenance of an aesthetically pleasing landscape and loss of a crop due to an introduced pest can result in fields being abandoned, becoming derelict and unsightly. This happened in Malta in 1993, when tomato crops were infested with the Tomato Yellow Leaf Curl Virus (TYLCV), transmitted by the whitefly *Bemisia tabaci*. Many tomato crops were devastated and for some time the landscape in these areas was degraded.

In small island states, agriculture is often afforded little importance, because it does not generate significant foreign exchange earnings. This may result in low levels of investment in the plant quarantine and agricultural extension sectors. However, when the economic and social consequences of some past introductions of insect pests are considered, it becomes apparent that these activities definitely deserve ongoing investment and development. The risk of accidental pest introduction is growing constantly, thanks to continually increasing mobility of people and growing international trade in fresh produce. The greatest plant quarantine risks are posed by importation of whole ornamental plants for the tourist and horticultural industries, and by importation of whole plants by visitors arriving by yacht or ferry. Tourists arriving by air seldom carry significant quantities of viable plant material. The best method of plant protection is to prevent pests ever entering the island in the first place. This requires appropriate legislation and effective quarantine inspection of imported living plant material at points of entry in order to enforce phytosanitary regulations. Up-to-date information is needed on which pest species are already present, as well as local expertise in crop monitoring and insect identification, so that any introduction can be quickly recognised and appropriate action taken promptly. Investment in such capability will not only benefit the agricultural and tourist industries, but is also required under the Global Biodiversity Convention.

ACKNOWLEDGEMENTS

The authors wish to thank the Keeper of Entomology, The Natural History Museum, London, UK for permitting use of the Museum's collections and library during the preparation of this work. We also thank Mr David Danria (Malta) for all his suggestions, and Stephania Mifsud (Malta) for typing a substantial part of the manuscript.

(Received 20th April 1999)

REFERENCES

Anonymous (1992a) *Frankliniella occidentalis*. Pp. 145-150, In: Smith, I. M., McNamarra, D. G., Scott, P. R. & Harris, K. M. [Eds.]. *Quarantine pests for Europe*. 1032 pp. CAB International, Wallingford, U.K.

Anonymous (1992b) *Bemisia tabaci*. Pp. 71-74. In: Smith, I. M., McNamarra, D. G., Scott, P. R. & Harris, K. M. [Eds.]. *Quarantine pests for Europe*. 1032 pp. CAB International, Wallingford, U.K.

Anonymous (1993) Virus fit-tadam tas-serer. *Il-Biedja llum*, **1**: 3, Agricultural Co-operative Ltd., Malta.

Baldacchino, A. E. & Pizzuto, A. [Eds.] (1996) *Introduction of Alien Species of Flora & Fauna*. Environment Protection Department, Floriana, Malta. 77 pp.

Bartlett, B. R. (1978a) Margarodidae. Pp. 132-136. In: Clausen, C. P. [Ed.] *Introduced parasites and predators of arthropod pests and weeds; a world review*. 545pp. Agriculture Handbook No. 480. United States Department of Agriculture, Washington, D.C.

Bartlett, B. R. (1978b) Pseudococcidae. Pp. 137-170. In: Clausen, C. P. [Ed.] *Introduced parasites and predators of arthropod pests and weeds; a world review*. 545pp. Agriculture Handbook No. 480. United States Department of Agriculture, Washington, D.C.

Bartlett, P. W. & Powell, D. F. (1981) Introduction of American serpentine leafminer, *Liriomyza trifolii*, into England and Wales and its eradication from commercial nurseries, 1977-81. *Plant Pathology*, **30**: 185-193.

Bellows, T. S., Perring, T. M., Gill, R. J. & Headrick, D. H. (1994) Description of a species of *Bemisia* (Homoptera: Aleyrodidae). *Annals of the Entomological Society of America*, **87**: 195-206.

Blackman, R. L. & Eastop, V. F. (1984) *Aphids on the world's crops - An identification and Information Guide*. John Wiley & Sons, Chichester, New York, Brisbane, Toronto, Singapore. 466 pp.

Borg, P. (1919) *The Scale-Insects of the Maltese Islands*. Malta Herald Office, Malta. 67 pp.

Borg, J. (1922) *Cultivation and diseases of fruit trees in the Maltese Islands*. Government Printing Press, Malta. 622 pp.

Borg, J. (1932) *Scale insects of the Maltese Islands*. Government Printing Office, Malta. 20 pp.

