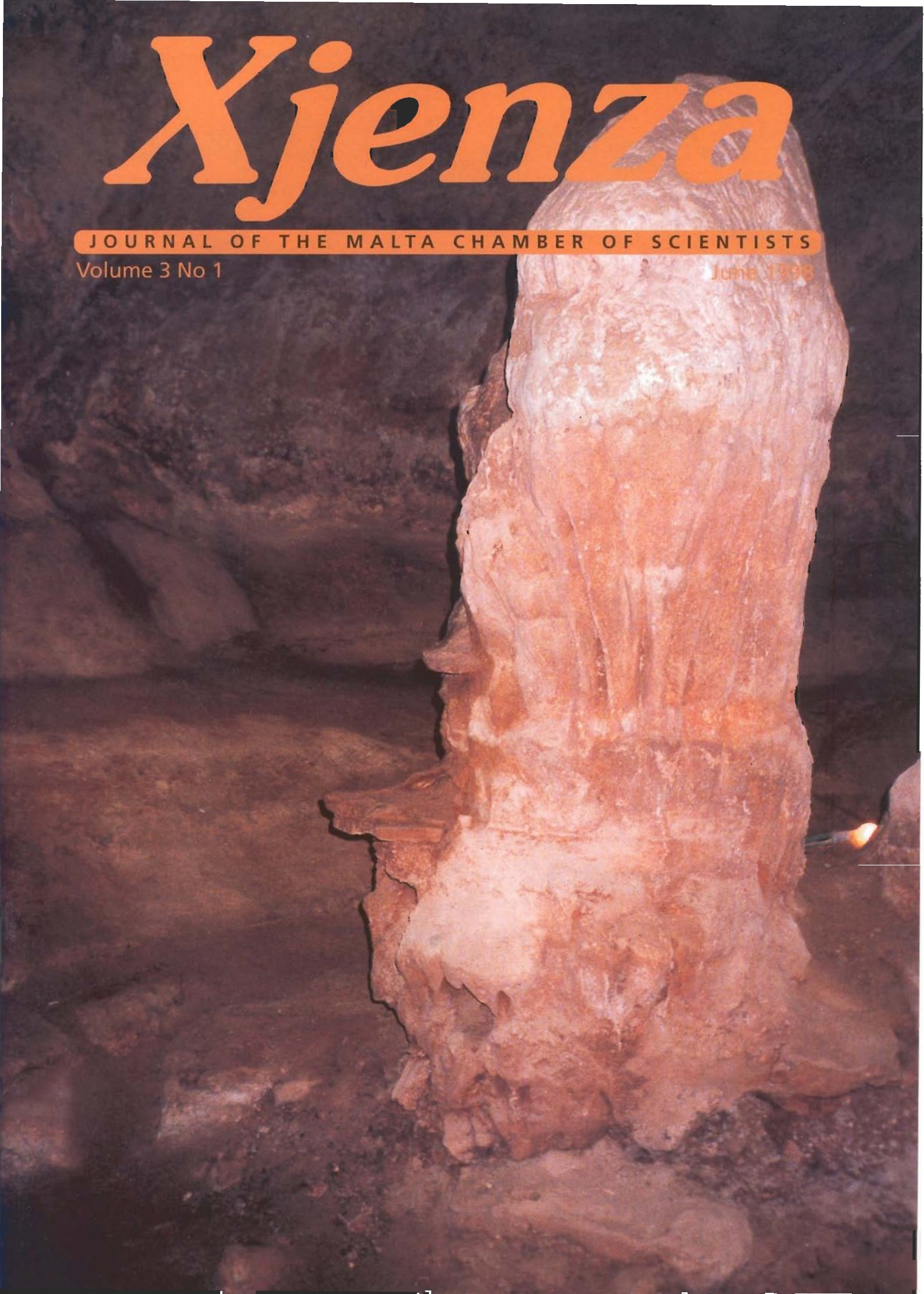


Xjenza

JOURNAL OF THE MALTA CHAMBER OF SCIENTISTS

Volume 3 No 1

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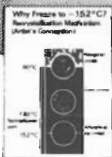
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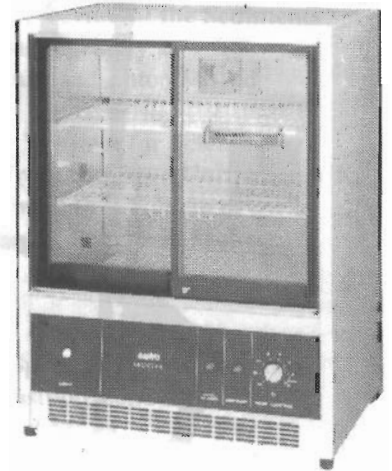


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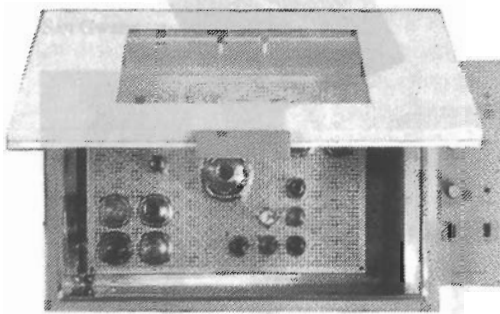
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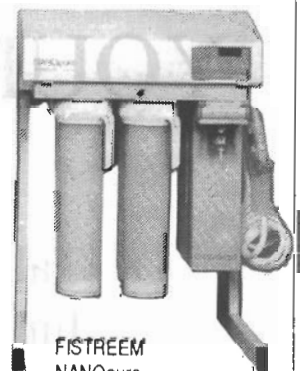
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Major stalagmites at
Ghar Dalam Cave.
(Photo: Dr. A. Mifsud)

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**P.O. Box 45,
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Editorial

Xjenza - Two Years On

Xjenza is now two years old. Since the first issue of *Xjenza* was published, a steady stream of papers have kept the Journal alive. This may bode well for the future but complacency is not a good position to adopt. We are particularly keen to see papers from recent graduates. All science students have to prepare a thesis or a project of original work. Let us read about it. Not enough use is being made of *Xjenza* in this regard particularly from the disciplines of mathematics and physics. Currently, it is the biologists who are the clear leaders.

The second issue of *Xjenza* (December 1996) was dedicated to the Proceedings of the Malta Forum for Science Teachers, held in Malta in September that year. This initiative of the Malta Chamber of Scientists has paid off and we are proud to note that the Department of Primary Education within the Faculty of Education of our University will be offering a certificate in Science Teaching at Primary Level from October this year. Also, Dr Susan Tresman from the Open University, UK, who was one of the invited speakers at the Forum, has been appointed as visiting associate professor at the University of Malta, and a British Council sponsored Scholar, to assist with the development of the course structure and materials. Learning methods will include the use of television programmes based on workbooks for the content credits. Aspects of methodology will utilise the services of the University Radio Station. All primary science teachers are strongly encouraged to avail themselves of this opportunity. This is a vital first step if we are to improve not only the facilities and level of science teaching at primary level, but possibly more importantly, the interest and enthusiasm for the subject, something which is sorely lacking in our country.

Another recent development that will affect the teaching of science has been the publication of the new curriculum. We are pleased to learn that some of the recommendations made in the Editorial (*Xjenza*, 1 (2), 5-6, 1996) have not fallen on deaf ears. At primary level, the teaching of science is to be made compulsory with a recommendation for a minimum of two hours per week. At secondary level (Forms 1 and 2) four hours of integrated science are being recommended whereas at Form 3 and higher, any one of the three science subjects (Chemistry, Biology or Physics) will be made compulsory. This is a change from previous requirements where Physics was the compulsory science subject. Another issue being raised in the revised curriculum is that the teaching of Science is to be conducted in English. Although this is all well and good when one considers the extensive terminology and available material in that language in contrast to what is available in Maltese, one cannot help feeling anxious that unless the standard of English also improves in our schools, our pupils will remain at a distinct disadvantage in their assimilation of scientific concepts and consequently lag behind in their development of scientific analysis and thinking.

An important event for science has taken place in Malta this year, namely, the competition for the Junior Scientist Award (refer to page 32). The recipient of this award will be competing against other young scientists from EU countries in the EU Scientist of the Year award which will be taking place in Portugal later this year. More Maltese young scientists should be encouraged to take part in the Junior Scientist award competition. The high standard of the projects presented and the enthusiasm with which the contestants presented their projects was very encouraging. Perhaps we should introduce a feature in *Xjenza* dedicated to such projects.

National Student Travel Foundation (NSTF) in collaboration with the Malta Chamber of Scientists annually runs a Science Forum over a six-month period in which current topics in science are debated among some fifty budding scientists. A panel of judges made up of university lecturers awards marks for presentation, content and debating skills of individual students. Students placed in the first ten positions at the end of the fora are flown to London for two weeks to attend a science festival consisting of some other three hundred young scientists from all over the world. Lectures, demonstrations and visits to the best laboratories and industries form part of this event. Participation must be an invaluable experience and the best of the ten reports from the students could perhaps be a feature of *Xjenza*.

Industry in Malta is also showing promise in encouraging science education by supporting various initiatives of the Malta Chamber of Scientists. Most of the Business and Scientific meetings organised by the Chamber are sponsored by various industries which have a direct interest in the subject being presented or discussed. In this regard particular thanks go to E.J. Busuttill Ltd. for generous sponsorship of *Xjenza*.

It is thus encouraging to witness some progress being made in Malta in the fostering of a science culture in our youth, perhaps it is the unstinting efforts of the Malta Chamber of Scientists which are bearing some fruit. However, much remains to be done. More motivation nationwide is required and parents themselves need to be educated about the value of some scientific training for all in order to help us develop further in an ever scientific and technological world. We at *Xjenza* will continue playing our part in this endeavour. All readers and local scientists, especially new graduates, are encouraged to submit papers for publication in this journal. Make it a thriving Journal - ~~Keep~~ *Xjenza* alive!

Angela Xuereb - Editor
Martin Ebejer - Associate Editor

Review Article

Ghar Dalam Cave: A review of the sediments on the cave floor stratigraphy

Charles Savona-Ventura and Anton Mifsud

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Summary: *The Ghar Dalam cave floor excavations conducted in the late nineteenth and early twentieth centuries have identified a number of stratigraphical divisions containing several fossil animal remains. The original excavation reports are reviewed and correlated to the presently existing floor sample pillar and wall, and the stalagmite structure situated at about 115 feet from the cave entrance. The study confirms the definite presence of eight stratigraphical layers making up four definite faunal stages and a sterile layer. The oldest faunal stages - Eliomys (Maltamys) sp. (=Leithia carteri) stage and Pitomys melitensis stage - have been dated to the Upper Pleistocene by absolute and relative dating techniques specifically to the Riss-Wurm interglacial and the Wurm glacial. The uppermost two faunal stages - Apodemus sylvaticus stage and Rattus rattus stage - have been assigned to the Holocene period.*

Introduction

The Ghar Dalam cave has yielded an uninterrupted sequence of fossiliferous deposits extending from the Late Pleistocene to Modern times, thus enabling a sequential study of the palaeogeographical state of the Maltese Islands during the Ice Ages. The first serious effort to excavate and study the cave floor was made by J.H. Cooke in the late nineteenth century after A. Issel outlined the importance of the cave in 1865 (Issel, 1866; Cooke, 1893a/b). Subsequent excavations were carried out by the Malta Museum Authorities during the second decade of the twentieth century. These early excavators carefully documented and published their findings in several geological and archaeological journals. The use of varying descriptive terms by the different workers to record the various strata and sub-strata making up the cave floor made stratigraphical correlation difficult.

In 1921, an attempt was made by G. Sinclair to review the stratigraphy of the cave floor basing his study on the sample pillars left in situ by the previous excavators and

extending the previous excavations with three trenches (Sinclair, 1924; Keith, 1924). Sinclair's work, after minor modifications, served as the basis for the descriptions of the strata used by subsequent excavators (Caton-Thompson, 1925; Baldacchino, 1934-38; Storch, 1974). Attempts at dating the various Pleistocene deposits have been based on stratigraphical evidence, faunal (microfaunal and macrofaunal) correlations, electron spin resonance and uranium series disequilibria, and chemical and radiometric relative dating using bone F-U-N (Fluoride, Uranium, Nitrogen) content. The Prehistoric deposits have been dated by comparing pottery shards with Carbon 14 dated shards from other prehistoric sites.

Following these studies, the Ghar Dalam cave floor has been described as consisting of a series of stratigraphical divisions reflecting different episodes in the geological history of the Maltese Islands (Zammit-Maempel, 1989). The generally accepted geological and faunistic division of the Ghar Dalam cave floor ignores the various

EXCAVATORS	YEAR	NOTES	REFERENCE
A. Issel	1865	1 trench at about 300 ft from entrance.	Issel, 1866
J.H. Cooke	1892	8 trenches at 20 ft, 30 ft, 50 ft - right & left, 170 ft, 200 ft, 350 ft, fissure at 400 ft from entrance.	Cooke, 1893a/b
N. Tagliferro, G. Despott, C. Rizzo	1912-13	2 trenches at 350 ft - right & left - from entrance.	Ashby & Despott, 1916
T. Ashby, G. Despott, C. Rizzo, R. Castillo	1914	2 trenches at 200 ft - right & left - from entrance.	Ashby & Despott, 1916
G. Despott, C. Rizzo	1916-17	3 trenches at 50 ft, 110 ft, 115ft from entrance.	Despott, 1916/1918
G. Despott	1918-20	3 trenches excavating completely (except for sample pillars/wall) to about 210 ft from entrance.	Despott, 1923
G. Sinclair, G. Despott, G. Flamingo	1921	3 trenches dug from Bone breccia layer to cave floor at 65 ft, 110 ft, and 205 ft from entrance.	Sinclair, 1924; Keith, 1924
G. Caton-Thompson	1922/24	5 trenches at 125 ft, 150 ft, 170 ft (2 trenches), 225 ft from entrance.	Caton-Thompson, 1923/1925
J.G. Baldacchino	1934-37	5 trenches at 20 ft, 42 ft, 120 ft, 138 ft, 170 ft from entrance.	Baldacchino, 1934-38; Trechmann, 1938
G. Storch	1969	1 trench in fissure at about 100 m from entrance.	Storch, 1970/1974
G. Zammit-Maempel	1996	1 trench at about 240 ft from entrance.	museum display

Table 1. History of excavations in Ghar Dalam

(Illicit excavations recorded in period 1892-1912 and 1914-16 - the latter in the region of 200ft from the entrance)

subdivisions noted by the earlier excavators, particularly the subdivisions of the Red Earth or *Cervus* layer, overall faunistically related to the *Pitymys melitensis* stage by Storch (Storch, 1974). This study attempts to review and correlate the various subdivisions as described by the early twentieth century excavators with the remaining geological features and the presently standing cave floor sample wall and pillar.

Material and methods

A literature search was conducted in the various melitensia-holding libraries (the National Library, University and Archaeology Museum Libraries) in Malta to identify the publications relating to the original Ghar Dalam excavations. A total of 34 formal excavations were identified. The larger proportion of these (24 excavations) had been conducted prior to G. Sinclair's publication of 1924 (Table 1). The descriptions in the various published reports were correlated to the presently accepted stratigraphy (Zammit-Maempel, 1989), noting major important sub-strata. Descriptions noting definite evidence of disturbance were not taken into account in the present review. Through the use of Sinclair's review (Sinclair, 1924), these observations were correlated to the geological features and cave floor sample wall/pillar still standing today at Ghar Dalam. The fossils excavated from the various divisions by the various excavators were reviewed. The results of the scientific analyses of the various samples of fossils from different horizons carried out by Prof. K. Oakley at the Museum of Natural History (London) in 1952-1968/69 were also reviewed. The *Hippopotamus* sp. samples submitted to Professor Oakley for scientific study are assumed to have been all obtained from the Bone Breccia *Eliomys (Maltamys)* sp. (= *Leithia cartei*); while the *Cervus* sp. samples were obtained from the Red Earth Layers dated to the *Pitymys melitensis* faunal stage and the *Equus* sp. sample from the Domestic layer *Apodemus sylvaticus* stage. The mean and standard deviation of the various test results were calculated using a statistical software package [MedCalc for Windows ver.4] to allow comparisons to be made.

Cave floor stratigraphy

G. Sinclair (Sinclair, 1924; Keith, 1924) subdivided the cave floor to four major layers including: (1) the Sterile layers of yellowish-blue clay (~3ft depth) overlaying the

cave floor, of which the upper 1 inch of this clay was hardened; (2) a Bone Breccia (~3ft depth) with the multiple hippopotamus and elephant remains, and which included an overlying rounded boulder layer (~1ft thick); (3) the Red Earth Layers (total depth ~7ft) with the principal remains of *Cervus*; and (4) the Surface layer consisting of the superficial boulder layer, cave earth floor and pebble layer under it. The deposits were not evenly distributed in depth, but they apparently thinned out the farther one proceeded into the cave. The Red Earth Layer was described as consisting chiefly of red vegetable soil with alternating layers of "torba" clay in the upper portion. It was subdivided into four sections: (a) the upper three feet consisting of red earth, (b) the middle well-defined bone layer a few inches thick, the principal remains being deer, (c) the lower layer consisting of red earth, and (4) at the bottom another bone layer consisting of deer, elephant and hippopotamus remains.

This description conforms with the descriptions of the previous excavators, notably G. Despott and his co-workers, who in a series of nine extensive excavations repeatedly reported the presence of several subdivisions in the Red Earth Horizon. The first excavation in 1912-13 (Tagliaferro Trench) was dug out at 350 feet (106.7 m) from the entrance, close to a trench dug up and refilled by Cooke in 1892 (Cooke Trench I). No detailed stratification notes are available for this trench, though Cooke subdivided this to a total of six layers (Cooke, 1893a, b). The second excavation was made in 1914 (Ashby Rt & Lt Trenches) at 200 feet (61m) from the entrance, again in an area previously disturbed by Cooke (Cooke Trench III). The trench on the right hand side of the cave was described to have no less than 10 layers and was possibly previously disturbed by Cooke's excavations and the subsequent refill. The trench on the left hand side of the cave had definite evidence of previous disturbance (Cooke, 1983a, b; Ashby and Despott, 1916).

In 1916, Despott excavated a trench in a previously undisturbed area (Despott 1916 Trench) around a large stalagmite at about 115 feet (35 m) from the cave entrance. The cave floor was here described as consisting of six layers with a further number of sub-strata separated by stalagmitic plates. Two further

Despott I 50 ft	Despott Outer ~50-80ft	Despott II 110 ft	Despott 1916 115 ft	Despott Middle ~90-123ft	Despott Inner ~128-141ft	Ashby Rt 200 ft	Overall DESCRIPTION
0 [<36"]	0 [<60"]	0	1 [<36"]				boulders
1 [6-12"]	1 [6-24"]					1/2 [24"]	red soil
2 [12-16"]	2 [12-18"]	1 [12-18"]	2 [12-18"]	1 [12-42"]	1 [12-24"]	3 [12"]	red soil with angular stones
3 [12-18"]	3 [9-18"]	2 [12-18"]	3 [36"]	2 [12-36"]	2/3	4/5/6 [39"]	red earth layers [approx. 3]
4 [<84"]	4 [60-84"]	3 [24"]	4 [26"]	3 [24-48"]	4/5	7/8 [12-36"]	red earth layers [approx. 2]
5 [12"]	5 [>42"]	4 [8"]	5 [8"]	4 [0-36"]	6	absent	flat angular stone breccia
6		5	6	5		9/10	bone breccia

Table 2. Despott's excavations at Ghar Dalam (all excavations failed to breach the bone breccia layer)

trenches were dug out in 1916-17 (Despott I and II Trenches) at 50 feet (15.2 m) and at 110 feet (33.5 m) from the cave entrance. The former cave floor area had been partially disturbed on the right hand side by Cooke in 1892 (Cooke Trench II), the latter site was undisturbed. These excavations have revealed six to seven strata (Despott, 1918). The areas between the trenches at approximately 50-80 feet (15.2-24.4 m), 90-123 feet (27.4-37.5 m), and 128-141 feet (39.0-43.0 m) were subsequently totally excavated during 1918-20 (Despott Outer, Middle and Inner Trenches) to show the presence of several main strata and a number of sub-strata (Despott, 1923). Table 2 correlates the descriptions of the various trench descriptions excavated by G. Despott and his co-workers where these are accurately described.