Brown, J. K., Frohlich, D. R. & Rosell, R. C. (1995) The sweepotato or silverleaf whiteflies. Biotypes of *Bemisia tabaci* or a species complex. *Annual Review of Entomology*, **40**: 511-534.
Brunt, A. A. (1986) Transmission of diseases. In: Cock, M. J. W. [Ed.] *Bemisia tabaci – A literature survey on the cotton whitefly with annotated bibliography*. Pp. 43-50, Ascot, UK, FOA/International Institute of Biological Control (IIBC) of CAB International.
Caruana Gatto, A. (1926) Primo Contributo alla conoscenza die Zooccidii delle Isole Maltesi. *Archivum Melitensis*, 7 (3): 103-126.
CIE (1964) Distribution maps of pests, Series A, no. 135. CAB International, Wallingford, UK.
CIE (1968) Distribution maps of pests, Series A, no. 18. CAB International, Wallingford, UK.
CIE (1969a) Distribution maps of pests, Series A, no. 43. CAB International, Wallingford, UK.
CIE (1969b) Distribution maps of pests, Series A, no. 256. CAB International, Wallingford, UK.
CIE (1971) Distribution maps of pests, Series A, no. 51. CAB International, Wallingford, UK.
CIE (1975) Distribution maps of pests, Series A, no. 399. CAB International, Wallingford, UK.
CIE (1979) Distribution maps of pests, Series A, no. 45. CAB International, Wallingford, UK.
CIE (1984) Distribution maps of pests, Series A, no. 93. CAB International, Wallingford, UK.
CIE (1986) Distribution maps of pests, Series A, no. 284. CAB International, Wallingford, UK.
CIE (1993) Distribution maps of pests, Series A, no. 538. CAB International, Wallingford, UK.
Cox, J. M. (1989) The mealybug genus *Planococcus* (Homoptera: Pseudococcidae). *Bulletin of the British Museum (Natural History)*, **58** (1): 1-78.
De Barro, P. J. (1995) *Bemisia tabaci* biotype B: *a review of its biology, distribution and control*. Second Edition. Division of Entomology Technical paper No. 36. Commonwealth Scientific and Industrial Research Organisation, Canberra, Australia.
Duffus, J. E. (1987) Whitefly transmission of plant viruses. In: Harris, K. F. [Ed.] *Current topics in vector research*. **4**: 73-91. New York, NY, USA, Springer – Verlag.
Fishpool, L. D. C. & Burban, C. (1994) *Bemisia tabaci* the whitefly vector of African cassava mosaic geminivirus. *Tropical Science*, **34**: 55-72.
Harrison, B. D. (1985) Advances in germinivirus research. *Annu. Rev. Phytopathol.*, **23**: 55-82.
Kennedy, J. S., Day, M. F. & Eastop, V. F. (1962) *A Conspectus of Aphids as Vectors of Plant Viruses*. Commonwealth Institute of Entomology, London. 114 pp.
King, P. D. & Rilling, G. (1985) Variations in the galling reaction of grapevines: evidence of different *Phylloxera* biotypes and clonal reaction of *Phylloxera*. *Vitis*, **24**: 32-42.
Mifsud, D. (1995) Whiteflies (Homoptera, Aleyroididae) from the Maltese Islands. *The Central Mediterranean Naturalist*, **2** (3): 61-78.
Mifsud, D. (1997) Biological Control in the Maltese Islands – past initiatives and future programmes. *Bulletin OEPP/EPPO Bulletin*, **27**: 77-84
Mifsud, D. & Palmeri, V. (1996) A new species of *Aleurolobus* Quaintance & Baker (Homoptera, Aleyrodidae) from Southern Europe. *Boll. Lab. ent. agr. "F. Silvestri", Portici*, Napoli, **52**: 89-95.
Mifsud, D., Viggiani, G., Dandria, D. & Lanfranco, E. (1995) Whitefly parasitoids from the Maltese Islands. *The Central Mediterranean Naturalist*, **2** (3): 101-107.
Petersen, C. L. & Charles, J. G. (1997) Transmission of grapevine leafroll-associated closteroviruses by *Pseudococcus longispinus* and *P. calceolariae*. *Plant Pathology*, **46** (4): 509-515.
Rapisarda, C., Mifsud, D. & Martin, J. H. (1996) Current studies on the Whitefly fauna of the Mediterranean Basin (Homoptera, Aleyrodidae). *Proceedings of the XX International Congress of Entomology*, Florence, Italy. 02-090, LVI + 820 pp.
Rosciglione, B. & Gugleri, P. (1986) Leaf roll and stem pitting diseases of grapevine; microscopic and serological analysis. *Revue Suisse de Viticulture, d'Arboriculture at d'Horticulture*, **18** (4): 207-211.
Roselló, S., Diez, M. J. & Nuez, F. (1996) Viral diseases causing the greatest economic losses to tomato crop. I. The Tomato Spotted Wilt Virus - a review. *Scientia Horticulturae*, **67**: 117-150.
Saliba, L. (1963) *Insect pests of crop plants in the Maltese Islands*. Department of Information, Malta. 35 pp.
Saliba, F. (1993) TYLCV f'Ghawdex. *Biedja u Sajd*, Department of Agriculture, Malta, **32**: 1.
Schembri, P. J. & Lanfranco, E. (1996) Introduced species in the Maltese Islands. Pp. 29-54, In: Baldacchino, A. E. & Pizzuto, A. [Eds.] *Introduction of Alien Species of Flora & Fauna*. Environment Protection Department, Floriana, Malta. 77 pp.
Strapazzon, A. & Girolami, V. (1985) The *Phylloxera* on European vines. *Informatore Agrario*, **41**: 73-76.
Watson, G. W. & Ismay, J. W. (1994) Strengthening of plant quarantine capabilities, Malta. FAO report in TCP/MAT/2351 (unpublished).
Watson, G. W., Ooi, P. A. C. & Girling, D. J. (1995) *Insects on plants in the Maldives and their management*. International Institute of Biological Control, Ascot, Berks, UK. 124 pp.
Wheeler, B. E. J. (1958) *A Plant Disease Survey of Malta*. Central Office of Information, Malta. 30 pp.
Wheeler, B. E. J. (1994) Plant Pathology Consultant's Second report (4-26 June, 1994) FAO report in TCP/MAT/2351 (unpublished).

The Central Mediterranean Naturalist | 3 (1): 35 - 42 | Malta, June 1999

MALTA'S NATIONAL PLANT *PALAEOCYANUS CRASSIFOLIUS* (BERTOLONI) DOSTÁL (ASTERACEAE) AND SOME ARTHROPOD VISITORS

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Abstract

The history, nomenclature and systematics of Malta's National Plant, *Palaeocyanus crassifolius* (Bertolōni) Dostál are reviewed and results are given of a survey of arthropod visitors to its flower-heads, carried out at three different sites during the period 1993 - 1997. Fifty-one species belonging to five insect orders (Diptera, Coleoptera, Heteroptera, Hymenoptera and Lepidoptera) and one arachnid order (Araneae) were recorded.