Before Sinclair's publication of his study in 1924, a series of excavations were conducted by G. Caton-Thompson. Caton-Thompson excavated a series of five trenches. Two of her trenches dug in some 150-210 feet (45.7-64.0 m) from the entrance had been previously excavated and refilled by J.H. Cooke and by T. Ashby & co-workers besides illicit diggers, and a large section of the trench showed evidence of disturbance. Her other three trenches included a trench dug up along the width of the cave at 225 feet (68.6 m) from the entrance, a deepening of that previously dug up (Cooke IV Trench) at 170 feet (51.8 m) from the entrance, and a ledge deposit 125 feet (38.1 m) from the entrance (Caton-Thompson, 1923,1925; Bate, 1923,1925). During the period 1934-38 J.G. Baldacchino conducted a series of five excavations in various regions of the cave floor. In his first two excavations, Baldacchino classified the cave-floor into seven layers, where the third, fourth and fifth layers referred to the Red Earth Layers. In subsequent excavations, Baldacchino subdivided the cave floor into six layers with the third layer referring to the Red Earth Layers and the fourth layer referring to the Pebble Layer (Baldacchino, 1934-38; Trechmann, 1938).

More recently, excavations were conducted on a limited scale in 1969 by Dr. Gerhard Storch of the Senckenberg Museum of Frankfurt am Main (Storch, 1970,1974). The most recent excavations reported in a display at the Ghar Dalam Museum were made by Dr. George Zammit-Maempel in 1996 in a recess situated at 75 m (~240 ft) from the entrance.

It would thus appear that all the excavators reported various sub-strata in the Red Earth Horizon. The various sub-strata in the Red Earth Layer are best illustrated by the section of the deposits at Despott 1916 (Figure 1). This trench excavated at 115 feet (35.1 m) from the entrance around a large stalagmite was described to consist of 6 strata. The first layer from the surface included the superficial boulders, while the second layer of about 12-18 inches (30.5-45.7 cm) depth consisted of small stones embedded in fine brick-red earth. The third and fourth layer made up the Red Earth Layer of about 5 feet (1.5 m) depth, while the fifth and sixth layers consisted of the pebble and Bone Breccia layers respectively. The third and fourth layers were characterised by a series of three stalagmitic plates extending from the large stalagmite situated about 10 feet (3.1 m) from the left side of the cave. Evidence of these stalagmitic sheets can still be seen today on the standing outermost stalagmitic column in the cave. At a higher level to the last stalagmitic plate lay a number of detached stalactites on which stalagmitic formations of about 12 inches (30.5 cm) height had developed. This stalagmitic transition is evident on the stalagmitic column as a marked widening of the column (Despott, 1916). The composition of the floor in the region below the bone breccia was demonstrated by G. Sinclair in a trench dug at about 110 feet (33.5 m) from the entrance (Sinclair, 1924).

The Ghar Dalam cave floor sedimentary sequence is presently demonstrated by a Sample Pillar and a Sample Wall situated at about 70 and 85 feet (21.3 and 25.9 m)

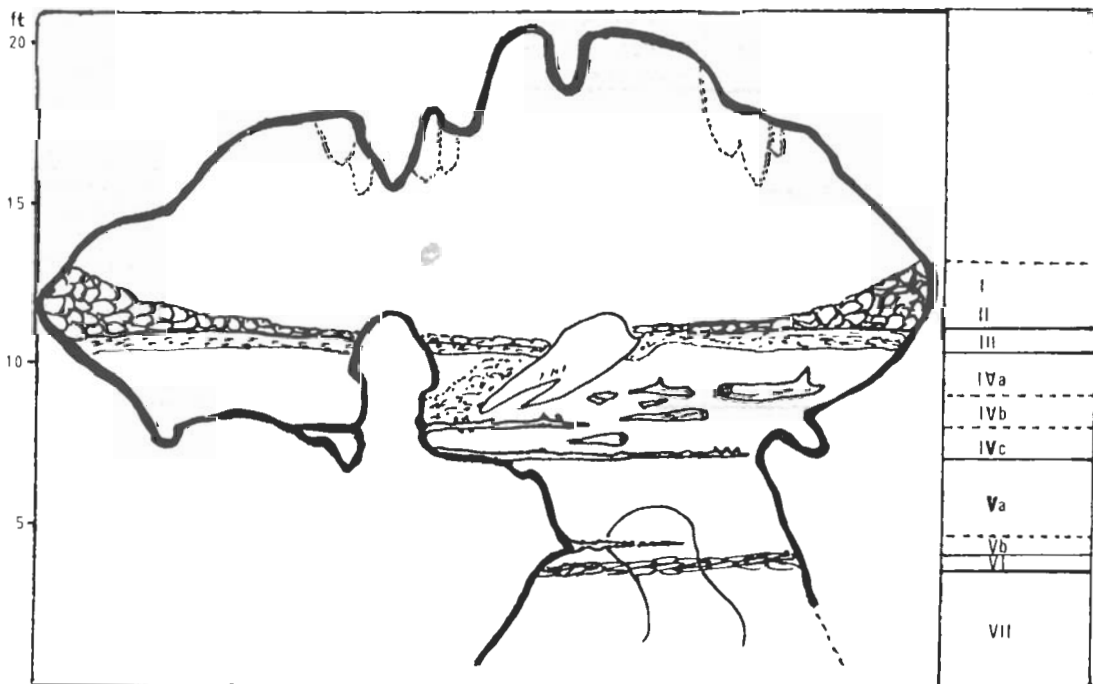


Fig. 1. Section of the deposits at Despott 1916

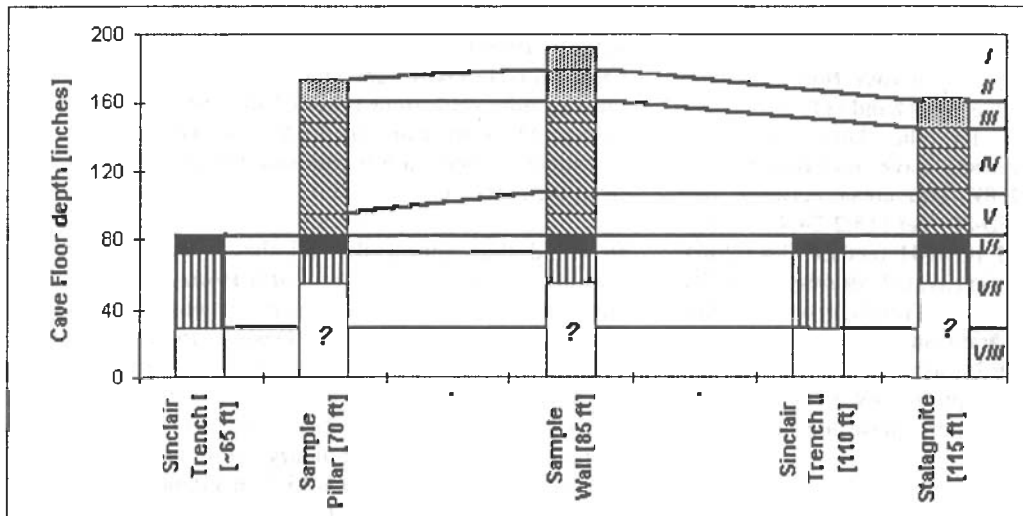


Fig. 2. Ghar Dalam stratigraphy. The correlation between the Sample pillar and wall, and the stalagmitic sheets of the Despott 1916 trench. (Superficial boulder layer (I) now not evident in sample sites)

respectively from the entrance. These have been accurately documented by G. Sinclair (Sinclair, 1924). The Sample Pillar is made up of seven layers consisting of an uppermost cave earth layer, four layers making up the Red Earth horizon, and the boulder/small stone layer overlying the bone breccia. The Red Earth horizon layers include an uppermost red soil, followed by a torba layer, a thick red earth layer and a fossiliferous layer containing red earth. The Sample Wall appears to be composed of eight layers. The superficial layers are made up of a cave earth layer overlying a pebble containing earth. These layers are separated from the underlying Red Earth Horizon by a thin stalagmitic cap composed of red soil. The Red Earth horizon is made up of six layers including a red soil, a torba layer, a fossiliferous layer, a red soil layer, a fossiliferous layer

and another red soil layer. This overlies the boulder/small stones layer and the Bone Breccia. At both sites the bone Breccia has not been completely excavated, thus the lowermost detrital clay layer has not been exposed. The composition of the lowermost cave floor layers was demonstrated by the first trench dug by Sinclair at about 65 feet from the entrance (Sinclair, 1924). The correlation between

the Sample pillar and wall, and the stalagmitic sheets of the Despott 1916 trench is shown in Figure 2.

Based on the above descriptions, it appears that the cave floor stratification at Ghar Dalam can be summarised as consisting of eight main strata (Table 3). During their deposition, the Red Earth Layers dried out periodically for a period sufficient for the stalagmite and the surrounding floor deposits to acquire a stalagmitic extension. This process occurred at least on three, possibly four occasions.

The macro & microfauna in the various cave floor layers

The faunal correlations as described during the excavations suggest a number of definite faunal stages

LAYER	STRATA	DESCRIPTION	FAUNAL STAGE
I	Superficial Stone/Boulder Layer	Layer of rounded boulders, particularly thick near the sides of the cave.	
II	Cave Earth Layer	Dark reddish clayey cave earth	<i>Rattus rattus</i> Stage
III	Small stones/pebbles Layer	Darkish grey cave earth thickly strewn with subangular stones and pebbles.	<i>Apodemus sylvaticus</i> Stage
IV a	Upper Red Earth Layers	A deep vegetable soil with a number of brownish-red and whitish alternating layers. This deep deposit was subdivided into at least five divisions by stalagmitic plates, calcite incrustations or torba floors.	[?] <i>Apodemus sylvaticus</i> Stage [lower level]
IV b			<i>Pitymys melitensis</i> Stage [Upper level] or <i>Cervus</i> stage
IV c			<i>Pitymys melitensis</i> Stage [Lower level] or <i>Carnivora</i> Stage
V a	Lower Red Earth Layers		
V b			
VI	Pebble Layer	A deposit consisting of rolled small boulders and pebbles embedded quite loosely in a clayey red earth.	
VII	Bone Breccia Layer	A clayey deposit containing markedly rolled fossil bone remains. Light green in colour becoming brownish in the inner regions of the cave. Markedly consolidated in the outer regions of the cave.	<i>Maltamys sp.</i> stage or <i>Gliridae</i> stage
VIII	Detrital Clay Layer	A plastic laminated clay, yellowish blue in colour.	Sterile Layer

Table 3. Stratification of Ghar Dalam cave floor.

represented by various layers. The Holocene deposits are represented from below upwards by the approximate upper fifth of the Red Earth layers, the pebble layer, the cave earth layer, and the superficial large stones/boulder layer (Table 3: layers I-III/IVa). These layers were characterised by the presence of domestic animals remains. These four layers have been subdivided into two faunal stages by G. Storch on the basis of their rodent fauna: an upper *Rattus rattus* Stage (level I-II) and a lower *Apodemus sylvaticus* Stage (level III/IVa) (Storch, 1974). The fauna of the Domestic Animals Layers was investigated by Storch and by Boessneck and Kuver in 1970. The micro mammalian fauna included the species *Crocidura russula*, *Rhinolophus hipposideros*, *Rhinolophus euryale*, *Myotis oxygnathus*, *Apodemus sylvaticus*, *Rattus rattus* and *Mus musculus*. The domesticated mammal species included *Bos taurus*, *Capra hircus*, *Ovis aries*, *Sus scrofa domesticus*, and *Felis catus*. In addition, the skeletal remains included the avian species *Gallus gallus domestica*, *Columba livia* and *Coccythraustes coccythraustes*; and the herpetofauna remains of *Testudo* sp., *Chalcides ocellatus tiligugu* and *Discoglossus pictus* (Storch, 1970; Boessneck & Kuver, 1970). These studies confirmed the findings of previous excavators who also reported the species *Equus* sp., *Cervus* sp., *Oryctolagus cuniculus*, *Branta bernicla* and *Bufo viridis* (Despott, 1916; Despott, 1923; Caton-Thompson, 1923; Bate, 1935). It is noteworthy that the lower levels, including those designated Prehistoric by pottery associations were characterised by the presence of *Cervus* remains. The presence of *Cervus* until comparatively late prehistoric times was noted by J.G. Baldacchino in 1935 (Baldacchino, 1934-38). The animal remains, including *Cervus*, from these upper layers were approximately identical to those excavated from the Neolithic tombs at Xemxija (Pike, 1971). Excluding the *Cervus* sp., *Rhinolophus euryale* and *Bufo* sp. remains, the wild fauna identified in the upper layers is similar to mammals presently occurring on the Maltese Islands, and suggest ecological conditions similar to those of the present day. The *Testudo* (? *graeca*) may have been imported by man for food or may have persisted from the Late Pleistocene period (Savona-Ventura, 1984).

The subsequent faunal stage includes the Red Earth layers below the first stalagmitic transition (Table 3: layers IVb-c/IVa-b) which have been designated by G. Zammit-Maempel as the Deer or *Cervus* Layer and by G. Storch as the *Pitymys melitensis* Stage (Zammit-Maempel, 1989; Storch, 1974). This layer is characterised by a number of present day living European mammalian, reptilian and amphibian species which are now extinct in the Maltese Islands. The mammalian microfauna investigated by Storch included the species *Pitymys melitensis*, *Crocidura* sp., *Rhinolophus hipposideros*, *Rhinolophus euryale*, *Rhinolophus mehelyi*, *Rhinolophus blasii*, and *Miniopterus schreibersi*. The avian fauna included the species *Turdus* sp., *Scolopax ghardalamensis*, *Corvus* cf. *frugilegus*, passerine birds and an unidentified Estrildidae. The herpetofauna remains included the species *Bufo bufo* and *Emys orbicularis* (Storch, 1974; Caton-Thompson, 1925; Fischer & Stephan, 1974; Despott, 1923; Savona-Ventura, 1984). The macro-

mammalian species are represented by a significant number of remains of *Cervus* sp., which have been shown to exhibit a graduated sequence of sizes of deer bones suggestive of a local progressive stunting event (Zammit-Maempel, 1989). Another herbivore excavated from these remains included the *Bos* sp. excavated from the middle third of the third layer of Baldacchino Trench IV (Baldacchino, 1934-38).

The macromammals of the Red Earth deposits of the deeper layers (Table 3: layers Va-b), are further characterised by the presence of carnivores in the form of *Canis lupus*, *Vulpes vulpes* and *Ursus arctos* (Cooke, 1893a; Ashby & Despott, 1916; Despott, 1923; Baldacchino, 1934-38). The lower Red Earth deposits were also described by a number of excavators to contain hippopotamus and elephant remains generally attributed to the species *Hippopotamus pentlandi* and *Palaeoloxodon mnaidrensis* (Cooke, 1893a/b; Despott, 1918; Despott, 1923; Caton Thompson, 1923). The carnivores and larger herbivores are conspicuously absent in the Upper Red Earth deposit (Table 3: layers IVb-c), and the only hippopotamus fossil recorded in the Upper Red Earth layer was a series of leg bones found in a moderately deep fissure in the Despott Middle trench which probably dated to an earlier period (Despott, 1923). The presence of these hippopotamus and elephant remains in the Red Earth layers has been attributed to these fossils being displaced from the lower Breccia deposits by the violence of the flooding, or by these fossils being by some coincidence caught up or lodged on ledges and fissures (Sinclair, 1924; Caton-Thompson, 1925). The difference in mineralization and the unrolled state of these Red Earth Layer fossils contrast with those found in the lower Bone Breccia deposits. Furthermore many of these deposits were distributed evenly throughout the deposit, and it is possible that these animals lived contemporary with the *Cervus* during the time of deposition of the Lower Red Earth Deposit (Cooke, 1893a; Despott, 1918; Despott, 1923; Baldacchino, 1934-38).

Hippopotamus pentlandi and *Palaeoloxodon mnaidrensis* are specific names referring to the pigmy forms of hippopotamus and elephant excavated from various Pleistocene sites in Malta. The remains of hippopotamus and elephant from the Lower Red Earth layer may however have referred to animal species having modern proportions. The recently excavated hippopotamus remains from Ghar Dalam appear to belong to an animal having proportions which match modern hippopotamus species (Ghar Dalam Museum exhibit). In 1914, the excavation of a hippopotamus skull was described. The skull measured 2ft 3in (68.58 cm) from tip of snout to the occipital bones. In contrast the modern rare pigmy hippopotamus (*Choeropsis liberiensis*) with a total length of about 1.5-1.7 m (4.9-5.7 ft), has a head length which approximates 37-43 cm. This species lives along streams and in wet forests of West Africa. The modern hippopotamus (*Hippopotamus amphibius*) may reach a length of 2.9-4.9 m (9.5-16 feet), with an approximate head length of 72-122 cm (Ashby & Despott, 1916). The excavation of elephant remains of normal dimensions attributed to the species *Palaeoloxodon antiquus* was excavated in 1908 by N. Tagliaferro from a Pleistocene

fissure deposit at Zebbug. The excavation of large sized elephant remains was previously reported by A.L. Adams and T. Spratt in the 19th century. The elephant tusks excavated from the Red Earth layer by J.G. Baldacchino in 1936 (Baldacchino Trench 4) were reported to be of large dimensions, measuring 86-165 cm along the outer curve (Tagliaferro, 1915; Adams, 1866; Spratt, 1867; Baldacchino, 1934-38). Both *Cervus* and *Palaeoloxodon* appear to have lived contemporaneously with the giant land tortoise *Geochelone robusta* (Tagliaferro, 1913).

The third faunal stage (Table 3: layers VI-VII) is characterised by a large amount of rolled bones belonging to *Hippopotamus pentlandi*, *H. melitensis*, *H. minor*, *Palaeoloxodon mnaidriensis*, *P. melitensis*, and *P. flaconeri* represented in the Pebbles and the Bone Breccia Layers. This stage has been referred to as the Hippopotamus Layer corresponding to the *Leithia cartei* Stage of Storch (1974) and Zammit-Maempel (1989). The identification of the *Leithia cartei* micromammal by Storch (1974) has recently been questioned, and G. Storch now prefers to refer the micromammal to the *Eliomys (Maltamys)* sp. (Storch, personal communication in lit. dated 24 March 1998). In view of this, the present authors prefer to refer to this stage as the Gliridae stage. The *Cervus* remains described from this stage were generally found in the uppermost parts of these deposits (Despott, 1918; Despott, 1923). This faunal stage would appear to require larger fresh water areas, forests with high trees and open areas (Storch, 1974). This stage is characterised by the absence of large carnivore species, accounting for the tendency towards dwarfism of the herbivores and towards gigantism of the lower mammals. The only record of an *Ursus arctos* remain from this horizon was a third upper incisor tooth obtained from the second trench dug by J.G. Baldacchino (sixth layer). This was a thin 9-12 inches

deposit and the specimen may have belonged to the upper deposit, particularly since the excavation site had been previously disturbed by Cooke and Caton-Thompson (Baldacchino, 1934-38). Only one carnivore has been definitely associated with this faunal stage - *Nesolutra euxena* - a mustelid found in the Tal-Gnien fissure at Mqabba, Malta (Bate, 1935). The micromammal fauna included the rodent species *Eliomys (Maltamys) ? gollcheri*; the shrew *Crocidura cf. russula*; and the chiropteran species *Rhinolophus hipposideros*, *Rhinolophus mehelyi birzebugensis*, *Rhinolophus blasii*, *Myotis exilis*, *Myotis bechsteini robustus*, *Myotis ghardalamensis*, *Myotis capaccini*, *Eptesicus praeglacialis*, *Pipistrellus pipistrellus*, and *Miniopterus schreibersi*. The avian fauna was represented by *Anas acuta* (?), *Coturnix coturnix*, *Alectoris graeca* (?), *Scolopax ghardalamensis*, *Tyto alba*, *Otus scops*, *Hirundo* sp., *Turdus* sp., *Carduelis chloris*, *Coccothraustes coccothraustes*, and *Sturnus vulgaris* (Fischer & Stephan, 1974).