I. THE PLANT.

History and nomenclature

The history of Malta's National Plant is somewhat complicated and stormy. The plant, which is not known to grow in the wild anywhere in the world except on the southern and western cliffs of Malta and Gozo, is of great antiquity and is considered to be a remnant of our prehistoric flora (Gulia Gav., 1890:43). Notwithstanding that its discovery is generally attributed to the Maltese doctor-naturalist Stefano Zerafa (1791-1871), it was actually his medical colleague Agostino Naudi (1783-1830) [PLATE I, top], who, in 1825, had discovered this endemic plant at Wied Babu, on the outskirts of Zurrieq.

Dr Agostino Naudi, formerly an architect, was a Maltese medical doctor enjoying a very high reputation and esteem in the medical profession. He set up a private 'school' for medical students and lectured on anatomy, botany, physiology, pathology and therapeutics.Italy recognised his valuable contributions and invited him to occupy the Chair of Medicine at the University of Naples (Camilleri, C. 1831:18; Zammit, N. 1864: 4; Cassar, P. 1965: 450). Agostino Naudi was also an enthusiastic collector of the flora of the Maltese Islands and in 1811, his large collection of local plants was described and published by the Italian Carmelite Friar Carlo Giacinto then Professor of Botany at the University of Malta. Giacinto's list and description of over 800 local plants was prepared with the collaboration of both Naudi and Zerafa. In 1829, the latter succeeded Padre Giacinto in the Chair of Botany.

After some time, Naudi passed the plant on to Stefano Zerafa, who, not finding it listed in botanical books, referred it to Professor Todaro for an opinion. Todaro agreed with Zerafa that this peculiar Maltese endemic, perennial, cliff-hanging plant represented a species that was new to science. On account of its fleshy spathulate leaves, Stefano Zerafa (1827, Part 1, Fasc.I, p.11, No. 102) called it ***Centaurea spathulata,*** recording in the original description that its flowers are purple or white - "*Flores purpurei vel albi*".

Zerapha (Zerafa) may not have been aware that the name "*Centaurea spathulata*" was pre-occupied by a form of a variety of another plant of the genus *Centaurea* - *Centaurea jacea* Linn. var. *transalpina* Schleich, forma *spathulata* Tenore 1811. In fact Tenore (1811) described this as a species *C. spathulata* and it was later demoted by others to "form" status. So, in 1829, on the basis of a dry specimen sent to him by Giovanni Gussone (author of *Florae Siculae),* the Bologna University botanist Antonio Bertoloni.corrected this nomenclatorial confusion. This he did by substituting the specific name *spathulata* by *crassifolia* (a reference to the fleshy nature of its leaves). In his *Annali di Storia Naturale* (1829 : 359-360) and in his subsequent work *Flora Italica* (1833-54), Bertoloni referred to the plant as "*Centaurea crassifolia* Bertoloni" , thereby disclaiming Zerafa's rights and claiming for himself its full authorship. Because of Zerapha's original error, however, Antonio Bertoloni was quite within the accepted practice to rename the plant and was not obliged to give credit to the original author in any way in the authorities (Dr.D.J.N. Hind, Kew, *personal communication*, 12/7/95).

Habitat and vernacular name.

The national plant grows naturally in the southern and south western valleys and cliffs of Malta and Gozo and visitors to Wied iz-Zurrieq and the Blue Grotto (Ghar Qattus) may get a good glimpse of it growing naturally in numbers on the high rocky cliff facing the natural arch of the Cave . It is this habit of growing close to the sea that earned for the plant its Maltese name of *Widnet il-Bahar* (Ear of the sea). This refers to the similarity between the shape of its leaves and those of the common fodder plant "Widna". This appellation is generally thought to have been first adopted by Professor Ganni Borg in 1927 (see Lanfranco E, 1989 : 142 footnote 1). Records show, however, that this vernacular name existed well before 1927. In fact, Dr Gavino Gulia (1890: 43) notes that "*Dai Maltesi la centaurea si conosce sotto il nome di* Uidnet il bahar" (the Maltese call the Centaury W*idnet il-Bahar*).

Zerafa's plant - or rather, Naudi's plant - was initially

[1] 148, Triq San Frangisk, Hal-Balzan, BZN 07, Malta..

thought to be limited to the Wied Babu region, but in 1874, the botanist J.F. Duthie records it growing naturally also on the cliffs at Ta' Cenc and Xlendi in Gozo - where the plant's leaves are said to have been serrated. This serrated variety was subsequently (1907) described by Fiori and Paolletti as "form *serratifolia* Nobili" (Vol. IV, Appendice p.188 No.3743. See also Vol. III, p.344 and Vol. IV, p.65).

Serrations of the leaves are not listed in Zerafa's initial description of the cliff hanger and no such features were noted by the present author in a 1994 survey of the 'Maltese Centaury' growing naturally at Ta' Cenc and Xlendi. Borg (1927), however, did record the development of some serrations in the leaves of some of his "normal' *potted* plants. In view of this, Lanfranco (1989 : 142) does not consider the serrated variety to be a stable one.

Systematics.

Taxonomically, Malta's National Plant belongs to the Family Asteraceae (= Compositae) and is the only member of its genus (*Palaeocyanus*). In the early 1970s, the Czech botanist Dostál revised the subtribe Centaureinae and discovered in the process that the Maltese plant ('*Centaurea spathulata* Zerapha, 1827'), though very much resembling members of the genus *Centaurea*, was not one of them. Such features as the fleshy leaves, the involucred calyx lacking spines or marginal bristles and the absence of trichomes were typically its own and necessitated the erection of a new genus. Even the shrubby nature of the plant is a rare feature in this genus. Dóstal consequently transferred the taxon from *Centaurea* to the new genus *Palaeocyanus* (Gk. *Palaeo*, old, and *cyanus*, heavenly blue, cf. the cornflower *Centaurea cyanus*), which he himself erected to accomodate this very peculiar Maltese endemic plant. - Zerafa's plant - thus came to be known as "*Palaeocyanus crassifolius* Dostál 1975" - thereby obliterating completely any reference to the original author Zerapha (Dostál 1973, 1975).