Relative dating of fossil remains

A variety of scientific tests utilising nitrogen, fluorine, iron, phosphate and uranium oxide, established as useful in determining relative dating of fossil remains, were performed on various animal bone samples excavated from Ghar Dalam by Prof. K. Oakley of the Museum of Natural History (London). These bones belonged to the *Hippopotamus* sp., *Cervus* sp., *Sus* sp., and *Equus* sp. excavated from various depths of the cave floor. The results of these tests are available in the form of original readings in the "Green Book" at the Museum (Brit. Mus., n.d.). These results were first fully published in 1997 (Brit. Mus., n.d.; Mifsud & Mifsud, 1997) (Table 4).

The assessment of the nitrogen, fluorine, phosphate and uranium content is a useful method of assessing whether several bones found in association in the same stratigraphic deposit are in fact of the same relative age.

SPECIES	SAMPLE	Fluorine	Uranium	Nitrogen	Phosphate	Iron
<i>Hippopotamus</i>	Ma.4	0.1 0.1	N/A	0	34	0
	Ma.21	N/A	4	0.23	N/A	N/A
	Ma.22	N/A	9	0.31	N/A	N/A
	Ma.33	N/A	N/A	0.4	N/A	N/A
	Ma.34	N/A	N/A	0.4	N/A	N/A
	mean+sd (n)	0.1+0.0 (2)	6.50+3.54 (2)	0.27+0.17 (5)	34 (1)	0 (1)
<i>Cervus</i>	Ma.3	0.25 0.3	N/A	0.13	33.5	<0.2
	Ma.23	N/A	12	0.23	N/A	N/A
	Ma.24	N/A	7	0 0.41	N/A	N/A
	Ma.25	N/A	4	0 0.48	N/A	N/A
	mean+sd (n)	0.28+0.04 (2)	7.67+4.04 (3)	0.21+0.24 (6)	33.5 (1)	<0.2 (1)
<i>Sus</i>	Ma.32	N/A	8	0.88	N/A	N/A
	mean+sd (n)	N/A	8 (1)	0.88 (1)	N/A	N/A
<i>Equus</i>	Ma.30	N/A	0	1.01	N/A	N/A
	Ma.31	N/A	0	2.64	N/A	N/A
	mean+sd (n)	N/A	0+0.0 (2)	1.83+1.15 (2)	N/A	N/A

Table 4. Chemical assay results (N/A: not assessed).

In the deposit, the bone's protein, mainly collagen, content is very gradually reduced by the process of chemical decay. Thus the most useful index for the amount of protein present is the bone's nitrogen content, which for a modern bone is around 4%. With increasing age, the nitrogen content progressively decreases. The rate at which the level of nitrogen declines depends on the temperature, the water, chemical and bacteriological content of the environment in which the bone is buried. The phosphate content similarly decreases with time. At the same time, percolating ground water has significant effects on the composition of bone. Elements present in solution in the ground water - fluorine, uranium and iron - are absorbed gradually by the bone. Thus, the content of fluorine, uranium and iron in buried bone gradually increases. The rate of increase in fluorine, uranium and iron depend on the local concentrations of the elements in the percolating water and the rate of water flow. Modern bone has only traces of these elements, with the level of uranium oxide being practically nil, fluorine being less than 0.1%, while iron amounts to about 0.007%. Nitrogen estimation alone can be misleading since the rate of chemical decay is a markedly complicated process dependant upon a number of chemical and biological variables. In addition, the assays available (Weiler & Strauss: unwashed and Government Laboratory using Kjeldahl) are not always reproducible and give a wide range of results for the same sample. In contrast, the uptake of fluorine and uranium by buried organic remains is related to chemical factors alone resulting in more accurate and reliable assays. In view of the variables, the chemical tests cannot be used for the basis of absolute dating tests, but on an individual site chemical dating can distinguish bones of different age found in apparent stratigraphical association. The interpretations of a series of results must thus be considered in the light of the limitations of the technique (Renfrew & Bahn, 1994; Mifsud & Mifsud, 1997).

It is generally presumed that at Ghar Dalam, the *Hippopotamus* predated the *Cervus* layers, although the stratigraphic evidence in fact suggests that these animals may have overlapped. The scientific results suggest that the *Hippopotamus* and *Cervus* samples submitted may have been contemporary or possibly that the *Cervus* specimens were in fact older than the *Hippopotamus* ones. The nitrogen and phosphate mean levels did not appear to show any differences, while the mean fluorine and uranium values appeared overall higher in the *Cervus* specimens. These observations could be interpreted as evidence that the *Hippopotamus* and the *Cervus* samples are contemporaneous. The observed results may, however, have resulted from the stalagmitic impregnation of the *Hippopotamus* bones in the Bone Breccia. The stalagmitic impregnation would have prevented further percolation into the bones by water carrying fluorine and uranium, thus maintaining stable values of these elements in the bones.

The *Equus* specimens assayed suggested that these were definitely younger than both the *Cervus* and *Hippopotamus* specimens on the basis of higher nitrogen values and markedly lower uranium values. The *Sus* specimen assayed appeared to be contemporary with the *Cervus* on the basis of the uranium level, and possibly younger on the basis of the nitrogen value. The specimen

was however definitely older than the *Equus* remains.

It would thus appear that the F-U-N tests performed on the Ghar Dalam bone remains confirm three definite stratigraphical horizons. The lowest horizon yielded the *Hippopotamus* and *Cervus* remains. This may in fact represent two divisions, with the lowest stalagmitic hardened division yielding the *Hippopotamus* and the upper Red Earth division the *Cervus* remains. The middle horizon yielded the *Sus* remains, while the upper horizon yielded the *Equus* remains.

Conclusions

It would appear that the Ghar Dalam cave floor stratification reflects a number of geological events with changes in the local fauna in each period. The lowermost layer consists of a detrital clay formed in a closed cave system with no influence from the external environment. The overlying *Hippopotamus* Bone Breccia has been dated by electron spin resonance and uranium series disequilibria to 130,000-110,000 BP and has been assigned faunistically to the *Leithia cartei* [Gliridae Stage] faunal stage (Bouchez et al, 1988; Storch, 1974) placing this in the Upper Pleistocene (Riss-Wurm interglacial or Early Wurm glacial). This is followed by the rounded boulder/small stones layer which, while faunistically poor, seems overall similar to the preceding one. The Red Earth horizon represents the deposits of the Wurm fourth glacial. This horizon appears to be faunistically composed of two main stages, the earlier [Carnivora Stage] being characterised by the macromammalian species *Hippopotamus* sp., *Palaeoloxodon* sp., *Vulpes vulpes*, *Canis lupus*, and *Ursus cf. arctos* besides the *Cervus* sp.; while the younger stage [Cervus Stage] being characterised by *Cervus* sp. and *Bos* sp. and a marked absence of carnivores and the larger herbivores. The date c. 125,000 BP has been adopted as the beginning of the last interglacial transgression and the beginning of the Wurm glacial (Phillips, 1980). The Maltese Islands were apparently connected with Sicily, Tunisia, Libya and Sardinia during the Riss glacial of the Middle Pleistocene (c.780,000-125,000 BP); and with Sicily during the Wurm glacial (Upper Pleistocene - c.125,000-10,000 BP). The Wurm glacial has been subdivided into three main subdivisions with a number of interstadials. The Late Wurm glacial started at c.23,000 years BP and was characterised by two short interstadials. This last connection with Sicily accounts for the present prevalence of a Sicilian-type fauna on the Maltese Islands (Phillips, 1980; Pasa, 1953; Corti & Lanza, 1973). The Islands area during the Ice Ages was, like the rest of the Mediterranean, not directly influenced by glaciation, but by Pluvial periods. These Pluvial periods were subdivided into three sub-phases. The first phase or the Pseudo-Pluvial Period was characterised by a summer which was cooler than today and a warmer winter. Rain precipitation was less restricted in spring and autumn. These climatic conditions resulted in the extension of the central European forest into the Mediterranean region. The unsettled weather further aggravated in the second phase or true Pluvial Period when the summer became more unsettled with much rain and rapid intense temperature changes while the winters were cooler. The Pluvial Phase was followed by a rapid return to present day type Mediterranean climate with a decline in total rain precipitation. The Mediterranean

region may in fact have been rather arid during the glacials, increasing in humidity during the interglacial periods (Attenborough, 1987; Hunt, 1997; Savona-Ventura, 1985). The Holocene period dated to c.<10,000 years BP is apparently represented by the uppermost layer of the Red Earth horizon, accounting for about one-fifth of the thickness of this horizon, together with the layers assigned as the *Apodemus sylvaticus* stage (dated 7,200-2,700 years BP) and the *Rattus rattus* stage (dated <2700 years BP). These are characterised by the presence of domesticated animals.

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Research Article

The Potential for the 'Physics for Science Teachers Project' (PST) from the Open University (OU) in the U.K. to Contribute to Solving the Problem of the Shortage of Teachers of Physics in Maltese Secondary Schools.

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Summary. *Given the nature and extent of the shortage of teachers qualified in physics, there are many features of the Physics for Science Teachers Initiative described in this paper, that could be utilised, adapted and reconciled to devise and implement programmes of retraining to meet the needs of Maltese Schools.*

Keywords: Physics, science teachers, Open University, Malta.

The effective delivery of physics within the Maltese Science Curriculum is threatened most sharply by teacher shortages amongst those appropriately qualified to teach this scientific discipline. There exists a mismatch between the expertise of individual teachers in particular areas of science, most notably biology, and the need for teachers of physics.

There is the resultant danger of the physics-oriented curriculum being under-represented in the secondary school curriculum in Malta.

This is likely to exert a damaging effect on the future of Maltese science, industrial and commercial efficiency and competitiveness in the world market place.

A similar story from England

In the late 1980's and early 1990's, a DES and British Petroleum funded project was able to make a major contribution to alleviating the 'crisis' in physics teaching by training science teachers with experience in other science disciplines to deliver the physics curriculum with confidence and enthusiasm. This was done by devising distance learning teaching materials which would:

- (i) improve teachers' understanding of key areas of physics included in GCSE science.
- (ii) provide a context of teaching physics within the secondary school curriculum, with opportunities for developing relevant school-based and classroom skills.

There was also the recognition, from the OU, that forms of local tutorial support and elaboration of written/video/audio materials would be essential in realising a fully effective training programme. In particular, the need to provide opportunities for associated practical and laboratory skills. Such local support utilised local Education Authority (LEA)-based expertise (through Science Advisory teachers) and facilities of other Institutions of Higher Education active in the field of In-service Training for practising teachers.

The PST resources

A series of texts were compiled in which comprehensive

physics content was explicitly related to the physics curriculum. In some cases this was drawn from existing OU undergraduate science texts, but much was newly written, by teams of teachers and OU academic staff acting as co-authors. In two of the texts (Blocks A and F, see Figure 1), broader issues of secondary science teaching and curriculum reviews were included. Throughout Blocks B-E considerable attention was paid to assisting science teachers to develop both the background subject knowledge alongside appropriate competencies and strategies for the classroom.

Block A - Issues in science teaching
Block B - Mechanics; temperature and heat
Block C - Electricity and Magnetism
Block D - Energy; atomic physics
Block E - Electronics; waves and rays
Block F - School science in focus

Mathematics support material; PST audiocassette and videocassette; local support, including practical activities and discussions at group sessions
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Figure 1. The structure and mode of delivery of the PST package. Blocks B-E consist of a number of individual booklets and their titles have been abbreviated here for convenience.

A variety of cost-effective patterns of use were negotiated by consultation between members of the PST Course Team (and in particular two Academic Liaison Advisers to the project) and local providers of training. The central feature of the various training programmes established through various collaborative schemes, was that training was achieved without removing scarce teachers from the classroom for long periods.

A selection of the training initiatives which evolved is described below, along with some of the key observations drawn from the early stages of the project. These have been taken from a paper by Tresman and Whitelegg (1989): 'In-service at a Distance: The 'Physics for Science Teachers Project'.

Modes of delivery of the PST resources

By the summer of 1989, some 650 teachers were studying the package. Within this overall number were 41 groups of teachers being sponsored by 59 local authorities through the provision of release time and local group tutorial provision (in some instances through a local HE College). An additional 15 LEA's plan an Autumn 89 start. Authorities have faced difficult choices in balancing the need for release time to attend group tutorial sessions, with the expense of providing and obtaining distance learning material that can be supported and extended by a wide variety of tutorial back-up arrangements. Thus we have seen the following types of enterprising course structures in operation.

- Weekly meetings alternating practical sessions with tutorials. Cover arranged for practicals that are full day sessions (9.30-4pm). Tutorials are twilight sessions (4.15-6pm). Also 4-5 hours release time per week for private study.
- Half a day per week release time for private study, a full day each half term for practicals plus a residential weekend every term.
- Release for 1 day per week plus 6 practical days at a local University with a University tutor. Fortnightly meetings with a local teacher for tutorials.
- 20 hours tutorial support per term plus week long Easter and Summer schools, totalling 30 hours, for practicals.
- 11 tutorials spread throughout the year and practical classes each half term at local HE College. (Teachers from State and Independent sector attend this scheme).
- Release for half a day per week for private study plus 6 tutor-led practical days.
- 3-4 evening meetings per term with a tutor from a local University plus involvement of heads of physics. No release time.
- 6 Saturday practicals at 5 different schools with a tutor from each school, plus telephone tutor available for about 2 hours per week. Half a day per week private study in school time.

The partnership of a large number of local authorities with the Open University has realised the objective that this science INSET resource should be equally accessible to all practising science teachers, irrespective of geographic location. The job of bringing the University to would be participants in the PST schemes was taken up by two Academic Liaison Advisers appointed to the Project. These were available to work with authorities and institutions to establish the most appropriate form of inclusion of PST within INSET courses to cope with the problem as perceived in that specific area.

Observations from the first year of PST

* The package:

- (i) *attracted teachers from a wide variety of scientific specialisations.* Most participating teachers were biologists, but there were many chemists and some earth scientists and home economics teachers.
- (ii) *needed to be flexible in structure.* There was an

advantage in offering a package that was sufficiently flexible in structure that it could be approached via a number of routes, forming study programmes of varying emphases and duration.

- (iii) *provided a means of fully integrating key physics content with pedagogic issues.* This helped place physics in a wider scientific context and provided teachers with fuller understanding of contemporary developments in the teaching of science in schools. In addition to covering in depth the key areas of physics, blocks B,E addressed the practical problems of the classroom teacher, helping teachers to consider and develop teaching styles and strategies which enabled them to approach physics teaching with increased confidence. Blocks A and F considered key issues of science teaching such as curriculum planning and design, problems of providing continuity throughout the secondary science curriculum, language and concept development, assessment and practical work, liaison with industry and curriculum models to deliver balanced science.
- (iv) *allowed for more intense periods of study at less busy times of the school year.* Since the choice of starting date resided with the participating teachers and the supporting LEA, episodes of concentrated study could be arranged to coincide with such periods in the school year, for example in the summer term, particularly after the examinations.
- (v) *enabled teachers to concentrate on particular parts of the package to support their weaknesses in certain topics.* The blocks are all self-standing, allowing those teachers who are more experienced in the teaching of physics to select those areas which are in need of support.
- (vi) *enabled the materials to be integrated into a University or Polytechnic scheme to provide a postgraduate qualification.* One consequence of the production of such a flexible resource was that Open University accreditation was not an integral part of the package. However, many LEA's and local institutions of higher education worked together to provide certification for those teachers studying the package in full and sometimes as part of a broader course of study.
- (vii) *overwhelming need for group sessions embracing practical work to support theory provided in the distance learning texts.* Although the frequency of tutor-led sessions has varied substantially according to the extent of resource the LEA is able to commit to PST led schemes, all the teachers placed an extremely high priority on the provision of practical work. The need for experienced teachers of physics to be on hand to provide a supportive environment in which teachers could develop confidence in handling unfamiliar apparatus was universally expressed.

* *The materials appeared to motivate the participating teachers.*

Given that some of the participating teachers may have been turned off physics during their own school career, the materials try to interest this audience by including consideration of the social implications of the subject and discussing technological applications wherever possible. We were also aware of the need to make the text as applicable to women as to men and this approach has been validated by some of the female teachers who say that they did not feel that they were studying material that was inappropriate for them, and did not address them, as so much physics material in the past has not done.

* Participation in courses based on PST materials appeared to influence considerably the view of individual participants of their ability to teach physics effectively.

Hands on experience with physics apparatus in the group sessions combined with a thorough grounding of the theory behind the experimental work has increased the confidence of the course participants.

* Where local tutorial provision for PST has been provided by a local institution, different forms of accreditation have developed.

29 schemes are offering local accreditation for PST through a university, polytechnic or college. A few examples are given below:

Edge Hill College of Higher Education

Reports on the practical sessions plus a 4,000 word essay lead to the award of an *Edge Hill Advanced Certificate* equivalent to 1 module from Lancaster University.

York University

PST is built into their 2 year course to form a *Diploma in Physics Teaching* assessed by a 10,000 word written report.

Sheffield Polytechnic

The Polytechnic will award a *Vocational Diploma in the Teaching of Physics*. The course (which also included 3 additional booklets produced by the Poly) will be continuously assessed and have examinations at the end of each section. It is deemed to be approximately equivalent to half a year's full-time study at Master's level. (Under CATS such a course would attract 60 credits at Master's level.)

Kings College, Centre for Educational Studies

A certificate from the Centre is awarded for satisfactory completion of 1 assignment of about 3,000 words, equivalent to 20-30 hours work.

Thames Polytechnic (2 year course)

The Poly awards of a *Postgraduate Diploma in Physics for Teachers*, if teachers pass an examination at the end of each year and fulfil coursework and laboratory requirements that are based on continuous assessment. The course uses PST in the first year only.

Homerton College, Cambridge

The College offers a *Certificate of Further Professional*

Study (CFPS) and a *Diploma* – the latter based on a more extended scheme of assessment. The *Diploma* offers 80 credits towards the *Modular Advanced Diploma in Educational and Professional Studies*. Students decide by the end of the first term which of the two levels of assessment they wish to follow.

Conclusions

Over 600 packs of resources were sold in the first year of the Project, with nearly 60 LEA's entering into training schemes of some kind, using Government funding designated as a 'National Priority Category' of funding to cover some or all of the costs.

During the following two to three years, this rose to around 1200 sales, reaching between 50 and 60% of the predicted shortage of 2000 physics teachers (Smithers and Robinson (1988).

In establishing related programmes of local face-to-face tuition and support, the degree of collaboration between the OU, other Institutions of Higher Education and LEA's was extensive and highly innovative, enabling large numbers of teachers to study OU materials and experience input from experienced tutors and fellow teachers of physics who helped to mediate the OU materials through face-to-face instances of enhancement.

There was evidence of substantial progress from a wide variety of backgrounds and starting points for teachers. Through a variety of forms of assessment and evaluation, they displayed increased knowledge of physics concepts and how to teach them and improved knowledge of resources and equipment. Teachers greatly valued the chance to come together for practical and study sessions, but, since the OU resources used distance learning strategies, they did not require a great deal of time away from the classroom.

Teachers' perceptions of their ability and confidence to teach physics effectively were radically altered in many cases. Through the provision of OU resources, they were left with a valuable resource for future teaching and support of colleagues.

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Research Article

The Macrobenthic Species of the Infralittoral to Circalittoral Transition Zone off the Northeastern Coast of Malta (Central Mediterranean)

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Summary. *The macrobenthic assemblages of the sedimentary bottoms off the northeastern coast of Malta were studied during the summer of 1993. Grab and dredge samples were collected from depths of 21-75m from an area of approximately 48 km² off Comino, Mellieha Bay and St. Paul's Bay. Below ca. 40m the bottom was predominantly sandy with meadows of Posidonia oceanica, giving way to bare sand in the lower infralittoral. Between 45m and 75m, the bottom consisted of organogenic gravel with abundant free-living calcareous rhodophytes, predominantly the corallines Phymatolithon calcareum and Lithothamnion corallioides. Such bottoms, known as maerl, have not been reported previously from the Maltese Islands. 19 species of macroalgae, 1 phanerogam, and 108 species of macrofauna were recorded, the bulk of these from the maerl bottom. An additional 122 species of molluscs occurred as empty shells. Maerl bottoms support a high species richness, even if abundance is low. There is evidence to suggest that maerl is the predominant bottom type all along the northeastern coast of the Maltese Islands in the transition between the lower infralittoral and the circalittoral, which occurs at depths of 45-75m.*

Keywords: Benthos, Infralittoral, Circalittoral, Macrobenthic assemblages, Maerl, Transition zone, Maltese Islands.

The sublittoral marine benthic assemblages of the Maltese Islands have only recently started being investigated (Borg 1991, 1995; Valentino, 1991; Busuttill, 1992; Buttigieg, 1993; Borg & Schembri, 1995a,b,c; Jones, 1996; Micallef, 1996; Pirotta, 1996; Borg et al., 1997). However, most studies were carried out by diving using SCUBA. Therefore, practically all work has focused on the infralittoral, mainly at depths not exceeding 40m, as this is considered to be the limit for safe diving using normal SCUBA techniques. The available scanty data on the biotic assemblages of the lower infralittoral and upper circalittoral is mainly descriptive and based on studies made more than a century ago (McAndrew, 1850; Piccone, 1883-84) and on the more or less casual observations of sports divers and fishermen (Rolié, 1991; Anderson et al., 1992).

In 1993, UNESCO funded an oceanographic survey of the coastal waters off the northeastern coast of Malta. Although primarily concerned with physical oceanography, we were afforded the opportunity of carrying out some remote sampling of the macrobenthos. We chose to focus on the transition zone between the lower infralittoral and the upper circalittoral, in order to extend our knowledge of the benthic assemblages of the Maltese Islands to those of deeper water. Being transitional between infralittoral assemblages dominated by photophilic algae and phanerogams, and circalittoral ones dominated by sciaphilic algae and sessile invertebrates, this zone is of considerable biological interest (Pérès, 1967; 1982; 1985). Such studies may be of more than local interest since these transitional biocoenoses have been extensively investigated only in

the Western Mediterranean and there are very few data from the central and eastern parts of this sea (Albertelli et al., 1995).

The study area was centred on a point located at 36°00.80'N/14°25.80'E and covered approximately 48 km² of the seabed off Comino, Mellieha Bay and St. Paul's Bay (Figure 1). Data on the water column in this area have been published recently by Drago (1997); some of Drago's stations lie very close to our own benthic sampling stations. During summer, the upper 50m layer of water shows considerable stratification in temperature and salinity. A sharp halocline occurring at a depth of ca. 16m separates a surface layer of warm water and high salinity from the underlying layers (Drago, 1997).

Material and Methods

Benthic samples were collected in August 1993 using a 0.1m² Van Veen grab and a 48cm wide naturalist dredge fitted with a 5mm mesh net bag. Both types of equipment were deployed from a 14m long Maltese fishing vessel (*luzzu*) equipped with derrick and capstan winch. Two replicate grab samples were collected from each of four pre-determined stations along a N-S transect off Ras il-Griebeg (Mellieha Bay); two replicate dredge samples were collected from each of four transects located off Comino, Mellieha Bay and St. Paul's Islands (Figure 1). Station details are given in Tables 1 and 2. All station positions were determined using a boat-mounted Global Positioning System (GPS).

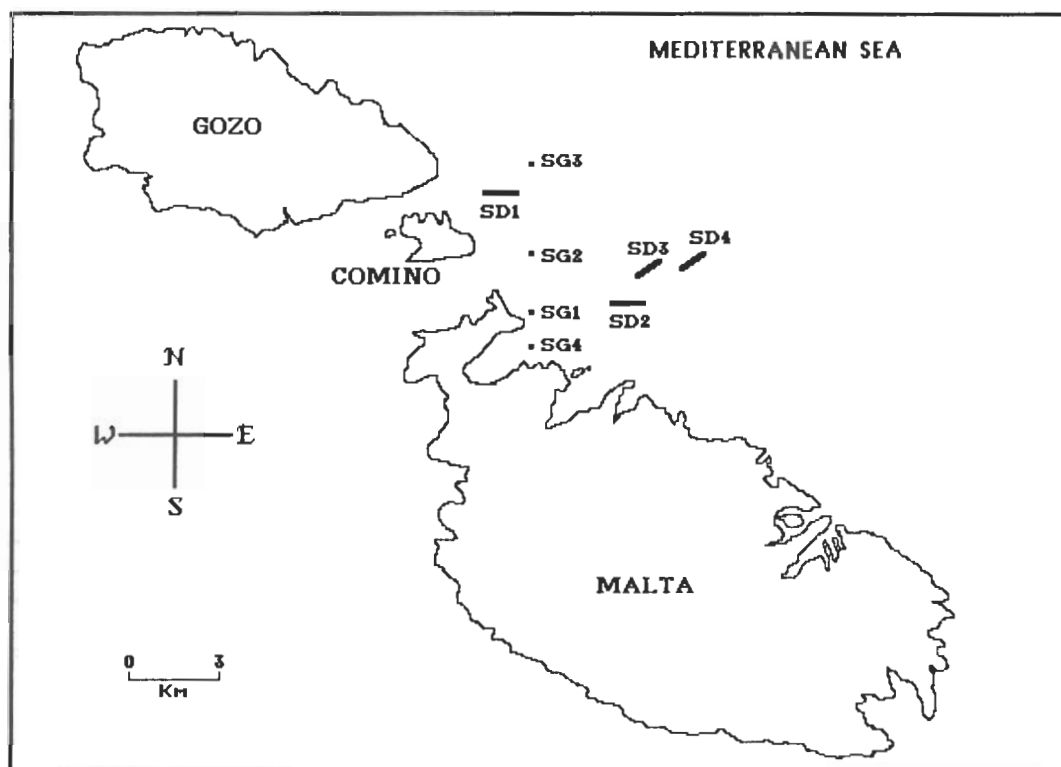


Figure 1. Map of the Maltese Islands showing the location of the sampling stations: SG - grab stations; SD - dredge stations (lines show the vessel's navigational route).

Station code	Station position	Depth (m)
SG1	35° 59.60'N/14° 23.00'E	38
SG2	36° 00.80'N/14° 23.00'E	21
SG3	36° 01.60'N/14° 23.00'E	75
SG4	35° 58.90'N/14° 23.00'E	30

Table 1 Details of the grab sample stations.
All stations were sampled on 24th August 1993.

Station code	Date (1997)	Station positions	Depth (m)
SD1	25/8	36° 01.60'N/14° 22.00'E	50
		to 36° 01.60'N/14° 22.35'E	60
SD2	25/8	35° 58.90'N/14° 25.19'E	65
		to 35° 58.90'N/14° 25.45'E	65
SD3	25/8	35° 59.55'N/14° 26.01'E	45
		to 35° 59.75'N/14° 26.25'E	46
SD4	26/8	35° 59.62'N/14° 27.52'E	51
		to 35° 59.85'N/14° 27.75'E	55

Table 2. Details of the dredge sample stations.

Samples were transported to the laboratory for subsequent sorting and identification of biota. In the laboratory, samples were sieved through a 2mm mesh and only specimens retained by the sieve were considered. Free living coralline algae were identified on entirely morphological grounds using the keys given in Hamel & Lemoine (1952). Other algae, phanerogams, and all fauna were identified using standard identification manuals. Difficult species were confirmed by specialists in the group (see Acknowledgements).

Results

All grab and dredge samples collected between depths of 45m to 75m (Tables 1 and 2) consisted of shell gravel with free living calcareous algae and little fine sediment and detritus. The dominant free-living algae were the corallines *Phymatolithon calcareum* and *Lithothamnion corallioides*, while the dominant erect forms were *Stilophora rhizodes*, *Cystoseira spinosa*, *Dictyota fasciola*, *Womersleyella setacea*, and *Flabellia petiolata*.

Grab samples collected from stations SG1, SG2 and SG4 consisted of fine sand. These samples had very few macrofauna and, with one exception, no macroflora. Live attached shoots of *Posidonia oceanica* were present in station SG4, the most inshore station. Water depth increases with increasing distance from the shore, except for station SG2 where the water is only 21m due to the presence of a rocky shoal, Is-Sikka l-Bajda.

A total of 19 macroalgae, 1 phanerogam, and 108 macrofaunal species were recorded as live individuals from the samples collected (Tables 3 and 4). An additional 122 species of molluscs were present as

unbroken dead shells (Table 5). No attempt at identifying fragments of shells, tests or other organic remains was made. Most of the specimens were identified to species level, except some polychaetes, which were only identified to family or genus.

In terms of taxocenotic abundance, the molluscs were dominant, followed by crustaceans and polychaetes. In terms of species abundance, the gastropod *Bittium latreillii* was the most numerous, with a total of 398 individuals collected from the dredge and grab samples. All other macrofaunal species were present at much lower abundances (less than 20 individuals collected from the dredge and grab samples).

Species	Station
HETEROKONTOPHYTA	
<i>Asperococcus bullosus</i> Lamouroux	SD3
<i>Cystoseira spinosa</i> Sauvageau v. <i>spinosa</i>	SD3, SD4
<i>Dictyota fasciola</i> Lamouroux	SD3, SD4
<i>Sporochnus pedunculatus</i> C. Agardh	SD4
<i>Stilophora rhizodes</i> (Turner) J. Agardh	SD3, SD4
RHODOPHYTA	
<i>Chondria</i> sp.	SD3, SD4
<i>Cryptonemia tunaeformis</i> (Bertolini) Zandarini	SD3
<i>Lithophyllum racemus</i> (Lamarck) Foslie	SD3
<i>Lithothamnion corallioides</i> P. L. & H. M. Crouan	SD1, SD3, SD4
<i>Osmundaria volubilis</i> (L.) R. E. Norris	SD3
<i>Peyssonnelia rosa-marina</i> Boudouresque & Denizot	SD1, SD3, SD4
<i>Phymatolithon calcareum</i> (Pallas) Adey & McKibbin	SD1, SD3, SD4
<i>Polysiphonia</i> sp.	SD3
<i>Rytiphloea tinctoria</i> (Clemente) C. Agardh	SD3
? <i>Sporolithon</i> sp.	SD4
<i>Syridia filamentosa</i> (Wulfen) Harvey	SD4
<i>Womersleyella setacea</i> (Hollenberg) R. E. Norris	SD3, SD4
CHLOROPHYTA	
<i>Flabellia petiolata</i> (Turra) Nizamuddin	SD3, SD4
<i>Halimeda tuna</i> (Ellis & Solander) Lamouroux	SD4
SPERMATOPHYTA	
<i>Posidonia oceanica</i> (L.) Delile	SG4

Table 3. List of macroalgae and phanerogams recorded during the present study.

Table 4. List of macrofaunal species recorded during the present study.

Species	Station
FORAMINIFERA	
<i>Miniacina miniacea</i> (L.)	SD3
ANNELIDA	
POLYCHAETA	
? <i>Autosyllis</i> sp.	SD4
<i>Dendronereis</i> sp.	SD1
<i>Eunice</i> sp. A	SD3
<i>Eunice</i> sp. B	SD3
<i>Eunice torquata</i> Quatrefages	SD4
<i>Glycera</i> sp.	SG3
<i>Hemipodus</i> sp.	SD1, SD3
<i>Hermonia</i> sp.	SD1
<i>Hydroides uncinata</i> (Philippi)	SD3
<i>Laeonereis</i> sp.	SD3
<i>Lumbrineris</i> sp.	SD3
Lumbrineridae sp.	SG1
<i>Lysidice ninetta</i> Audoiu & Milne Edwards	SG2, SD4
<i>Lysidice</i> sp.	SD3
<i>Nematonereis unicornis</i> (Grube)	SD4
<i>Nereis</i> sp.	SD1
<i>Nicon</i> sp.	SD1
<i>Psammolyce</i> sp.	SD3
Sabellidae sp.	SD1
Sigolonidae sp.	SD4
Spionidae sp.	SG2
SIPUNCULA	
<i>Aspidosiphon muelleri</i> Diesing	SG1, SG3, SD1, SD3
CRUSTACEA	
DECAPODA CARIDEA	
<i>Alpheus macrocheles</i> (Hailstone)	SD3
<i>Athanas nitescens</i> var. <i>laevirhincus</i> (Risso)	SD3
<i>Hippolyte</i> sp.	SD4
Hippolytidae sp.	SD4
<i>Processa</i> cf. <i>robusta</i> Nouvel & Hothuis	SD1
<i>Thorulus cranchii</i> (Leach)	SD3
DECAPODA ANOMURA	
<i>Anapagurus</i> cf. <i>breviaculeatus</i> Fenizia	SD4
<i>Calcinus tubularis</i> (L.)	SD3
<i>Cestopagurus timidus</i> (Roux)	SD3, SD4
<i>Galathea intermedia</i> Lilljeborg	SD3
Paguridae sp.	SD4
<i>Pagurus chevreuxi</i> (Bouvier)	SD3
<i>Pagurus cuanensis</i> Bell	SD2, SD3
<i>Pagurus excavatus</i> (Herbst)	SD4
<i>Pagurus forbesii</i> Bell	SD4

Table 4 continued. List of macrofaunal species recorded during the present study.

Species	Station
DECAPODA BRACHYURA	
<i>Atelecyclus rotundatus</i> (Oliv)	SG3
<i>Ebalia edwardsi</i> Costa	SD3, SD4
<i>Eurynome aspera</i> (Pennant)	SG3
<i>Liocarcinus corrugatus</i> (Pennant)	SD3, SD4
<i>Macropodia longirostris</i> (Fabricius)	SD3
<i>Parthenope massena</i> (Roux)	SD4
TANAIDACEA	
<i>Apeudes ? talpa</i> (Milne Edwards)	SG3
ISOPODA	
<i>Anthura gracilis</i> (Montagu)	SG2
AMPHIPODA	
<i>Amphithoe ramondi</i> Audouin	SD3, SD4
<i>Ceradocus orchestiipes</i> A. Costa	SG3, SD1
<i>Ceradocus semiserratus</i> (Bate)	SG2, SG3, SD1
<i>Cheirocratus sundevallii</i> (Rathke)	SG3
<i>Dexamine spinosa</i> (Montagu)	SG2, SD3
<i>Lepidepcreum longicorne</i> (Bate & Westwood)	SD3
<i>Leucothoe cf. spinicarpa</i> (Abildgaard)	SD3
<i>Lysianassa costae</i> Milne Edwards	SG2
<i>Lysianassa longicornis</i> Lucas	SG2, SD1
<i>Maera grossimana</i> (Montagu)	SD1
<i>Socarnes filicornis</i> (Heller)	SD3, SD4
MOLLUSCA	
POLYPLACOPHORA	
<i>Acanthochitona fascicularis</i> (L.)	SD4
<i>Leptochiton cancellatus</i> (G. B. Sowerby II)	SD1
GASTROPODA	
<i>Bittium latreillii</i> (Payraudeau)	SG3, SD1, SD3, SD4
<i>Caecum subannulatum</i> (De Folin)	SD1
<i>Caecum trachea</i> (Montagu)	SD1, SD3
<i>Calyptra chinensis</i> (L.)	SD4
<i>Gibbula ardens</i> (Von Salis)	SG1
<i>Gibbula magus</i> (L.)	SD3
<i>Haminoea hydatis</i> (L.)	SD3, SD4
<i>Melanella polita</i> (L.)	SD3
<i>Natica hebreus</i> (Martyn)	SD1
<i>Rissoella inflata</i> (Locard)	SD3
<i>Vermetus semisurrectus</i> Ant.Bivona	SG3, SD4
<i>Vitreolina philippi</i> (Rayneval, Ponzi & Van Den Heck)	SD3
<i>Volvarina mitrella</i> (Risso)	SD4

Table 4 continued. List of macrofaunal species recorded during the present study.

Species	Station
BIVALVIA	
<i>Aequipecten opercularis</i> (L.)	SD4
<i>Anomia ehippium</i> L.	SD4
<i>Arca noae</i> L.	SD1
<i>Astarte fusca</i> (Poli)	SD1
<i>Chlamys flexuosa</i> (Poli)	SD4
<i>Chlamys varia</i> (L.)	SD4
<i>Diplodonta apicalis</i> Philippi	SD2, SD3
<i>Glans aculeata</i> (Poli)	SG3
<i>Glans trapezia</i> (L.)	SG2
<i>Gonilia caliglypta</i> (Dall)	SD1, SD4
<i>Goodalia macandrewi</i> Smith	SD2, SD3
<i>Gouldia minima</i> (Montagu)	SD4
<i>Hiatella arctica</i> (L.)	SD1
<i>Lissopecten hyalinus</i> (Poli)	SD4
<i>Modiolarca subpicta</i> (Cantraine)	SD1, SD2, SD3
<i>Neolepton sulcatulum</i> (Jeffreys)	SD3
<i>Palliolum incomparabile</i> (Risso)	SD4
<i>Pecten jacobus</i> (L.)	SD4
<i>Plagiocardium papillosum</i> (Poli)	SG1, SD3
<i>Pteromeris minuta</i> (Scacchi)	SD1, SD3, SD4
<i>Timoclea ovata</i> (Pennant)	SD3
<i>Venus verrucosa</i> L.	SG3
SCAPHOPODA	
<i>Pulsellum lofotense</i> (M. Sars)	SD1
BRYOZOA	
<i>Celleporina pumicosa</i> (Pallas)	SD3
<i>Hippopodinella lata</i> Busk	SD1, SD3
<i>Lichenopora radiata</i> (Audouine & Savigny)	SD3
<i>Margaretta cereiodes</i> (Ellis & Solander)	SD3
ECHINODERMATA	
CRINOIDEA	
<i>Antedon mediterranea</i> (Lamarck)	SD1, SD3
ASTEROIDEA	
<i>Asterina gibbosa</i> (Pennant)	SG2
<i>Astropecten aranciacus</i> (L.)	SD1
<i>Echinaster sepositus</i> (Retzius)	SD1
ECHINOIDEA	
<i>Brissus unicolor</i> (Leske)	SG1
<i>Genocidaris maculata</i> A..Agassiz	SG2, SD3
<i>Echinocyamus pusillus</i> (O. F. Muller)	SG2, SD1, SD3
<i>Neolampas rostellata</i> A..Agassiz	SD1
<i>Spatangus purpureus</i> O. F. Muller	SD2

Table 5. List of empty gastropod shells and dead bivalves recorded during the present study.