Not all authors recognize the genus *Palaeocyanus*, so that the plant from Malta is still known as "*Centaurea crassifolia* Bertoloni" in some texts - with "*Centaurea spathulata* Zerapha *Fl.Melit.*(1827) non Tenore 1811" and "*Palaeocyanus crassifolius* (Bertoloni) Dostál" as its synonyms. It is important to state, however, that *Flora Europaea* does recognize the genus *Palaeocyanus* and refers to the plant as "*Palaeocyanus crassifolius* (Bertoloni) Dostál" - with "*Centaurea spathulata* Zerapha *Fl.Melit* (1827) non Tenore 1811" and "*Centaurea crassifolia* Bertoloni" as its synonyms.

National Status

As the Maltese Centaury is endemic to the Maltese Islands and is not known growing in the wild in any other country, the Natural History Society of Malta in 1962 chose "*Centaurea spathulata* Zerapha 1827" as its emblem [*Notes & News*, December 1971, p. 5]. That same year (1962), the Zurrieq Civic Council and the above-mentioned Society - which afterwards came to be known as the SSCN (Society for the Study and Conservation of Nature) and in 1999 as Nature Trust (Malta) - made strong recommendations and requests for the Government to adopt "Widnet il-Bahar" (the *Centaurea spathulata* of Zerafa, 1827) as the National Plant of Malta and "Il-Merill" (the Blue Rock Thrush, *Monticola solitaria* L., a common resident of the Maltese Archipelago) as the National Bird of Malta. The recommendation also had the full support of the Head Gardener of the Argotti Botanic Gardens, Mr Carmelo Penza. On the 100th anniversary of Zerafa's death (1971), the Zejtun Civic Council and the Natural History Society made an official request to the Minister of Trade, Industry and Agriculture to issue a stamp commemorating Zerafa (*The Times of Malta*, Sat.16 January 1971, p.4).

In spite of the general belief in the official status of the above-mentioned plant and bird, however, the present author could find no Government Notice in *The Malta Government Gazette* (the official organ of the Government of Malta) declaring "Widnet il-Bahar" (*Centaurea spathulata* Zerapha, 1827) and "Il-Merill" (*Monticola solitaria* L.), respectively the National Plant and the National Bird of Malta. Their "National" status is, apparently, based on the Government's acceptance to issue a set of postage stamps figuring respectively the plant and the bird. It is unfortunate, however, that none of these stamps carries the words "National Plant" or "National Bird" printed on them. The commemorative issue was released on 18th September 1971, and consisted of four postage stamps each measuring 48.26 mm x 20.32 mm. Those with vertical format (face value of 2d and 1/6d respectively) represent the plant and those with horizontal format (face value 5d and 10d respectively) depict the bird. [Plate I, bottom].

Botanical observations.

This evergreen plant flowers from late May to early August, producing a great number of unscented, large, thistle-like, purple/lilac flower-heads on long (c. 355 mm) uniformly rounded stalks that branch and widen close to the bud. At the site of the branching there develop two leaflets (av. 15mm x 3mm). Before producing the flower, the branched stalks bear 2 whorls of small longilinear leaflets (3-4 per whorl) that diminish in size distally, becoming hardly perceptible in the most distal region.

The large flower head or capitulum (diameter 30 - 40 mm, rising to a height of c.25mm abovebracts) is made up of numerous narrow tubular purplish florets each with a white base and a very long thin purple stigma. The edge of the corolla of each floret is prolonged as four fimbriae - each almost the length of the tubular part of the floret. The involucred calyx consists of about 60 hard, smooth pentagonal bracts that characteristically lack spines, marginal bristles or trichomes. The bracts increase in length (3mm - 23mm) and width, reaching a maximum of about 18 mm towards the central row. The innermost row, however, is long (max.23 mm) and narrow (min.3 mm). When all the purple florets have fallen off, these innermost and tallest hard bracts will ultimately form the hard "crown"

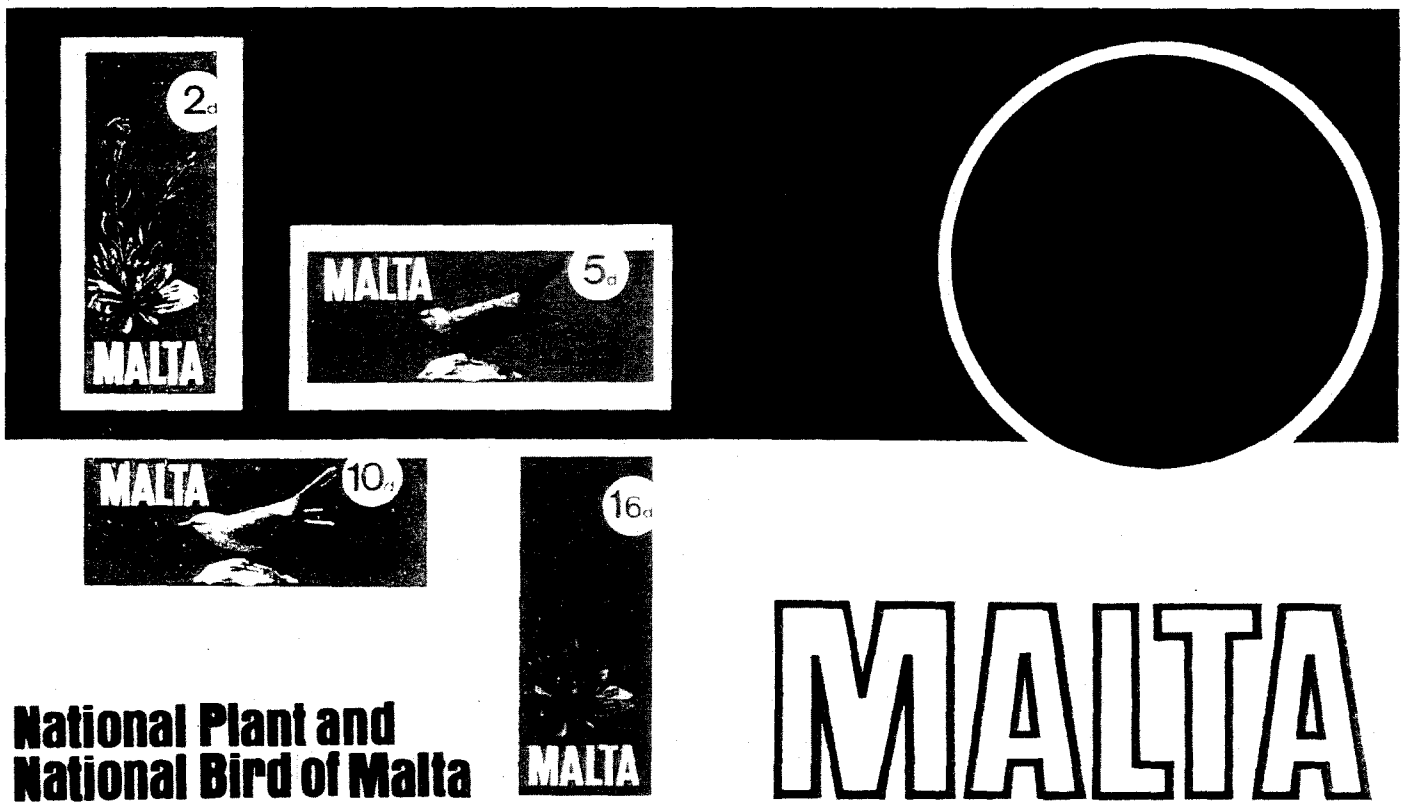

PLATE I Top: Portrait of Dr. Agostino Naudi P.A.A., M.D. (1783 - 1830) (*Reproduced from "L'Arte" 2 (33): 3).*
Bottom: The four postage stamps that gave official status to the National Plant and the National Bird.

bordering the wide, soft, smooth centre - looking very much like a daisy with hard petals. In spite of Zerapha's statement "*Flores purpurei vel albi*", no white flowers have ever been seen by this author anywhere on the Island. The deepest parts of the inflorescence, however, are white and the tips of some of the florets may be white.

In appearance, its involucred buds much resemble a miniature artichoke, but the external surface of each of the hard bracts forming the calyx bears, on its distal end, a deep purple spot with a lighter purple smudge just proximal to it. This gives the closed bud a very characteristic appearance - deep purple at its distal pointed end, with a number of large deep purple spots scattered regularly on its entire surface.

In cultivation the National Plant's short main stem, its irregular, low-lying and wide-spreading branches with a dense growth of leaves and its long weight-tipped flower-stalks give the plant a characteristic, but somewhat shabby and bushy appearance. In the wild, however, the plant seems to be less bushy and its flower stalks shorter than those growing under cultivation. Observation on the short-petioled, spathulate, entire, fleshy, hairless leaves of a large number of cultivated Maltese Centaury plants has shown also that the dorsal surface midrib may, at times, become coloured deep purple - without any evidence of any such pigmentation on the very prominent ventral surface midrib. The pigmentation invariably starts proximally and may proceed distally, with or without involvement of the lateral venations.

II. THE SURVEY.

The only studies known to have been carried out on "*Widnet il-Bahar*", Malta's National Plant, relate to its taxonomy, so that the present survey of insect pollinators and some other visitors to its flower-heads/buds, covering the period 1993-1997 is the first of its kind. In spite of the long duration of the survey, however, the number of arthropod species recorded visiting the national plant in flower is relatively small - 51 species.This is undoubtedly due to the short time devoted by the author to each inspection, carried out mostly during office hours or on the way home from work.The survey is, consequently, by no means comprehensive.

During this period, *cultivated* plants of *Palaeocyanus* in flower at Ghar Dalam Museum unwalled gardens (Birzebbuga, SE Malta), at a private orange grove in Hal Lija (Central Malta) and in a roundabout and in a central strip at San Gwann (Eastern Malta) were inspected regularly for their arthropod visitors. Those at Ghar Dalam Museum gardens were inspected every other day - repeatedly between 0830 and 1400 hours throughout 1993-94 and occasionally in 1995-97; those in the high walled private orange-grove and flower gardens at Hal-Lija received only occasional visits in 1993 (between 1830-1945 hours) , whilst those in the central strip in the region of San Gwann were investigated (1993), every other day between 1400 and 1500 hours. The record of three caterpillars of the moth *Plusia gamma* L. on the leaf of a potted plant in the back yard of the author's residence at Birkirkara (31st May 1988) is also being listed on account of its related interest.

Unless otherwise stated, the records are of arthropod visitors to the open flower-heads of the National Plant. It was observed, however, that wasps and most flies (especially the larger ones) preferred to settle on ripe, partially open buds (i.e.buds that had opened enough to show colour of flower). Some of these insects were noted "feeding" on the buds, notwithstanding that naked eye inspection revealed no aphids and/or mildew. Such visitors are marked [B].

LIST OF ARTHROPOD VISITORS

INSECTA

DIPTERA

Bombyliidae
- *Geron* sp.

Calliphoridae
- *Calliphora vicina* Robineau-Desvoidy [B]
- *Chrysomya albiceps* (Wiedemann)
- *Pollenia rudis* (Fabricius) [B]
- *Stomorhina lunata* (Fabricius) [B]

Muscidae
- *Musca domestica* Linnaeus [B]

Rhinophoridae
- *Stevenia deceptoria* (Loew) [B]
- 2 undetermined species [B]

Sarcophagidae [B]
- 2 ♀♀ [not possible to identify].
- *Helicophagella novercoides* (Böttcher)

Sepsidae
- *Sepsis punctum* Fabricius

Tachinidae
- *Leucostoma* sp.