Species	Station
GASTROPODA	
<i>Acmea virginia</i> (O. F. Mueller)	SD1
<i>Alvania beani</i> (Hanley in Thorpe)	SD1
<i>Alvania lineata</i> Risso	SD2, SD3
<i>Alvania mamillata</i> Risso	SG2
<i>Alvania wienkauffi</i> Jacobusi-Oliviero, Amati & Nofroni	SD2, SD3
<i>Anisocyclus pontieli</i> (Folin)	SD1
<i>Atlanta fusca</i> Souleyet	SD1
<i>Atlanta peroni</i> Lesueur	SD1
<i>Barleeia</i> cf. <i>unifasciata</i> (Montagu, 1803)	SD1, SD2
* <i>Bittium latreillii</i> (Payraudeau, 1826)	SG2, SG3, SD1, SD2, SD3, SD4
<i>Buccinulum corneum</i> (L.)	SG3
<i>Caecum clakii</i> Carpenter	SD1
* <i>Caecum subannulatum</i> De Folin	SD1, SD3, SD3
* <i>Caecum trachea</i> Montagu	SD1, SD3
<i>Calliostoma zizyphinium</i> (L.)	SD4
* <i>Calyptra chinensis</i> (L.)	SD4
<i>Careliopsis modesta</i> (De Folin)	SD3
<i>Cerithidium submammillatum</i> (De Rayneval, Ponzi & Van Den Heck)	SD1, SD2, SD3
<i>Cerithiopsis tubercularis</i> (Montagu)	SD1, SD2, SD3
<i>Cerithium vulgatum</i> Bruguiere	SG3, SD4
<i>Chrysallida clathrata</i> (Jeffreys)	SD1, SD3
<i>Chrysallida doliolum</i> (Philippi)	SD1
<i>Chrysallida emaciata</i> (Brusina)	SD1
<i>Chrysallida excavata</i> (Philippi)	SD1, SD3
<i>Chrysallida obtusa</i> (T. Brown)	SD1, SD3
<i>Clathromangelia quadrillum</i> (Dujardin)	SD3
<i>Conus mediterraneus</i> Hwass in Bruguiere	SD3, SD2, SD4
<i>Coralliophila meyendorffi</i> (Calcara)	SD3
<i>Crassopleura incrassata</i> (Dujardin)	SD1
<i>Cresis acicula</i> Rang	SD1
<i>Curveulima</i> sp.	SD1
<i>Cylichnina umbilicata</i> (Montagu)	SD1
<i>Dermomurex scalaroides</i> (Blainville)	SD4
<i>Dikoleps cutleriana</i> (Clark)	SD1
<i>Dikoleps nitens</i> (Philippi)	SD3
<i>Dikoleps pusilla</i> (Jeffreys)	SD1, SD3
<i>Eatonina ochroleuca</i> (Brusina)	SD1, SD3
<i>Emarginula rosea</i> Bell T.	SD1
<i>Epitonium aculeatum</i> (Allan)	SD1
<i>Eulimella aciculata</i> (Philippi)	SD1
<i>Eulimella ventricosa</i> (Forbes)	SD1
<i>Euspira nitida</i> (Donovan, 1804)	SD1
<i>Fusinus rostratus</i> (Olivi)	SD4
<i>Fusinus rudis</i> (Philippi)	SD1

* Also recorded live from the same or other stations (see Table 4).

Table 5 continued. List of empty gastropod shells and dead bivalves recorded during the present study.

Species	Station
<i>Gibberula miliaria</i> (L.)	SG2, SD2, SD3
<i>Gibberulina philippi</i> (Monterosato)	SD1, SD2
* <i>Gibbula ardens</i> (Von Salis)	SG1
<i>Gibbula guttaurii</i> (Philippi)	SD1, SD2, SD3
<i>Gibbula turbinoides</i> (Deshayes)	SG1
<i>Granulina marginata</i> (Bivona)	SD2, SD3
<i>Granulina occulta</i> (Monterosato)	SD1
<i>Haedropleura secalina</i> (Philippi)	SD1
<i>Haedropleura septangularis</i> (Montagu)	SG3
* <i>Haminoea hydatis</i> (L.)	SG1, SG2, SG3, SD1, SD2, SD3
<i>Jujubinus exasperatus</i> (Pennant)	SG2, SG3, SD1, SD4
<i>Jujubinus montagui</i> (W. Wood)	SD4
<i>Jujubinus striatus</i> (L.)	SD4
<i>Lamellaria perspicua</i> (L.)	SD3
<i>Limacina inflata</i> (D'Orbigny)	SD1, SD3
<i>Mangelia smithi</i> (Forbes)	SD1
<i>Mangeliella fieldeni</i> Van Aartsen & Fehr de Wal	SD3
* <i>Melanella polita</i> (L.)	SD1
<i>Mitrella scripta</i> (L.)	SG3, SD4
<i>Mitrolumna olivoidea</i> (Cantraine)	SD2, SD4
<i>Nanobalcis nana</i> (Monterosato)	SD1
<i>Obtusella intersecta</i> (S. W. Wood)	SD1, SD3
<i>Odostomia acuta</i> Jeffreys	SD1
<i>Odostomia carrozzai</i> Van Aartsen	SD1
<i>Odostomia clavulus</i> (Loven)	SD1
<i>Odostomia conoidea</i> (Brocchi)	SD1
<i>Odostomia conspicua</i> Alder	SD1, SD3
<i>Odostomia eulimoides</i> Hanley	SD1
<i>Odostomia fusulus</i> Monterosato	SD1
<i>Ondina vitrea</i> (Brusina)	SD3
<i>Opalia hellenica</i> (Forbes)	SD1
<i>Philbertia</i> cf. <i>philberti</i> (Michaud)	SD1
<i>Philbertia pseudohystrix</i> (Sykes)	SD1
<i>Philene catena</i> (Montagu)	SD3
<i>Philene intricata</i> Monterosato	SD1
<i>Philene scabra</i> (Mueller)	SD1
<i>Protatlanta souleyeti</i> (E. A. Smith)	SD3
<i>Pyrunculus hoernesii</i> (Weinkauff)	SD1
<i>Raphitoma echinata</i> (Brocchi)	SD1, SD3
<i>Raphitoma laviae</i> (Philippi)	SD1
<i>Retusa mammilata</i> (Philippi)	SD2, SD3
<i>Rissoa incospicua</i> (Alder)	SD1, SD3
<i>Rissoa philippi</i> (Aradas & Maggiore)	SD1, SD3
<i>Rissoa radiata</i> (Philippi)	SD1
<i>Rissoa violacea</i> Desmarest	SD3
* <i>Rissoella inflata</i> Locard	SD2, SD3
<i>Rissoina bruguiere</i> (Payraudeau)	SG2, SD1

* Also recorded live from the same or other stations (see Table 4).

Table 5 continued. List of empty gastropod shells and dead bivalves recorded during the present study.

Species	Station
<i>Roxania utriculus</i> (Brocchi)	SD1
<i>Sabinella bonifaciae</i> F. Nordsieck	SD1
<i>Scissurella costata</i> D'Orbigny	SD1, SD3
<i>Skenia serpuloides</i> (Montagu)	SD1, SD3
<i>Skeniodes exilissima</i> (Philippi)	SD3
<i>Stricteulima jeffreysiana</i> (Brusina)	SD1, SD3
* <i>Timoclea ovata</i> (Pennant)	SD1
<i>Tricolia speciosa</i> (Van Muehlfeldt)	SG2
Triphoridae sp.	SD1, SD2, SD3
<i>Turbonilla pumila</i> Seguenza	SD3
<i>Turbonilla pusilla</i> (Philippi)	SD1
<i>Turbonilla rufa</i> (Philippi)	SD1
<i>Turitella turbona</i> Monterosato	SD1, SD4
* <i>Vermetus semisurrectus</i> Ant. Bivona	SD2
<i>Vexillum ebenus</i> (Lamarck)	SG3, SD4
<i>Vexillum savignyi</i> (Payraudeau)	SD1, SD2, SD4
* <i>Vitreolina philippi</i> (De Rayneval, Ponzi & Van den Heck)	SD2
* <i>Volvarina mitrella</i> (Risso)	SG3, SD4
<i>Volvulella acuminata</i> (Bruguere)	SD1
<i>Weinkauffia turgida</i> (Forbes)	SD1
<i>Williamia gussoni</i> (O. G. Costa)	SD1
SCAPHOPODA	
<i>Dentalium dentalis</i> (L.)	SD1
<i>Dentalium vulgare</i> Da Costa	SD1
* <i>Pulsellum lofotense</i> (M. Sars)	SD1
POLYPLACOPHORA	
<i>Acanthochitona fascicularis</i> (L.)	SD1, SD2
BIVALVIA	
<i>Abra prismatica</i> (Montagu)	SD3
* <i>Aequipecten opercularis</i> (L.)	SG3, SD1, SD4
<i>Arca noea</i> (L.)	SD4
* <i>Astarte fusca</i> (Poli)	SG3, SD1, SD4
* <i>Goodalia macandrewi</i> (Smith)	SD2, SD3
* <i>Chlamys flexuosa</i> (Poli)	SD4
* <i>Chlamys varia</i> (L.)	SD4
<i>Clausinella brogniarti</i> (Payraudeau)	SD1
<i>Digitaria digitaria</i> (L.)	SD2, SD3, SD4
* <i>Diplodonta apicalis</i> Philippi	SD3, SD4
* <i>Glans aculeata</i> (Poli)	SG3
* <i>Glans trapezia</i> (L.)	SD4
<i>Glycymeris</i> sp.	SD4
* <i>Gonilia calyglypta</i> (Dall)	SD1
<i>Gouldia minima</i> (Montagu)	SD2, SD3, SD4
<i>Hyalopecten similis</i> (Laskey)	SD1
<i>Kellia suborbicularis</i> (Montagu)	SD1

* Also recorded live from the same or other stations (see Table 4).

Table 5 continued. List of empty gastropod shells and dead bivalves recorded during the present study.

Species	Station
<i>Limatula subauriculata</i> (Montagu)	SG3, SD1, SD3, SD4
* <i>Lissopecten hyalinus</i> (Poli)	SG1, SD1, SD4
<i>Modiolula phaseolina</i> (Philippi)	SD1
* <i>Neolepton sulcatulum</i> (Jeffreys)	SD1
<i>Nucula nitidosa</i> Winkworth	SD4
<i>Nuculana pella</i> (L.)	SD1
* <i>Palliolium incomparabile</i> (Risso)	SD1, SD4
<i>Parvicardium scriptum</i> (B.D.D.)	SD1, SD3
* <i>Pecten jacobus</i> (L.)	SD4
* <i>Plagiocardium papillosum</i> (Poli)	SG3, SD1, SD4
<i>Psammobia costulata</i> Turton	SD2
* <i>Pteromeris minuta</i> (Scacchi)	SD2, SD4
<i>Scacchia oblonga</i> (Philippi)	SD1
<i>Tellina donacina</i> (L.)	SD2

* Also recorded live from the same or other stations (see Table 4).

Discussion

The lower limit of the Mediterranean infralittoral is defined as the maximum depth at which marine phanerogams and photophilic algae can live (Pérès and Picard, 1964; Pérès, 1967, 1982; 1995; Bellan-Santini et al., 1994) and the seagrass *Posidonia oceanica* is often used as an indicator species. In the Maltese Islands, the maximum depth at which stands of this species have been recorded is 44m (Borg and Schembri, 1995c). Grab samples from depths less than 40m taken during the present study consisted of fine sand devoid of epiflora and with an impoverished epifauna. The nature of the substratum and the biota present suggest that this assemblage is closest to the SFBC 'sables fin bien calibrés' [fine well-sorted sand] biocoenosis of Pérès and Picard (1964) (see also Pérès, 1967; 1982; Picard, 1983; Bellan-Santini et al., 1994). On the basis of the distribution of *Posidonia oceanica*, it appears that with the exception of stations SG2 and SG4, our samples were taken from the lower limit of the infralittoral zone (SG1, SD3) and from the upper circalittoral (SG3, SD1, SD2, SD4).

Below depths of 45m and down to 75m (the maximum depth sampled in this study) the substratum consisted of shell and algal gravel. This corresponds to the coastal detritic bottoms of Pérès and Picard (1964), consisting of organogenic gravels derived from present-day organisms (Pérès, 1985; Bellan-Santini et al., 1994). The biota present, particularly the abundant free-living corallines *Phymatolithon calcareum* and *Lithothamnion corallioides* characterise these assemblages as belonging to the 'nullipore facies' of the coastal detritic biocoenosis of Pérès and Picard (1964). Such bottoms and the assemblages they support are better known as 'maerl'. Maerl is characterized by accumulations of unattached,

calcareous rhodophytes which take the form of either twig-like thalli, or ones encrusting some solid but mobile granule, usually a stone or shell. Maerl beds form on level sea-bottoms within the photic zone where currents are strong enough to turn the free-living thalli over, preventing them from getting buried and exposing all their surfaces to light (Bosellini & Ginsburg, 1971; Steneck, 1986). Although maerl assemblages occur worldwide (Bosence, 1983), they have been little studied, including in the Mediterranean. In the Western Mediterranean, maerl beds occur down to depths of 65m (Pérès, 1985) while in the Eastern Mediterranean, where the water is more clear, some maerl beds extend below 100m (Jacquotte, 1962). Maerl therefore appears to be associated with the infralittoral to circalittoral transition zone.

Due to its complex structure, maerl generally provides a heterogeneous bottom with a range of microhabitats, and consequently it has a high biotic diversity (Cabioch, 1969; Keegan, 1974; Bosence, 1979). Furthermore, it appears that maerl beds support a number of rare and unusual species, some of which are exclusive to this habitat type. For example, in the Mediterranean, the alga *Cryptonemia tunaeformis*, which was also found in our study, seems to occur only in this habitat type (UNEP/IUCN/GIS Posidonie, 1990). For these reasons and because they are isolated and inextensive biotopes, maerl beds are of considerable conservation value (Bellan-Santini et al., 1994). However, maerl beds are under threat in many places from direct exploitation and anthropogenic impacts. In the Mediterranean the main threats are dredging and trawling, which disrupt and erode the maerl beds, and modification of the hydrodynamic regime due to coastal developments such as construction of harbours and artificial beaches (UNEP/IUCN/GIS Posidonie, 1990). Elsewhere, maerl beds are also threatened by direct exploitation for agricultural fertiliser, and due to eutrophication (Guiry & Blunden, 1991).

This is the first time that living maerl beds have been reported from the Maltese Islands. Previously, the only maerl known was a very small patch (ca. 3400m²) at a depth of 42m discovered off the coast of the island of Comino in 1994 (Borg & Schembri, unpublished). This bed did not contain any live maerl thalli, indicating that it is probably a relict ground.

The maerl grounds discovered in this study support a high species richness but overall a low abundance. The most abundant macrofaunal species was the gastropod *Bittium latreillii*. Locally, this species occurs also in abundance in other (infralittoral) biotopes, including *P. oceanica* meadows and the assemblages of photophilic algae on hard substrata (Borg, 1991). A number of species listed by Pérès (1967) as characteristic of the maerl facies, such as the echinoderms *Echinocyamus pusillus* and *Spatangus purpureus*, and the crabs *Parthenope massena* and *Ebalia edwardsi*, were also recorded by us. A particularly interesting record is that of the circumtropical alga *Womersleyella setacea*, which was first recorded from the Mediterranean only recently,

initially on the French coast (Verlaque, 1989) and subsequently on the Tuscan coast (Airoldi et al., 1994) and Lampedusa (Cormaci et al., 1994).

Surprisingly, Pérès (1967) describes the benthic assemblages of maerl as "rather poor". In the present study, over a hundred different macrobenthic species have been recorded live from the maerl grounds off the northeastern coast of Malta, and over a hundred additional species as dead shells. This species richness is comparable to that of meadows of the seagrass *P. oceanica*, which normally have 100-200 different macrobenthic species in each single locality (Templado, 1984) and which are considered to be one of the most species-rich of Mediterranean biotopes. It is likely that in making his statement, Pérès (1967) was probably referring to species abundance rather than to richness. For our study area, Admiralty charts give the bottom type as 'coral'. As no organisms, apart from calcareous algae, which could be interpreted as 'coral' were recovered during our study, we are of the opinion that in the context of the northeastern coast of the Maltese Islands at least, 'coral' on Admiralty charts refers to maerl bottoms. If this is so, then maerl may cover extensive areas of sea bed off the northeastern coast of Malta, since Admiralty charts show 'coral' bottoms to be present all along this coast at depths greater than ca. 40m.

In summary, this work, although limited, shows that in our study area, and possibly all along the north-eastern coast of the Maltese Islands, the lower infralittoral consists of sandy bottoms with sea-grass meadows giving way to bare sand at depths greater than ca. 40m, although seagrass may occur down to 44m or even deeper. The infralittoral grades into the fine sediments of the circalittoral at depths of more than 80m via a strip of maerl where conditions permit the formation of this type of bottom. This transitional maerl bottom provides a complex habitat with a high diversity of associated macrobenthos, which contrasts with the lower diversity of the generally bare sediments of the lower infralittoral and the circalittoral. Little is known about this biotope and a more detailed study of local maerl would be of great interest.

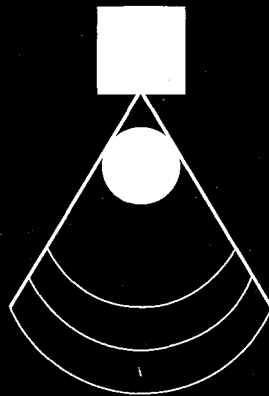
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Research Article

Lead Shot Pellets as Soil Pollutants in the Maltese Islands.

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Summary. *The fate of lead shot in Maltese soils is investigated. The study shows that soil lead levels are directly proportional to the exposure of the region to bird and clay pigeon shooting. The dispersed lead shot subsequently undergoes weathering effects with the rate of erosion of the shot being dependent on the soil type. The mobility of the soil lead is shown to be dependent on the soil type, salinity and the use of chemical artificial fertilizers.*

Keywords: lead, soil, pollution, fertilizers

The Maltese population has been found in various studies to have high blood lead levels at various stages of life (Bruaux et al, 1983; Sammut and Savona-Ventura, 1996; Savona-Ventura et al, 1994), though educational and legislative measures instituted in the last decade appear to have had a positive role in decreasing the mean blood lead levels in the population (Savona-Ventura et al, 1997). There are many potential sources of lead contamination in the Maltese environment, the main ones being petrol lead (Sammut and Savona-Ventura, 1996), and the use of leaded paint with subsequent use of painted wood as fuel in bakeries. Another potential source of lead in the Maltese environment is the use of lead shot pellets for bird and clay pigeon shooting. The annual lead shot importation to Malta amounts to about 100 metric tonnes or the equivalent of about 0.5g of lead per square metre of agricultural and countryside areas per year (Dept of Statistics, 1987-89). Lead shot pellets settling on the soil are subjected to various weathering factors enhancing the spread of lead in the soil environment through the production of fine particles and the possible mobilization in the form of ions or complexes. In as far as we know, the potential hazard of lead shot contamination in the local environment has never been assessed. While lead shot cannot be considered a major source of lead pollution, the amount is constantly increasing and is accumulative. This study attempts to quantify soil lead levels from various sites in Malta and Gozo, and to determine the fate of these lead pellets in Maltese soils under different circumstances under laboratory conditions similar to environmental conditions to which the pellets are possibly exposed.