Tephritidae
- *Acanthiophilus helianthi* (Rossi)

Ulidiidae
- *Physiphora demandata* Fabricius

COLEOPTERA

Anobiidae sp.

Bruchidae sp.

Coccinellidae sp. [Retained by Ebejer for further study]

Curculionidae sp. [Retained by Ebejer for further study]

Dermestidae sp.

Mordellidae
- *Mordellistena* sp.

Oedemeridae
Oedemera brevicollis Schmitt
Oedemera barbara Scop.

Scarabaeidae
Aethiessa floralis Fabricius
Oxythyrea funesta Poda

HETEROPTERA

Pentatomidae
Codophila raria (Fabricius)

HYMENOPTERA

Anthophoridae
Thyreus sp.

Apidae
Apis mellifera Linnaeus

Braconidae sp.

Formicidae
Plagiolepsis pygmaea (Latr.)

Halictidae
Halictus fulvipes (Klug.)
Lasioglossum malachrum (Kirby)

Megachilidae
Chalicodoma sicula balearica Tkalcu
Megachile schmicdekrechti Costa

Scoliidae
Megascolia bidens (Linnaeus) ♀

Vespidae
Polistes omissus (Weyrauch)

Xylocopidae
Ceratina cyanea (Kirby)
Ceratina sp.
Xylocopa violacea (Linnaeus).

LEPIDOPTERA

Lycaenidae
Polyommatus icarus Rottenburg

Nymphalidae
Vanessa cardui Linnaeus

Papilionidae
Papilio machaon Linnaeus

Pieridae
Artogeia rapae (Linnaeus)
Gonepteryx cleopatra (Linnaeus)

Satyridae
Lasiommata megera Linnaeus.

Noctuidae
Dicestra trifolii Hufnagel
Plusia gamma Linné

ARACHNIDA

ARANEAE

Thomisidae
Thomisus onustus Walckenaer [8 imm. ♀♀]
Xysticus sp. [imm. ♀]

Salticidae
?Euophrys sp. [imm. ♂]

III. DISCUSSION AND REMARKS.

General observations

In the exposed unwalled gardens of Ghar Dalam Museum, insect visitors to the *Palaeocyanus* plant were most abundant and most active on warm calm mornings. In the high-walled sheltered orange garden at Lija, however, activity persisted very late into the afternoon, well after sunset.

The most common, most diligent and longest-staying visitors to the National Plant at Ghar Dalam gardens were the Common Halictid bees *Halictus fulvipes* (Klug.). Their activity does not seem to have been affected by wind, cloud and other climatic conditions but was influenced by time. Very little bee activity could be seen in the afternoon, whilst in the morning it was common to see 2-4 of these bees assiduously and almost continuously feeding on the same flower-head in the bentdouble position, with a yellowish (occasionally orange) pollen basket protruding horizontally from either side at their middle. Another very common visitor to the flower-heads was the honey bee, *Apis mellifera*, which seemed to linger for shorter periods than the former species.

Throughout the last week of May 1994 and 1995, the most common visitors (2-8 per flower) and the ones staying longest on the same flower-head were the beetles *Oedemera brevicollis*. They stayed on the same inflorescence most of the morning undisturbed by the continuous passage of tourists (0.5 metre away).

In June 1997, the plants at Ghar Dalam were noticeably patronized by Large Carpenter Bees (*Xylocopa violacea*), with one to six bees working assiduously and for protracted periods on the same plant.

Diptera

Most of the fly species included in the above list of visitors to the *Palaeocyanus* plant have been recorded previously from the Maltese Islands. The two beeflies (*Geron* sp.) and the fruit fly *Acanthiophilus helianthi* (Rossi), however, are of very particular interest.

Locally, there is only one record of the genus *Geron* - *Geron* sp. aff. *gibbosus* Olivier 1789. This was taken at 0830 hours from the garigue area of St. Paul's Island, Malta in 1975, where it was found by Ebejer hovering low over the soil. In addition to the field notes, Ebejer gives also illustrations of the male hypopygium. (Ebejer, 1988: 233, figs. 1-3). The two identical specimens recorded herein were feeding on the flower-heads of the National Plant in the Ghar Dalam Museum grounds on a warm calm day (25.6.93) at about 0930 hours. They differ from the already recorded *Geron* species and represent, not only a new record for the Island, but probably also a species new to science (*personal communication*, M. Ebejer, who has been donated the specimens for further study).

All the Diptera species are probably coincidental visitors, having come to the flower-heads for an extra feed. The presence of the fruit fly *Acanthiophilus helianthi* (Rossi) on the thistle-like flower-head of the National Plant in citrus - gardens, however, may be of some significance. Given the common occurrence of the fly (especially in orange gardens), its wide distribution and its many recorded host-plants among the genera *Centaurea, Silybum, Carlina, Carthamus, Notobasis* and *Onopurdum*, it is most unlikely that *Palaeocyanus* is its major host plant. It could, however, be an additional one. *Acanthiophilus helianthi* (Rossi) is very alert and not easily caught. Several specimens were seen in the well-sheltered citrus garden with associated flowers at Lija and although they hovered and zig-zagged swiftly and repeatedly over the flower-heads, all seemed to prefer alighting and staying on buds rather than on open flower-heads. They were still active and hovering over and around the flower-heads late in the evening (1930 hours, 4.7.93), well after sunset.