Material and Methods

Different surface soil samples were obtained from twelve sites in Malta and Gozo. The sites were classified according to the authors' estimated popularity with bird or clay pigeon shooters, thus reflecting exposure of these sites to lead shot deposition (Table I). Each soil sample collected was sieved on site through a 2 mm mesh and after air-drying stored in plastic bags at -20°C. The twelve samples were analyzed using a flame atomic absorption spectrometer (AAS) for the total lead content after digestion with concentrated nitric acid. Six of the samples (I-IV, VIII and X) were repeatedly assayed for five times enabling a mean and standard deviation result. The other six samples (V-VII, IX, XI-XII) were assayed

once. The four soil samples obtained from sites quantified as having low exposure to lead shot deposition (samples I-IV) were further analyzed chemically.

In vitro studies to determine mechanical and leaching effects on lead pellets were further performed on the two soil samples representing Carbonate Raw soils and Terrarossa soils obtained from sites quantified as having a low exposure to lead shot pellets (samples II & IV). The mechanical erosive effects of the two soil types on lead pellets was assessed after continuously shaking two sets of nine soil sample tubes for 4 hours per day. Each tube contained 5 g of soil and one lead pellet (average weight 0.06g). The sample tubes were shaken for 3, 7 and 14 days, respectively. After each time-point determination, three sample tubes of each set were analyzed for total lead content using AAS. This analysis was performed after removing the lead pellet and digesting with concentrated nitric acid.

Sample	Lead shot dispersion	LOCATION
I	Low exposure	Ghar Ilma, Gozo
II		ByPass, St.Paul's Bay, Malta
III		Buskett, Malta
IV		Qajjenza, Malta
V	Moderate exposure	Madliena, Malta
VI		Ghalis, Malta
VII		Bidnija, Malta
VIII		Delimara, Malta
IX	High exposure	Mizieb, Malta
X		Fanal tal-Gordan, Malta
XI		Mellieha Ridge, Malta
XII		Bidnija Shooting Club, Malta

Table 1. Soil samples.

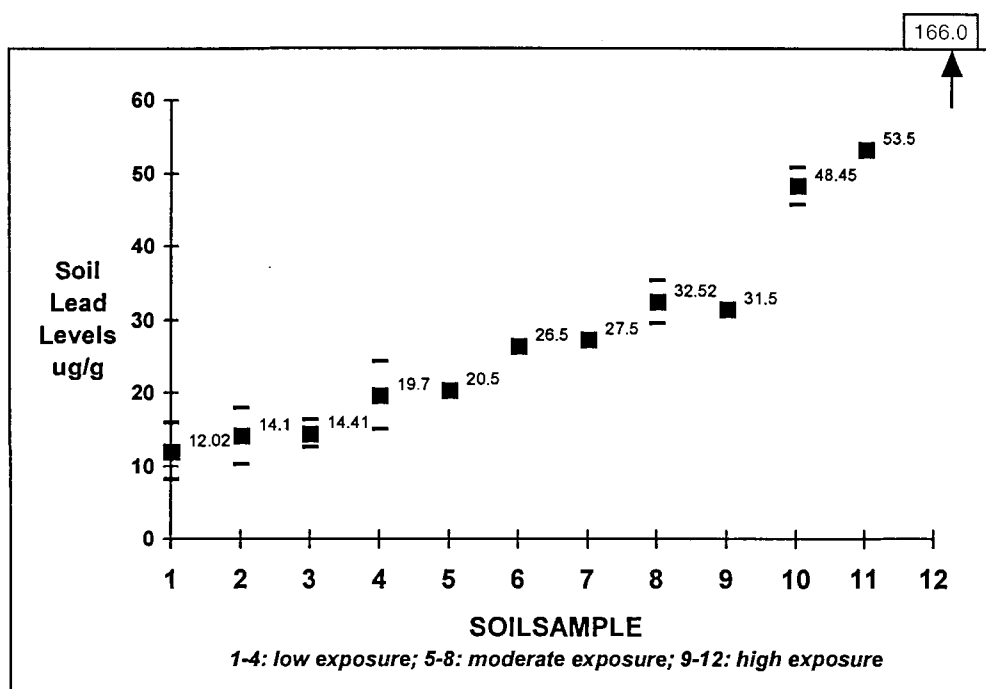


Figure 1. Soil lead levels.

The leachability of lead from soil samples II & IV was assessed by preparing soil sample tubes containing 5 g of soil with/without a lead pellet and adding 10 ml of tap water. Further soil samples containing natural fertilizers - manure and primary effluent sludge - and artificial fertilizers - ammonium sulphate and water soluble NPK: F1, F2, F5 - were also prepared in a similar manner. These tubes were mechanically shaken for 18 days at 25°C for 4-hour intervals per day. After centrifugation, the supernatant was digested with concentrated nitric acid and the lead leachate level was analyzed with single readings using Anode Stripping Voltmeter (ASV).

Results

The total soil lead levels appeared to be proportional to the estimated degree of lead shot deposition at the various sites. Thus, those sites estimated to have a low exposure to lead gave a mean soil lead level in the range of 12.02-19.70 ug/g, while those with a moderate and high exposure gave a mean soil lead levels in the range of 20.5-32.52 and 31.5-53.5 ug/g respectively. The site

estimated as having a very high exposure had a soil lead level of 166.0 ug/g (Figure 1).

The soil lead levels in samples obtained from low exposure sites, (samples I-IV) appeared to be inversely dependent on the chloride and conductivity (salinity) levels of the soil samples. There appeared to be no further correlation with other chemical constituents of the soil (Figure2/Table II).

Lead pellets in the soil are apparently eroded gradually by the mechanical abrasive effects of the soil. Thus, the dry shaking experiment in vitro suggests that in

both soil types (samples II & IV), pellet erosion was marked by Day 3, increasing mean soil lead content by 28.9 ug/g in sample II and 26.6 ug/g in sample IV. Further prolonged shaking continued the erosive mechanism which was reflected in an increase in the mean soil lead content by a total of 41.5 ug/g in sample II and 36.6 ug/g in sample IV by day 14. The rate of abrasion was apparently greater in sample II irrespective of the duration of shaking. The mean soil lead levels were overall higher in sample IV, but only showed a significant increase prior to shaking and after day 7 of shaking. This difference seems to suggest that abrasive properties are dependent on the soil characteristics and are different for Carbonate Raw soils and Terrarossa soils, the former showing the higher rate (Table III).

Tap water added to the soil sample helps to mobilize the intrinsic soil lead salts and particles as lead leachates. The amount of lead leachate increases minimally by 3.7 ug/g in sample II and 6.9 ug/g in sample IV in the presence of a lead pellet, an approximate 1.25 fold increase. The addition of primary effluent sludge or

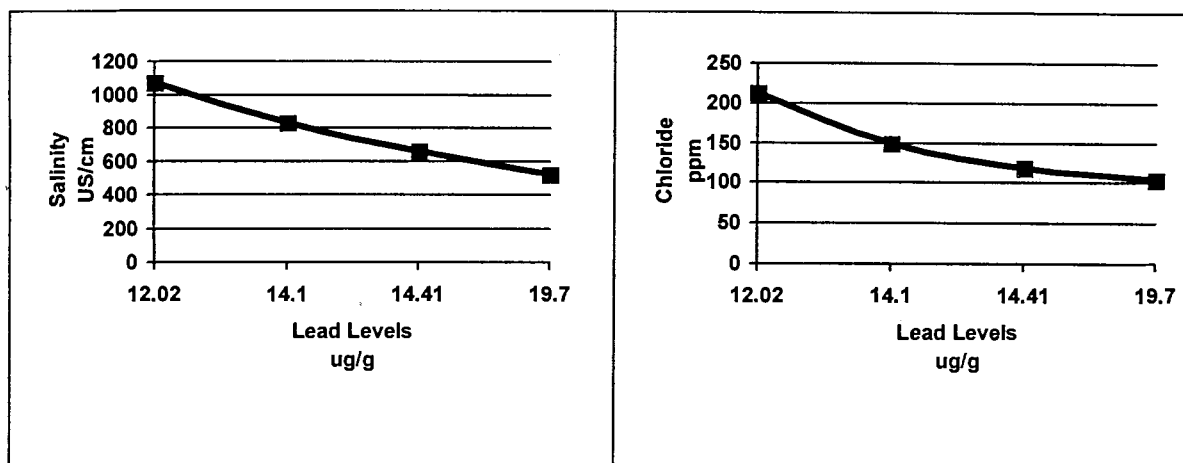


Figure 2. Soil lead levels by soil salinity.

SOIL SPECIMEN	I	II	III	IV
SOIL TYPE	Carbonate Raw	Carbonate Raw	Xerorendzina	Terrarossa
Soil lead ug/g (mean+sd)	12.02+3.9	14.1+3.92	14.41+1.9	19.7+4.7
Salinity US/cm	1070	833	660	519
pH	7.13	7.41	7.05	7.26
Phosphorus ppm	8000	7000	9500	9000
Potassium ppm	84	32	72	8
Chloride ppm	213	149	119	105
Sodium ppm	204	68	160	84
Nitrogen %	0.316	0.246	0.221	0.285
CaCo ₃ %	29.1	36	51.57	22.5
Organic matter w/w %	8.1	4.7	5.0	6.0

Table 2. Chemical analysis of soil types.

ammonium sulphate fertilizer minimally increased the amount of lead leachate by approximately 1.36- and 2.07-fold, respectively. Manure increased the lead leachate by 7.8-fold, while NPK water soluble fertilizers increased the lead leachate by 62.05-305.2-fold depending on the NPK values (Table IV).

Discussion

The presence of lead in soil may theoretically pose a serious health hazard since soils are considered to be

MECHANICAL SHAKING	SOIL SAMPLE II [mean+sd, n=3]	SOIL SAMPLE IV [mean+sd, n=3]	significance
Day 0 (n=5)	14.10+3.92	19.70+4.70	t=2.046 p<0.05
Day 3 (n=3)	43.00+2.00	46.33+5.51	t=0.984 p>0.5
Day 7 (n=3)	45.33+3.51	53.33+1.53	t=3.619 p<0.001
Day 14 (n=3)	55.67+4.16	56.33+5.03	t=0.175 p>0.5

Table 3. In-vitro mechanical abrasion.

strong accumulators of lead. Lead incorporated in alkaline soil is usually of very low mobility and thus once contaminated, a soil is liable to remain polluted with lead for a long time. Lead shot is irretrievably dispersed in the environment. The amount of lead shot dispersion in the Maltese agricultural countryside approximates 0.5g of lead per square metre annually (Dept of Statistics, 1987-89). However, the lead shot dispersion is not even, but depends on the use of the locality for bird or clay-pigeon shooting by enthusiasts. This varied dispersal is further reflected in the difference of soil lead levels from various sites in Malta and Gozo. The present study confirms that soil lead levels are directly dependent on the popularity of the site with shooting enthusiasts, being very markedly elevated at 166.0 ug/g levels at the Bidnija Shooting Range and lowest at 12.02 ug/g levels at Ghar Ilma, a site not particularly popular with shooting enthusiasts.

The dispersed lead shot in the soil is gradually eroded by weathering forces reflecting mechanical and chemical factors. The extensive weathering and erosion processes that the lead shot is subjected to at the topsoil tend to encourage the spread of lead as a result of the physical transformation into finer particles (Mudge, 1984). The rate of mechanical erosion of lead shot pellets is apparently dependent on the soil type. This study has shown that the finer particled Pleistocene Terrarossa soil deposits had poorer abrasive properties when compared to the relatively younger Carbonate Raw soils. The chemical and organic constituency of the different soils did not generally appear to influence the soil lead levels, though an inverse relationship between soil lead levels and the soil salinity measured directly or as a function of chloride level has been shown in the present study. Lead

in Maltese soil has been shown to be present in a free uncomplexed form. Consequently, soil lead levels would be governed by the solubility product of Lead Chloride (PbCl₂), thus explaining the observed inverse relationship (Vella, 1997).

The high alkaline pH of Maltese soil types and the high calcareous content tends to render the eroded particulate lead immobile as a result of the formation of insoluble compounds such as PbCO₃, Pb₃(PO₄)₂ and PbSO₄ (Zimdahl, 1977). The high clay content of Maltese soils further contributes towards lead immobilization possibly through the high adsorptive powers of clay. The adsorptive properties of clay and probably iron oxide were demonstrated by the lower lead leachate obtained after the soil sample was added to the Terrarossa soil in contrast to the Carbonate Raw soil. The addition of a lead pellet did not seem to have much effect on the amount of lead leached by tap water. Similarly, very minimal differences could be noted when the soil was leached in the presence of primary effluent sludge or ammonium sulphate used as fertilizers, though a two-fold increase in leachate was observed with the latter. Significant changes in lead mobility were observed when the soil samples were leached in the presence of manure or water soluble NPK fertilizers, being very marked at

CHEMICAL EROSION	SOIL SAMPLE II	SOIL SAMPLE IV	mean increase
Tap water alone	24.2	18.8	-
In presence of lead pellet	27.9	25.7	x 1.25
Primary effluent sludge	27.3	31.0	x 1.36
Manure	170.9	164.5	x 7.8
Ammonium sulphate	38.0	51.2	x 2.07
F1 [NPK:11,0,30]	1504.0	1164.3	x 62.05
F2 [NPK:30,3,11]	1941.4	3300.0	x 121.9
F5 [NPK:25,5,30]	7775.0	5350.0	x 305.2

Table 4. Chemical soil leaching of lead.

approximately three hundred fold with F5 NPK[25,5,30] fertilizer. The mobilization of lead from soil may possibly be due to the formation of soluble organic and inorganic lead species, thereby enhancing mobilization in the aqueous medium. These soluble species may include the formation of soluble organic complexes or chelates, inorganic ion pairs or free metal ions. Once mobilized, these soluble lead species may be made available to vegetation thus entering the food chain.

The mechanism of lead uptake by plants is still not clear and disagreement exists as to the proportion and the form in which lead is taken up from the soil system. The relationship between the lead content of certain plant species such as lettuce, oats, grain and radish grown in contaminated soils and the concentration of lead in soils has been determined (Harrison and Laxen, 1984; Bolt and Bruggenwert, 1978). The lead content of most plant species is normally in the range 0.5-3.0 ppm. Plant toxicity generally occurs above this concentration. However, certain species of plants can withstand high levels of lead without showing any toxic effects. This high concentration of lead is, however, toxic to humans if consumed.

Conclusion and Recommendation

Lead shot dispersion is a minor lead additive in the Maltese ecosystem, more important factors in the process being vehicular lead and the burning of old wood painted with leaded paint products. However, the continuous dispersion of lead shot, particularly in agricultural areas, may pose a long-term hazard since soil lead tends to be accumulative. By virtue of their carbonate content and alkalinity, Maltese soils generally limit lead mobility and restrict uptake by vegetation. The use of fertilizers, particularly the NPK water soluble fertilizers, significantly mobilizes the soil lead making the ion available for uptake by vegetation and for the subsequent introduction of lead in the food chain. The introduction of steel shot or non-toxic tungsten polymer

shot as an alternative to lead shot for birdshooting in agricultural areas should be considered. Lead shot should be restricted for use in clay shooting on suitable grounds where spent pellets could be collected and where agriculture is not practised.

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Article

A New Plastic Light Source: Electroluminescence

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For the last six decades or so synthetic oil-derived plastics - polymers - have been inexorably displacing traditional materials - metals, glass, cellulose - in an endless variety of applications. Indeed it would be difficult to maintain a "modern" living standard without the availability of plastics for packaging, transportation, construction, consumer articles, etc. One measure of the success of this "plastics revolution" is the fact that for several years now the total worldwide production of synthetic polymers has exceeded that of all metals combined.

Many of the applications of the versatile materials are regarded as somewhat mundane, even "low-tech", though in fact there are currently thousands of extremely sophisticated usages. Some of these applications rely on very carefully designed chemical structures, for example, contact lenses, whereas others on a highly refined processing technology as are modern synthetic fibres. We are now, perhaps, on the threshold of applications for plastics where these materials will compete with, or form an adjunct to, silicon and silicon-related semiconductor compounds which are rightfully regarded as the foundation of our current electronic "hi-tech" society.

The development of polymers with important electro-optical properties is one of the most active areas of academic and industrial research in materials science today. Of course polymers have been used in the electrical and electronics industry for decades, chiefly to take advantage of their superior properties - as insulators and dielectrics. More recently, however, polymers have been synthesized whose properties mimic those of classical metals, semi-conductors and even of electro-optically active inorganic crystals.

The class of polymers which are of the most interest in this regard are members of the so-called π -conjugated macromolecule family. The prototypical member of this class is polyacetylene, which is simply a long chain of CH moieties covalently bonded by alternating single and double carbon-carbon bonds (Fig. 1). This alternation is the critical element, and because of the versatility of organic chemistry there is literally an infinite number of polymer compounds that can be envisaged (and, in many cases, synthesized fairly easily) that display π -conjugation. The structure of another well known example, poly(phenylene vinylene) is also shown in Fig. 1.

About twenty years ago it was discovered that polyacetylene, when partially oxidized or reduced, shows remarkable electrical conductivity, in some extreme cases equalling or surpassing that of copper itself. This discovery led to an avalanche of research

both in academia and industry which continues in somewhat abated fashion to the present day. It must be mentioned, however, that the earlier promise of these "synthetic metals", for example, that they could displace classic metallic conductors such as copper or aluminum, has not been fulfilled as yet. Indeed the current uses of these polymeric electrical conductors are still relatively minor. The explanation is that in materials application it is typically a spectrum of properties rather than an individual property, no matter how spectacular or scientifically interesting, that dictates how readily, or if at all, a new material can displace an existing product.

Another property of certain π -conjugated polymers was discovered about eight years ago, that of electroluminescence, which is the capability of emitting light on the imposition of an electrical field. The conversion of electrical energy into light is surely amongst the most ubiquitous and important applications of technology incandescent and fluorescent lamps, and cathode ray tubes are obvious examples and the electro-luminescence of inorganic semi-conductor materials which display this phenomenon has been an important area of research and development for three or four decades. The light emitting diode (LED) seen as a pin-point of light, usually red, and based on gallium arsenide or a similar material, is very widely used and familiar to all. Thus it is now known that some of the same polymers that have high electrical conductivity or, in fact, certain organic low molecular weight materials, can display this phenomenon. Moreover, as already noted, these polymeric chromophores (the luminescing element in LEDs) are structurally very versatile which implies a ready tunability of the colour of the light output, and they are of course film forming, which implies at least the possibility of making large area devices, a distinct advantage over their inorganic counterparts. At the present time all these advantages remain to be proven as far as commercial devices are concerned. LEDs based on

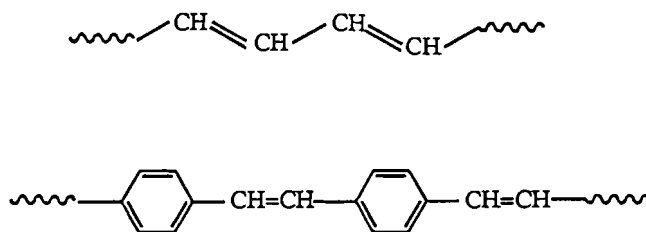


Fig. 1(Karasz) Chemical structures of representative sections of two typical π -conjugated polymers, polyacetylene and poly(phenylene vinylene).

low molecular weight organic chromophores, are apparently closer to commercialisation; it is said that the Japanese company Pioneer will market such devices later this year.

A basic polymer LED is illustrated schematically in Fig. 2. The device consists of an anode, usually a metal such as calcium or aluminum, and a cathode which for technical reasons discussed below is typically an inorganic conducting glass; the mixed oxide of indium and tin known as ITO is widely employed. Sandwiched between the anode and cathode is a very thin film of the polymer chromophore. When a voltage of the correct polarity and strength is applied to the anode and cathode, photons will be emitted from the polymer and in the example shown will emerge from the anode side, since ITO is transparent. It may be noted that for mechanical convenience the anode material is usually present as a thin film on a more robust substrate of ordinary glass. In a typical device the polymer film is of the order of 100 nanometers (one ten thousandth of a millimeter) thick; somewhat surprisingly, a film of this thickness with the required integrity (pin holes or nonuniformity, for example, must be totally avoided) can be prepared using relatively simple polymer processing techniques. At a typical operating voltage of 10v the electrical stress is quite severe; thus the film, amongst many other properties, must have outstanding dielectric strength. In practice, this means great attention must be paid to chemical purity and to the elimination of particulate matter. If a reactive metal is used for the anode it will also be necessary to seal the device in a vacuum or in an inert gas.

How does a polymer LED work? One may carry the analogy with the well-understood classical semiconductor LEDs quite far. For historical reasons the explanation is usually couched in the terminology of solid state physics and adopts the band theory of metals and semiconductors. Thus we postulate that the electrons in the π -conjugated polymers can occupy both valence and conduction bands, the latter being of higher energy. The magnitude of the energy difference, the so-called band energy gap of the polymer will ultimately dictate the colour of the emitted light. The function of the anode and cathode is then simply to inject positive charges, "holes", and negative charges, electrons, into the valence and conduction bands, respectively, of the polymer chromophore. These charges of opposite sign will migrate in opposite directions because of the presence of the electric field and in a properly designed LED, will recombine within the polymer film forming a spectroscopically excited state or "exciton". The relaxation of this exciton to the ground state releases the energy in the form of a photon. The injection process is one that requires the surmounting of or tunnelling through a potential energy barrier. This means that current will not flow, nor will light be emitted, until a critical voltage is applied - the so-called "turn-on" voltage. Above this level the light emission and current flow both increase very rapidly until, usually, the device breaks down due to dielectric failure. Electroluminescence is actually quite analogous to the well-known fluorescence effect that is found in many organic materials. In the latter case, however, energy is

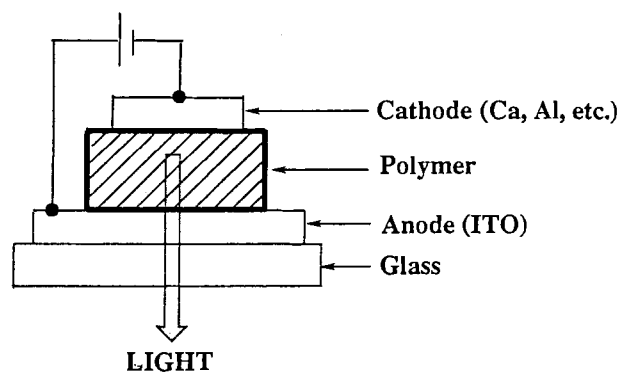


Fig. 2. (Karasz) Sketch (not to scale) of a basic polymer light emitting diode. The vacuum tight enclosure is not shown.

introduced into the material by irradiation with light, though not necessarily visible light: fluorescence is often induced in an organic material by illuminating with ultraviolet or "black" light.

In any LED a highly sought after feature is brightness of the light emitted and high efficiency measured in terms of the conversion of electrical into photonic energy. It turns out that brightness is quite easily achievable. Polymer LEDs have been reported with brightnesses orders of magnitude greater than, for example, that of the familiar cathode ray or "picture" tube used in TVs. Acceptable efficiency is harder to come by, however, and in order to improve the relatively poor efficiency of the simple single layer device described above, a substantially more sophisticated design and material selection process must be employed. For example, one must select electrode materials which optimize the injection of the respective charge carriers - electrons and holes - into the chromophore. Moreover it is important that the injection process is balanced. It is counter productive to have an excess of either charge carrier in the polymer. This requires the careful assessment of the electronic properties of the electrodes and the relation of these properties to the band energy levels of the polymer. It is customary to use additional polymeric films interspersed between the chromophore and the electrodes in a multi-layer architecture. The primary purpose of these so-called transport layers is two fold: to increase and at the same time balance the charge carrier flux into the chromophore, and also to provide the desirable feature of charge and exciton confinement. The latter is important because it is known that efficiency improvements can be achieved by preventing charge recombination anywhere other than in the chromophore itself. Moreover by using transport layers with the correct electronic properties it may be possible to reduce the operating voltage of a device. There are several other features that have been found to improve polymer LED efficiency. One is to use a carefully selected polymer blend instead of a single component as the all important chromophoric layer. Because of certain energy absorption and emission processes that can occur within such a polymer mixture, the final output of light from a blend may well be substantially brighter and the device efficiency greater than in single component devices. In some of the latest designs the chromophore blend may

even incorporate the transport layer materials discussed above. An LED based on such a multicomponent blend is obviously more readily fabricated than one in which several different polymer layers may have to be sequentially deposited.

A chromophore blend also offers a rather obvious approach to the design of a white light emitting LED. It is not too difficult to design and synthesize polymers of a selected band energy gap and hence with a selected colour emission. In principle, at least, one may blend chromophores emitting the three respective primary colours at the correct intensities so that the perceived output is pure white.

What is the commercial future of polymer LEDs? Indeed is there a future? In the context of the over-optimistic predictions for electrically conducting polymers alluded to above, one should be more than a little cautious. However, it seems reasonable to suggest that polymer

LEDs will eventually find application in display devices, in the so-called flat panel displays so widely sought after in electronics and communication. Perhaps one may even speculate that the inherent film forming properties of polymers may lead to an essentially all-plastic flexible flat panel display, which could form the basis of a sort of electronic newspaper. The same film forming capability also leads one to speculate that polymer electroluminescent devices could be developed for large area lighting in competition with conventional light sources. All this will depend on achieving a capability for the routine and inexpensive fabrication of bright, stable devices with satisfactory operating lifetimes (upwards of 1000 hours, depending on the application) and of higher efficiencies than those that are currently available. These are tall orders. However, progress in LEDs using organic materials has been very rapid from a laboratory phenomenon eight years ago to one that is on the verge of pilot plant production today.

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Report

Young Scientist of the Year

Richard Muscat and Edgar White

Last year's 9th Young European Scientist of the year award winners hailed from the Dominican College in Belfast and were rewarded for their efforts in the study of decomposition of "bog bodies". All three young ladies are budding Forensic Pathologists. The 10th European Union Contest for Young Scientists will be held in Porto, Portugal this year between the 20-27th September. Representations from the 15 member states together with those of Iceland, Israel, Lichtenstein, Norway and under special arrangements, Bulgaria, The Czech Republic, Hungary, Latvia, Lithuania, Poland, Russia, Slovenia, Switzerland, Ukraine and Malta will be confirmed following National contests that take place during the months of April and May. The following might give some insight into what our own young scientists have been up to during the long winter months in their bid to represent Malta in Portugal later on this year.

Water, water everywhere and not a drop to drink !

Brian Azzopardi, from Junior College, based his study on the much publicised problem of "Water Resource Management". Like all marvelous ideas his basic concept was simple and straightforward. It concerned making better use of water within the typical Maltese household. Most of the panel of judges during the initial stages agreed that this was an excellent idea and would be worth pursuing but putting it into practice would take some hard work and lots of long hours. However, last week the fruits of Brian's labour were there for all to see, a model designed to illustrate the resourceful use of water either provided by the Water Services, that collected in a well or that recycled from your modern washing machine. Depending on the time of year and thus the demand for water, the use of well water and second class water can be made available therefore reducing the need for that provided by the Water Services by approximately 60%.

IDEA

Adam Bartolo and Edward Sammut, currently dental students at the University and frustrated by the lack of any educational tool available anywhere, for home use for the study of Dental Anatomy decided to put an end to their misery. IDEA or Interactive Dental Anatomy is the sum of their valiant efforts and it comprises a software package on CD that offers an integrated perspective of both morphology and histology. It would appear that following their astounding success the days of dental students hunting around dental clinics for extracted teeth will now or in the very near future become an extinct form of behaviour attributed to such a student cohort. The program is written in Microsoft Visual Basic 4.0 and

is divided into three modules namely, tooth morphology, a tooth identifier and the virtual microscope. The graphics are excellent and importantly it is very user friendly unlike some academics!

Bionic limbs

Not to be outdone by their dental counterparts, Maryanne Caruana, Reuben Griscti and Maria Mallia all currently medical students at the University put forward their novel idea of using small motors to mimic the function of muscles following damage due to injury of the nerve fibres in the upper limb. The present solution to such a problem is the use of a prosthesis or a false arm. Normally this procedure involves the amputation of the damaged limb and replacement with the prosthesis. This is somewhat traumatic to the patient and is a relatively expensive procedure. The young trio suggested the retention of the problematic limb and the fitting of small motors to the bones which in turn can be manipulated by an external circuit. Their model was to say the least very convincing and if such a procedure could be utilised it would certainly attract those patients not prepared to undergo the trauma or expense involved with artificial limbs.

Talking plants

Communication in man at the cellular level is mainly an activity of our nervous system and as such the final marvel in the development of such a system is that wonderful thing we call our mind. In plants however, such a system is not to be found but botanists over the last century have been able to record some form of electrical signalling that resembles that found in man. Ernest Azzopardi, Andrea Biondo and Maria Blanco from the sixth form college of St. Aloysius gave themselves the undaunting task of establishing the nature of such signals and their function. Adopting a systematic approach they designed an electrode or Biosensor and built it in house to detect electrical impulses in plants under the following conditions; mechanical wounding and different lighting conditions. They observed that mechanical wounding produced signals similar to those found in the nervous system in man while changes in lighting produced electrical impulses that were more prolonged. These findings it was suggested could have economic implications in modern large-scale plant cultivation.

Computerised transformer tester

The final submission for our local contest which has already attracted significant commercial interest is that by Christopher Mangion, from the Fellenberg Training Centre. A transformer to most of us is that piece of apparatus one requires for example to run ones electrical

train set, scalectrics or more to the point that electrical item you purchased from America and now wish to use at home. Moreover, these gadgets are supposed to raise or lower the voltage within a given set of parameters over an extended period of time. To ensure that your commercially available transformer lives up to its specifications the Computerised Transformer Tester has been developed to do such a job. The output from a transformer under test is sent to a computer, which through clever software written by Christopher Mangion, analyses its performance and suggests what needs to be done in order that the gadget lives up to its expectations.

The tester was built for the use in industries concerned with the manufacture of such transformers. It could become an indispensable tool to those seeking to produce a high quality product.

One final note, we would like to thank all the young budding scientists for their excellent efforts but we hope that next year we will see many more project proposals especially from those schools who for some reason or another were unable to participate in this inaugural science festival.



The Honourable Minister Evarist Bartolo talking to the Young Scientists during the finals of the Competition.

Report

International Council on Alcohol and Addictions.

**42nd Institute on the Prevention and Treatment of Dependencies.
31st August - 4th September 1998, Westin, Dragonara, St. Julians.**

During the first week of September some six hundred delegates from all over the world will descend on the Westin Resort, Dragonara to discuss alcohol and drug related issues as well as the theme of this years conference, *The Changing Face of Addictive Behaviours*.

Against a background of increasing numbers of users world wide of substances both licit (alcohol, tobacco and medicines) and illicit (narcotics) and the development of dependencies related to the use of such substances that impact on health and socioeconomic norms, the appearance of dependencies that hitherto do not emanate from traditional routes (as above) are also now emerging and impinging on the quality of life of the individual and as such that of society. The delegates will take a hard look at what we have learned from what may be termed as the "established" dependencies and question whether such knowledge acquired from such efforts may be used to tackle the so called "emerging" dependencies.

As can be appreciated the vast subject area has resulted in the meeting being divided into a number of sections that reflect the participant's interest in this diverse field. Some appreciation of the topics to be tackled may be obtained from the following list, which in fact covers the 23 sections on offer during the week.

- Alcohol Policy, Alcohol and Drug Treatment and its Organisation, Epidemiological Research on Alcohol Related Issues, Alcohol Education, Alcohol, Drugs and Traffic Safety, Alcohol and Drug Problems in Business and Industry, Alcohol and Drug Problems of Indigenous Peoples, Communication in Alcoholology.
- Epidemiological Research on Drugs, Drug Education, HIV, AIDS and Substance Abuse, Therapeutic Communities and Rehabilitation Programmes.
- Tobacco Dependence.
- Gambling.

- Professional Management, Primary Health Care Providers, Social Work, Psychology, Family Therapy.
- Focus on Women, Youth, Ethnic Dimensions; Culture, Migration and Alcohol and Drug Issues.
- Information and Dissemination.

In addition to these 23 sections there are five special sessions which are directly relevant to the current situation in Malta, these are;

- The Mediterranean Situation.
- Responding to Addictive behaviours in Island States.
- Addictions and the Criminal Justice System.
- Narcotics Anonymous.
- Disulfiram for the Treatment of Alcoholism.

There are also two one-day symposia solely dedicated to:

- 1 Alcohol Research: From Basic Science to Public Policy.
- 2 The Hospitality Industry's Programmes for the Prevention of Substance Abuse.

Over 450 abstracts have been submitted which will provide the basis for the presentations to be made in the 23 sections. Malta will be represented (abstracts published in this issue pg 35-40) in most of the sections by leading protagonists in the field. The subject areas as the section areas are as diverse as one could hope in the light of the fact that as a nation we are at the early stages of getting to grips with problems of dependencies. However, the fact that the International Council on Alcohol and Addictions have come here to have their 42nd Institute probably reflects on our efforts in the area and our desire to do even better.

Richard Muscat

Abstracts

RE-DIMENSIONALISING LIFESTYLE THROUGH EXPERIENCE IN A RESIDENTIAL COMMUNITY

Grech, G.
sedqa, 2, Braille Street, Santa Venera, Malta.

This paper provides an overview of the philosophy and treatment strategies utilised at Komunita' Santa Maria, a residential community for clients who have a substance abuse problem which has caused profound disruption in their life style.

The Community can take up to thirty residents, males and females and on specific occasions treatment for mother and baby is also provided. Since its inception, it has sought to adopt Italy's "Comunita' Incontro" philosophy. It offers a structured life style and also a therapeutic element. The people running the Community include ex-drug addicts who have received basic training in addiction and a group of professionals including counsellors and social workers. Residents are urged to attain self-responsibility and are given different tasks in the running of the community. The length of the residential period is one year. Re-entry and after care programmes are also provided. In the gradual progress of the client the family is also urged to participate.

HIV AND IV DRUG INJECTION IN MALTA: THE WAY FORWARD.

Bugeja, S.
sedqa, 2, Braille Street, Santa Venera, Malta

Malta has experienced its own epidemic amongst haemophiliacs and sexual/gay/heterosexual sectors of the general population. However, the I.V. drug abusing population does not figure on the available data of known HIV positive individuals. In New York, Edinburgh and Milan, the prevalence of HIV infection among drug injectors grew rapidly, with 50% or more infected within a few years of the first appearance of the virus in those populations. Malta is nowhere similar in size to these cities but none of them are in the same geographical situation as this little island. Malta, with its central position in the Mediterranean, is en route from Asia to Europe and possibly the USA and therefore is quite vulnerable.

HIV prevention activities should target both current and potential injectors. These prevention programmes should include activities, which help current injectors to reduce risks of HIV infection and/or discourage the use of drugs by injection. Safer sexual behaviour cannot be ignored in this reality as it contributes quite significantly to the spread of this virus.

There is still time for action, but it is rather precious! This paper will discuss the feasibility of introducing an

HIV prevention activity among I.V. drug misusers whilst taking in consideration the possible legal and cultural limitations.

EMPOWERING PEOPLE: THE KEY TO DRUG EDUCATION AND PREVENTION.

Pace, P.
sedqa, 2 Braille Street, Santa Venera, Malta.

Ideally, primary prevention programmes should be planned to reach whole populations and/or whole categories of populations. Very few countries or agencies within countries, if any, can muster the necessary human, financial and material resources to deliver such programmes themselves. It is only through empowering others that primary prevention can really reach its goals.

This paper focuses on the Maltese experience of implementing primary prevention programmes in the various fields envisaged in sedqa's strategic plan using the "global approach" perspective.

Two main conclusions are indicated:

- primary prevention has to be constant, unrelenting and long-term and that it must tackle drug education across many fields simultaneously;
- once the main programming methodology and tools are being followed, the key to success is the empowerment of the community to deliver programmes to its various members.

THE ROLE OF THE MALTESE FAMILY IN PREVENTION, CONTROL AND TREATMENT OF DRUG ABUSE

Azzopardi, C.
sedqa, 2, Braille Street, Santa Venera, Malta.

Like virtually all other human difficulties, drug addiction has in the past been attributed to individual pathology. Still, many of the present treatment modalities focus on the individual drug addict. It was only recently that the family has started to be taken into account and included in the treatment of drug abuse. This has particular implications to Maltese culture.

In Malta, the minute size of the island and the still relatively traditional concept of the family lessen proximal and psychological distances between the individual and the family. It therefore appears to make sense to think seriously about the systematic inclusion of the family not only in the treatment of the individual drug addict but also in provision, control and prevention strategies.

In times when cultural changes are increasingly rapid

and the 'war' against supply less effective, the family is essential and unique in the provision of a secure base for individuals. It offers unique resources to its members uncomparable to what the state, through its agencies, can ever hope to provide. This paper explores how our work with families can enable the already existing resources within them. It provides some ideas and explores possibilities about how the family can be included in holistic drug addiction prevention strategies.

NON-FATAL DRUG-RELATED HOSPITAL EMERGENCIES

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St Luke's Hospital, Gwardamangia, Malta.
*sedqa, 2, Braille Street, Santa Venera, Malta.

For a number of years now with colleagues on the epidemiology working group of the Pompidou Group within the Council of Europe, we have been attempting to obtain comparable information on the use of illicit drugs. As it is notoriously difficult to detect drug consumption using conventional epidemiological tools the group have proposed the alternative use of indicators of drug use. The indirect demand indicators, namely drug related arrests (users), treatment demands and drug related deaths are all now in operation but that related to hospital emergencies was not. The objective of this study was, to assess the feasibility of the use of such an indicator. A study period of 1 month in the first instance was selected on the basis that 18 other general hospitals located in 12 European cities had also agreed to participate. The major problem encountered with inclusion related to distinguishing between true overdose and a suicide attempt which in part may be related to the misuse of psychoactive substances such as benzodiazepines and tricyclic antidepressants. However, during the said period, the hospitals casualty unit handled 7892 emergencies but only three of them related to illicit drugs. More specifically, 2 were due to heroin whereas the other case was a result of cocaine but 20 cases of benzodiazepine acute reaction and 1 tricyclic antidepressant case were recorded but not included for analysis. Two problems that are immediately apparent are the low numbers of emergencies related to illicit drug consumption and emergencies related to illicit drugs are not randomly distributed throughout the year. To remedy the latter we have now been evaluating these cases from January and will do so until the end of the year.

SOCIAL WORK INTERVENTION IN THE ADDICTIONS FIELD: A CASE FOR THE ECOLOGICAL MODEL.

Schembri, J.
Sedqa, 2, Braille Street, Santa Venera, Malta.