The presence of *Chrysomya albiceps*, *Physiphora demandata* and *Sepsis punctum* in this list might seem incongruous. It should be noted, however, that though *Chrysomya albiceps* breeds on carrion and dead fish and *Physiphora demandata* breeds on dung, the adults of both insects are known to feed on flowers. *Sepsis punctum*, also lives on dung. It was noted, however, that the only *Chrysomya albiceps* seen during this survey was feeding persistently on the buds and never on the flower, and whenever it did land on the flower, it quickly worked its way down to the calyx (externally). *Physiphora demandata* was often seen alighting on discoloured and semi-shrivelled flowerheads.

The record of the above-mentioned Diptera is also of ecological interest as some of them parasitize specific members of the local fauna. Thus, members of the genus *Geron* are parasitic on moths of the small families Psychidae and Tortricidae -- represented in the Maltese Islands by three and eight species respectively [Valletta, 1973: 57-58]. Likewise, *Stomorhina lunata* is parasitic on the egg pods of locusts, *Pollenia rudis* parasitises earthworms, *Stevenia deceptoria* parasitises terrestrial isopods, and *Leucostoma*, like the majority of flies in the tachinid sub-family Phasiinae, parasitize Hemiptera (true bugs). In addition, *Chrysomya albiceps* is known to cause secondary myiasis in animals.

Coleoptera

The commonest beetles observed were *Oedemera barbara* and *Oedemera brevicollis*. Their large numbers and their long visits to the flower-heads have already been stressed. The "Barbary bug", *Oxythrea funesta* Poda (locally known as "Busuf"), was also a common visitor, with more than one specimen foraging contemporaneously on the same flower. Saliba (1963: 13) remarks on the frequency of this species on peaches. The present author found them to be extremely common (1- 4 per flower) on arum lilies where they tend to gather at the bottom of the conical inflorescence. Cases are known of this beetle entering the human ear canal, and elderly people are known to caution children about this danger when they see them shaking off the insects from the tall-stalked arum lily inflorescence, as the "bug" may fly erratically into their ear when disturbed.

Lepidoptera.

The swallow-tail butterfly, *Papilio machaon* (popularly known locally as *Farfett tal-Fejge* lor *Farfett tar-Regina*), was noted to prefer the red flowers of *Pelargonium* to the lilac ones of the neighbouring *Palaeocyanus*, alighting on the first but never on the second. It was only on 17th July 1994, when at Ghar Dalam there was great activity by different butterflies, that the Swallow-tail was noted feeding assiduously and persistently on a flower-head of the National Plant. This apparently anomalous behaviour makes one speculate that, *possibly*, the Swallowtail's colour vision renders the red flower attractive and the lilac/purple flower visually unappealing and that an accidental landing on the flower and the tasting of its nectar proved otherwise! There is, however, no scientific data to support this speculation.

The moth *Dicestra trifolii* Hufnagel, known as "The Nutmeg" on account of its very characteristic colour, was taken on 25.6.93 at 1000 hours after it had been seen feeding continuously for some time on the flowerhead. In Malta, this moth is recorded as being quite common in March-May and August-October and its green larva (with a black line on its back and a red stripe on its side) feeds on Chenopodiaceae (Valletta, 1973: 24) . A number of plants of this family are to be found in the Ghar Dalam gardens, with *Rumex lunaria* as the most abundant represemtative.

Three green caterpillars feeding on the leaf of the National Plant (31.5.88) are also being recorded herein. They had the peculiar habit of eating solely the thick green pulp on the underside of the distal three fourths of its fleshy leaf. The uppermost epidermis is left completely intact as a flimsy transparent membrane. After three days in captivity (fed on leaf and stalk of *Palaeocyanus* and of *Pelargonium*), each of the 25mm green larvae formed a flimsy horizontal cocoon within the curled leaf of these plants and 10 days later (13/6/94, temperature 24°C), developed into the moth *Plusia gumma* Linnaeus, which is very common in Malta. Valletta (1973: 44) records this moth as being common and its larva as feeding "on all sorts of vegetables and on ornamental plants like *Coleus, Geranium, Impatiens* and *Datura*".

Araneae

All spider records listed herein are from the back garden of Ghar Dalam, where no spider was noticed on the flower-head / plant of *Palaeocyanus* before mid-June. In May 1994, however, a c.15 cm vertical sheet-like web was found between the leaves of two different branches of one of the plants. A careful search failed to reveal its owner.

During the five-year survey, spiders visiting the flower-heads comprised eight white immature female crab spiders *Thomisus onustus* (Walckenaer, 1805), one immature female *Xysticus* sp. (specific identification not possible) and one immature male Salticid (*?Euophrys* sp. - specific identification not possible)]. It is not usual to find members of the Salticidae on flowers. The only record of this genus from the Maltese Islands is of *Euophrys rufibarbis* (Simon, 1868) from Comino (Baldacchino, 1983; see also Baldacchino, *et al.* 1993: 45).

With its typically-shaped, elevated, laterally-angular large abdomen, the orange circular plate-like cephalothorax, the convex, dark brown lateral flaps on the thorax and the two dots on the ventral surface, *Thomisus onustus* has a characteristic appearance. The Thomisidae are crab-like spiders which tend to assume different colours according to their background. They are chacterised by the lack of cheliceral teeth. The commonest form encountered locally is the yellow coloured one, found on the crown daisy (*Chrysanthemum coronarium*), where it blends perfectly well with the background colour (*personal communication*, D. Dandria).

The *T. onustus* specimens recorded herein (all from different flowers) are white-coloured immature females and the only background they could possibly blend with are the deepest parts (white) of the purple flower. Only one specimen, however, was located deep in the inflorescence, the others being noticed as a motionless white blotch on the purple flower -- where they could very easily have been mistaken for a white tipped floret. *T. onustus* is said to be one of the most static of spiders, depending on complete stillness for the success of its ambush. This spider waits patiently for its prey to lower its head in search of nectar, then seizes it and inserts its teethless chelicerae into the head or thorax of the victim, sucking it dry and leaving it apparently undamaged. [Bristowe, 1958].

ACKNOWLEDGEMENTS

I would like to thank the following for identifying the arthropods: Dr Martin Ebejer (Diptera and Lepidoptera), David Dandria (Araneae) and Stephen Schembri (Coleoptera and Hymenoptera). I am also grateful to Dr. J.N. Hind, Head of Compositae sub-section at the Royal Botanic Gardens Kew, and to Guido and Edwin Lanfranco for helpful discussions and advice.

(Accepted 12th March, 1999)

REFERENCES

Anon. (1971). "A National Plant" from a Correspondent. *The Times of Malta*, Saturday, 16 January 1971, p. 4.
Baldacchino, A. E. (1983). Spiders. *Civilization*, (11) : 294 - 296, Malta .
Baldacchino A. E., Dandria D., Lanfranco E. & Schembri P.J. (1993). Records of spiders (Arachnida: Araneae) from the Maltese Islands (Central Mediterranean). *The Central Mediterranean Naturalist* (1993) **2** (2) : 37 - 59, 7 figs.
Bertoloni, A. (1829). Flora Melitensis Thesaurus. Curante Stephano Zerapha Med. Doct. *Annali di Storia Naturale*, Fasc. 1°. 2 : 359-360. Bologna.
Bertoloni, A. (1833-54). *Flora Italica sistens planta in Italia et in insules circumstantibus sponte nascentes.* Bologna, 10 Volumes.
Borg, J. (1911). Remains of the Prehistoric Flora of Malta. *Archivum Melitense* (1910-12). 1 (2-4) : 39.
Borg, J.(1927). *Descriptive Flora of the Maltese Islands.* Government Printing Office, Malta. 864 pp.
Bristowe, W.S. (1958). *The World of Spiders.* The New Naturalist No. 37, Collins, London. 204pp, 36 pls., 116 figs.
Camilleri, C. (1831). *Elogio funebre .... del Dr Agostino Naudi, professore di Medicina e Chirurgia.* Malta, Stamperia del Governo, 1831. 18 pp.
Cassar, P. (1965). *Medical History of Malta.* The Wellome Historical Medical Library, London. New Series, Vol. 6. 586 pp., 19 pls.
Dostál, J. (1973). Preliminary notes on the subtribe Centaureinae. *Acta Bot. Acad. Sci. Hung.*, 19 (1-4) : 73-79.
Dostál, J. (1975). "New nomenclatural combinations and taxa of the Compositae subtribe Centaureinae in Europe" In: Heywood, V.H. (ed.) *Flora Europea Notulae systematicae ad Floram Europeam spectantes*, Issue No. 18 *Bot. J. Linn. Soc.* 71 : 191-210.
Dostál, J. (1976). "Palaeocyanus" *In*: Tutin, T.G. et al. *Flora Europaea,* Vol. 4, *Plantaginaceae to Compositae.*
Duthie, J.F. (1874-75). On the Botany of the Maltese Islands in 1874. *J ournal of Botany British and Foreign* (London), Part 1 (1874): 321 - 326; Part 2 (1875) : 36 - 42.
Ebejer, M. (1988). Beeflies (Dipt., Bombyliidae) from Malta. *Entomologist's Monthly Magazine* 124 : 233 - 241, 9 figs.
Ellul-Micallef, R. (1989). Tobba Maltin ma tul iz-zminijiet. *In:* Toni Cortis (ed.). *L-Identitá kulturali ta' Malta.*. Kungress Nazzjonali 13 - 15 April 1989. 235 - 262. Dipartiment ta' l-Informazzjoni, Malta.
Fiori, A. & Paolletti, G. (1896-1909). *Flora analitica d'Italia.* 5 vols. Padova.
Giacinto, C. (1811). *Saggio di Agricoltura per le isole di Malta e Gozo* . Messina, Giovanni del Nobolo, 275 pp..
Gulia G. (1890). *Centaurea crassifolia*, Bert. *Il Naturalista Maltese*, 1 (5) : 42-43.
Gussone, J. (1844). *Flora Siculae Synopsis.* 2 Vols. Neapoli, ex Typis Tramater. Vol. 2: 451- 452.
Lanfranco, E. (1989). "Il-Pjanti vaskolari endemici tal-Gzejjer Maltin", pp. 141 - 164 *In:* Cortis, T. (ed.). *L-Identitá kulturali ta' Malta*, Kungress Nazzjonali, 13 - 15 ta' April 1989. Dipartiment ta' l-Informazjoni. Malta 278 pp.

Lanfranco, G. (1972). "L-Istorja tal-Pjanta Nazzjonali ta' Malta'. *Pronostku Malti. Almanakk ta' Malta u Ghawdex,* Malta. 98 - 107, 1 fig.
Saliba, L. (1963). *Insect pests of crop plants in the Maltese Islands.* Department of Information, Valletta, Malta. 35 pp.
Tenore, M. (1811). *Prodromo della Flora Napolitana.* Napoli, 5 Vols. + Appendices. Vol. 1, p.61].
Valletta, A. (1972). *The Butterflies of the Maltese Islands.* Giov. Muscat & Co. Ltd., Malta. 64 pp., 16 pls.
Valletta, A. (1973). *The Moths of the Maltese Islands.* Progress Press, Malta. 118 pp., 16 pls.
Zammit, N. (1864). 'Biografie'. *L'Arte,* **2** (33) : 3-5. Malta, 1864.
Zerapha, S. (1827-31). Florae Melitensis thesaurus, sive plantarum enumeratio quae in Melitae Gaudosque insulis aut indigene aut vulgatissimae recurrunt Melitae. The Author, Valletta, MDCCCXXVII - MDCCCXXXI. 2 fasciculi. Fasc.I, 1827, pp. iv + 36; Fasciculus alter 1831, pp. 37-86 (including Index).

THE CENTRAL MEDITERRANEAN NATURALIST

JUNE 1999

CONTENTS