Social work is a broadly focused profession and tends to perceive the person-in-situations complex as a whole. Such a perspective might render the relationship between social work intervention and the predominantly medically-modelled addictions field as problematic. This paper presents the Ecological Model as an alternative

model to the medical one. It is argued that this model presents itself as a more congenial approach to the profession's identity and to its unique role in the addictions field. The principal tenets of this model are presented and their application to assessment and intervention within an addictions context are discussed. This is done with special reference to the Maltese situation.

ATTITUDES OF PRIMARY SCHOOL CHILDREN TOWARDS THE USE OF ALCOHOL, TOBACCO AND OTHER DRUGS.

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sedqa, 2, Braille Street, Santa Venera, Malta.

The European School Survey Project on Alcohol and Other Drugs (ESPAD) carried out in Malta in 1995 included data for age at first use in which it was reported that 41.3% imbibed wine before the age of 11, 32.7% had consumed beer, 13.5% had smoked their first cigarette while 1.5% had used inhalants. In order to determine at what age these behaviours become apparent the following study was conducted among 400 Grade 5 primary school children in which 59% were 9 year olds, 39% 10 year olds and 2% were 11 years old. All in all 9 primary schools were randomly selected to provide a sample that consisted of 184 boys (46%) and 216 girls (54%). Of these 235 (59%) were in Stream A while 165 (41%) were in Stream C/D. On the question of the relative likelihood of using any of these substance in the future, 28% reported having already done so with respect to wine, 16% for beer, 1% for cigarettes and none for other drugs. Male to female pupil ratio was 2:1 in as far as reporting as engaged in drinking wine and beer, cigarette smoking on the other hand could be totally accounted for by the male pupils. The same pattern of results was in evidence when one compares the use of these substances in those pupils that reported parental use, peer use but no differences were found between pupils in stream A and stream C/D. The results of the present study would seem to support the findings of the first ESPAD project and are a further illustration of the problem of underage drinking in Malta.

A PRELIMINARY ASSESSMENT OF MDMA USE IN MALTA

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sedqa, 2, Braille Street, Santa Venera, Malta.

MDMA is a synthetic ring-substituted amphetamine commonly known as Ecstasy. In recent years, we have witnessed an increasing number of police and customs seizures for the drug in addition to increased self reports of use by patients attending the detoxification centre here

at the general hospital. In light of these observations and trends occurring world wide, this study was a first attempt to assess the situation on the island of Malta. Six male volunteers were recruited, two were currently attending a Drug Community Service Centre while the remaining four were not attending any service at the time of the study. 70 questionnaires were distributed through this network in August 1997, and the response rate was 64% (n=45), 14 of these were returned from those attending the community service while 31 from those that were not. 76% (n=34) of the total respondents were males. Most of the sample, males 42%, females 54%, reported first encountering MDMA between the ages 16-19. The majority of respondents, 41% males 55% females, claimed to use between one and two tablets per session while a third claimed to use between 2-4 tablets. Almost half the sample replied that they had been using the drug for the past 3-5 years. A high proportion stated that they used alcohol in combination while 71% acknowledged the use other drugs before, or in combination or following a session. This first study has demonstrated that the use of ecstasy is prevalent in Malta but the number of users within the population of drug consumers or the general population per se has yet to be established.

BENZODIAZEPINE MISUSE BY PATIENTS ON A METHADONE PROGRAMME.

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Benzodiazepine misuse in the general population and the drug using population may arise for a number of reasons but the fact that these agents are reinforcing in their own right might be the overriding factor for their use by both these groups. This class of compound is also thought to produce memory impairments and a general disinhibition of behaviour that may in turn increase the risk of accidents and/or deviant behaviour. In the first half of the study reported here in which 98 patients were randomly selected from an on going methadone programme at the local Outpatient Detoxification Unit it was found that 80% (n=78) of patients had at least used benzodiazepines once in their lifetime. Of these, 24% reported daily use, 31% weekly use and 42% reported no use in the past six months (for 3% data was not available). Verification of use was confirmed by the REMEDI HS drug profiling system. Diazepam and Flurazepam were the two most frequently cited benzodiazepines in terms of use. The three most popular reasons given for their use included, to sleep better, to feel calmer and to feel good. 18 subjects had a previous history of overdose, 16, had at one time or another made use of benzodiazepines. 77% of the sample were IDU's, 85% stated use of these compounds at some stage in their life while 92% of this cohort reported needle sharing. Finally, of the 69 subjects with at least one record of arrest, 57 of these had a previous history of benzodiazepine use.

NALTREXONE ATTENUATES AMPHETAMINE-INDUCED SENSITIZED LOCOMOTOR BEHAVIOUR.

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Behavioural sensitisation to the locomotor stimulating effects of dopamine agonists such as amphetamine would appear to be a valid model to study the neurochemical basis for addiction and dependence in man. Drug sensitisation in humans is hypothesised to contribute to acquisition and maintenance of drug seeking behaviour as well as increasing the vulnerability to relapse. Environmental stimuli associated with this type of behaviour are also posited to play a significant role in relapse however, it has been previously demonstrated that opiate antagonists of the three receptor types failed to abolish the discriminative stimulus effects of amphetamine and cocaine. Sensitised locomotor responding was induced in one group of rats by intermittent administration of 1.0mg/kg amphetamine while a further group received saline before being placed in the open field while a final group was administered 1.0mg/kg amphetamine in the home cage. Following the expression of such a response, all animals were exposed to 0.5mg/kg amphetamine to determine the degree of sensitised responding. Administration of naltrexone to all animals in a counterbalanced design resulted in the sensitised group responding in manner similar to that observed in the other two groups. It would appear from these preliminary findings that naltrexone may indeed attenuate conditioned responding and thus may be of use in the prevention of relapse as is the case for alcohol.

THE ROLE OF THE CRIMINAL COURTS

Agius, C.A.

Courts of Justice, Malta.

This paper examines the necessary and inevitable involvement of the criminal justice system and particularly of the criminal courts in dealing with drug abuse cases and the relation that undoubtedly exists between illegal drug abuse and other criminal activity. Today we understand drug addiction to be a chronic, recurring illness with personal and social underpinnings. We know that drug addiction produces changes in brain chemistry, but that treatment can help restore chemical balance and give patients a chance to regain control of their lives. In conjunction with treatment, addicts need job training, relapse prevention, supervision, psychological support and medication where indicated. The situation, however, becomes complex when illegal drug abuse is accompanied with other criminal activity. How effectively do our laws and our courts respond to the drug abuser's needs especially when there is other criminal activity involved? How much discretion does the law allow the courts to balance the exigencies of the law, the interests of society and the needs of the drug abuser who also commits other crimes or who becomes a pusher in the normal evolution of his addiction? The

paper tries to answer some of these and other related questions trying to explain the importance of the role which the courts have within the societal context of dealing with the phenomenon of drug abuse and all that it entails, a role which is not merely that of applying the law but also in giving their contribution in trying to understand and do what's best for the national strategy to succeed.

SUBSTANCE ABUSE REHABILITATION IN A CORRECTIONAL FACILITY

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This presentation will focus on the preliminary results of a rehabilitation unit operating within the Maltese correctional services. The Unit was established in October 1995 as a substance abuse assessment unit and was subsequently upgraded to a therapeutic unit. The paper will focus on the related results, in particular:

- psychological impact of the programme
- re-offending rates of discharge
- reduction of the use of psychotropic drugs
- reduction of disciplinary infringements.

MALTESE SOCIETY'S REACTION TO SUBSTANCE ABUSE: MORAL PANIC, FEAR OR WISDOM?

Azzopardi, A. E., *Bell, A. & Clark, M.
Youth Studies-Programme, Faculty of
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Much research and intellectual energy have been expended in trying to find out why some people, especially youth, are using substances (Weil, 1986). The definitions surrounding the use and abuse of substances is however ambiguous. Within the context of Maltese society and especially in relation to young people, the use of some substances has been strongly condemned while that of others is not only tolerated but apparently encouraged. Whether or not this incongruence is the result of a distorted social construction or of an ambivalent attitude is a matter of great interest and concern.

This paper attempts to explore the predominant definitions of what constitutes substance abuse on the Maltese islands. Self-report surveys will be used to underpin the hypothesis that the social construction of drug abuse as an alarming youth problem may have contributed to the prevailing situation. There is ample evidence that a number of commendable prevention and educational measures are in place. However, there is no escape from the fact that the 'problem' remains unsolved and that it is gradually becoming more complex. The authors maintain that other measures, such as health promotion, harm reduction and the control of media

interventions, deserve careful consideration.

DRUG WORKERS' EXPERIENCES OF SUBSTANCE ABUSERS

Mifsud Sciberras, A.
sedqa, 2, Braille Street, Santa Venera, Malta

Drug-workers' experiences of their work with substance abusers were explored within a systematic framework and analysed using a grounded theory approach. The case consisted of twenty-two participants working at an out-patient and in-patient detoxification unit.

Content extracted from the participants' interviews was compiled into a questionnaire. The data collected was given back to participants as feedback during a workshop, where action contracts were decided upon and later evaluated. Various positive and negative experiences emerged within the relationship between staff and clients. Negative feelings, such as frustration, hurt, fear, anger, sadness, helplessness and hopelessness emerged when staff perceived their work as not having the desired outcome, when they felt not appreciated enough by clients and when they felt manipulated and not respected enough. Positive feelings, such as satisfaction, were less frequently reported. These emerged when staff perceived their work as having the desired outcome, when they felt appreciated for helping and when they felt respected and trusted by their clients. These experiences were found to be modulated through factors such as self-reflection, training and role structures. Suggestions are made at the unit level based on these modulating factors with the aim of improving the staff's well-being and the ultimately the service given to clients. Further implications for policy are discussed at the wider organisational level.

ALCOHOL CONSUMPTION DETERMINANTS IN THE MALTESE ISLANDS

Mamo, J.
In-Nahlija, St Paul's Street, Naxxar, Malta.

Combining data from Malta's participation in a survey on schoolchildren's attitudes, knowledge and habits on alcohol and other drugs with that ensuing from the recent national Census in Malta - replete with a new question addressing alcohol consumption - allows a useful overview of principle factors associated with alcohol use and abuse in Malta to be obtained.

Among clear determinants of overall consumption patterns are Age, Gender, Education, Occupation and other Socio-economic variables as Income, Private Health Insurance and Dwelling type. Interesting patterns of convergences emerge between alcohol and tobacco consumption from both principle sources.

The particular profile of high beer consumers is established as opposed to the very different one seen of wine consumers, both reflecting different ages and cultures. In particular, the culturally strong influences

that see wine consumed in the home from a very tender age, something of a Mediterranean trait are examined. This area is of principle concern to those wishing to promote early prevention. Towards the same goal it is crucial that future research clearly examine the attitudes and knowledge of young parents towards alcohol and use among children.

A CONTINUUM OF CARE FOR OPIOID USERS, ACCOMPANYING THE USE OF NALTREXONE. A REVIEW OF THE MALTESE EXPERIENCE.

Pell, J.
sedqa 2, Braille Street, Santa Venera, Malta

In June 1996 Naltrexone was introduced at the Substance Misuse Detoxification Unit in Malta. At the time, the history of compliance to treatment offered to opiate users, was being evaluated on a national level. Findings revealed a poor track record for successful detoxification from heroin after withdrawing the person from methadone-based maintenance/substitution treatment regimes. However, the number of opiate users that were seeking detoxification with methadone was still increasing at an average rate of up to 30 new clients per month. The introduction of the Naltrexone-based, rapid opiate detoxification regime countered these difficulties and within six to nine months, success rates for inpatient detoxification increased. As the demand for Naltrexone as an opiate-antagonist grew, Sedqa, the National Agency for Drug and Alcohol Abuse, felt the need to cater for the psychological and social needs of this client group. This resulted in the setting up of "Stima" a community-based residential rehabilitation programme focusing on the provision of psycho-social support to clients undergoing rapid opiate detoxification. This paper shall attempt to unravel the experience and outcomes of the "Stima!" programme. It will review relevant qualitative and quantitative data gathered during the last two years in an effort to validate or refute the efficacy of the programme, whilst forwarding recommendations that ascertain the direction for future developments in this regard.

A CROSS-CULTURAL STUDY OF FACTORS INFLUENCING THE PSYCHOLOGICAL WELL-BEING AND ATTITUDES OF RELATIVES OF ILLICIT DRUG USERS IN RESIDENTIAL REHABILITATION

Micallef, P. D.
Caritas, 5, Lion Street, Floriana, Malta

This research report outlines a study of close relatives of illicit drug users in residential rehabilitation in two countries - the United Kingdom (N=20) and Malta (N=23). Close relatives were compared on three variables; psychological well-being, attitudes towards the drug user's future as expressed in terms of hopefulness-hopelessness and involvement of the close relative in the rehabilitation process. Differences

between British and Maltese participants were found in relatives' hopes towards the drug user's future. Close relatives in Malta were found to be more optimistic. No significant differences were found on the other variables. When the sample was divided into mothers and all other relatives, a significant difference on involvement was found between the two countries for other relatives. Also reported are the inter correlations of the three variables within the two countries separately. In each country as expected, significant positive correlations were found between the two variables measuring psychological well-being, and negative correlations between psychological well-being and hopefulness. Most of the correlations between involvement and the other measures were in the opposite direction to those predicted although they did not achieve statistical significance. The qualitative information that was gathered from the relatives allowed for these results to be interpreted more effectively. Although this cross-cultural study suggests various differences between the two countries, it also highlights several similarities that were not predicted.

ADDRESSING CURRENT TRENDS IN THERAPEUTIC COMMUNITIES FOR ADDICTIVE BEHAVIOURS

Grech, V. & Micallef, P.
Caritas, 5 Lion Street, Floriana, Malta

Over the last 18 months, Caritas New Hope has been undergoing another intensive review and evaluation process to address rehabilitation services. Although this process is on-going, it is clear for New Hope that in order to survive the future it first needs to converge and organize all its resources, given today's drug user and the different drugs being used. Once this is done, then diversification could start allowing for independent programmes to be set up supported by a number of services. This paper discusses the recent review and evaluation process and the results Caritas New Hope has achieved to date. It also highlights the need for convergence of resources prior to diversification of services and promises a discussion on the "how holistic rehabilitation could be achieved" rather than "what would be done" in the rehabilitation of illicit drug users.

SECURING A EURO-MED PERSPECTIVE IN THE FORMULATION AND IMPLEMENTATION OF DRUGS POLICY

Bugeja, S., & Bell, A.,
sedqa 2, Braille Street, Santa Venera, Malta

Malta's strategic geo-political role in the centre of the Mediterranean has proved central to the promotion of Euro-Med dialogue on the necessity of a structured socio-economic inter-dependence. The need to safeguard a peaceful and prosperous co-existence rests on the precept that the security and well-being of the Euro-Med region cannot be fostered unless there is a definite "supranational" commitment toward the building of a tangible inter-regional nexus characterised by concrete initiatives in the social, economic, cultural and legal spheres.

This presentation examines why multi-national collaboration should also be endemic to the formulation and implementation of drugs policy in the Euro-Med region, particularly in the light of the multicultural dimension the drugs scourge is assuming. It discusses, explores and divulges ways of how a common Euro-Med drugs policy may be implemented and collaboration in the area secured. This presentation also places central importance of how Malta, given its historic Euro-Med stance, may be pivotal in the facilitation of co-operation and collaboration on substance misuse related issues in the region.

SUBSTANCE ABUSE IN THE COUNTRIES OF THE EASTERN MEDITERRANEAN REGION OF THE WORLD HEALTH ORGANISATION

Mohit, A.,
WHO, Eastern Mediterranean Regional Office,
Cairo, Egypt.

The Eastern Mediterranean Region of the World Health Organisation is composed of 23 countries extending from Morocco and Atlas mountains in the West to Kheyber Pass and Hindukush mountains in Afghanistan and Pakistan. Almost all countries of the Region are Muslim countries, many are Arab speaking. However, the Region has diverse cultural and economic characters.

Substance abuse is a major health and development problem faced by almost all countries of this Region, and almost all substances with abuse potential are abused in one way or another.

Thanks to strict prohibition of alcohol in Islam, the per-capita consumption of alcohol in this Region is less than other parts of the world, but this is just one side of the story. Per-capita consumption, legal production and importation and illegal home-made alcohol production are on the increase in the Region.

Narcotics, including opium and heroin are ahead in many countries of the Region. The hardest hit are Afghanistan, Iran, and Pakistan. Countries in North Africa including Egypt, Morocco, and Libya, are also threatened. The Members of the Gulf Cooperative Council are also increasingly endangered. The continuation of conflicts and problems in Afghanistan severely contributes to the production and smuggling, thus increasing the risk.

Cannabis and hashish are abused in most countries, but the greatest danger is in North African countries. The special problem of Khat exists in Yemen and Djibouti. While in these countries it is a socially accepted

stimulant drug, severe socio-economic risk is attached to its use. The paper will discuss the existing situation, some constraints existing for prevention and treatment and suggests a resource-oriented strategy for action.

THE RATIONALE FOR EURO-MED CO-OPERATION IN THE DRUG SECTOR

Veresies, K.
Kenthea, Cyprus

The Euro-Mediterranean region has its own peculiarities in the spread and use/abuse of illegal psychoactive substances. A concrete programme of prevention with priority in decreasing of the demand of drugs must be based in a wide research programme among the whole population of Knowledge, Attitudes, Beliefs and Practices, that will cover all countries of the region. The data of such a research will help the local governments and volunteer organizations to establish strategic plans for prevention. Establishing of an Organization of the Non-Governmental Organizations (such as the existing Euro-Mediterranean Partnership Against Substance Abuse, EMPASA) will unite the efforts for an effective and planning action.

ON-GOING COLLABORATION IN THE DRUG SECTOR BETWEEN EURO-MEDITERRANEAN COUNTRIES IN THE POMPIDOU GROUP

Luckett, C.
Council of Europe, Pompidou Group
Strasbourg, France.

The presentation will review the relevance of various Pompidou Group activities in recent years to the European countries around the Mediterranean, particularly in the fields of data collection, specific treatment issues such as female drug misusers, children of drug misusers and minority groups, prevention activities and co-operation against maritime trafficking.

Social factors such as family ties and religion may impact differently in the subregion compared with Northern Europe and hence suggest different programme opportunities.

The comparative weakness of demand reduction networking and of systematic training for professionals in the subregion suggests that initiatives could be developed with Pompidou Group support, drawing ideas in particular for the training issue from the successful training initiative undertaken recently in central and eastern Europe.

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- Reviews
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Manuscripts should be sent to the Editor.

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University of Malta Medical School,
G'Mangia.
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8 keywords. Research reports should give an appropriate introduction, a single methods section (with the methodology of all experiments reports), results, and discussion. Either British or American spellings are acceptable, but please be consistent. Authors should express measurements in SI units, although they may include older conventional units in parentheses if they wish. Except for units of measurement, abbreviations should be spelled out on first use, and should be standard. Drug names should be generic, although authors may add brand names in parentheses if they wish.

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Scerri CA, Abela W, Galdies R, Pizzuto M, Grech JL and Felice AE (1993) The b+ IVS, 1-nt No. 6(T->C) Thalassaemia in heterozygotes with an associated Hb Valletta or Hb S Heterozygosity and homozygotes from Malta. *British Journal of Haematology*, 83, 669-671.

Felice AE (1992) Molecular Epidemiology of Haemoglobin, and the Molecular biology of Normal and Abnormal Globin gene expression. In: *Collected Papers* (Eds R Ellul-Micallef and S Fiorini), pp. 357-391. University Press, Malta.

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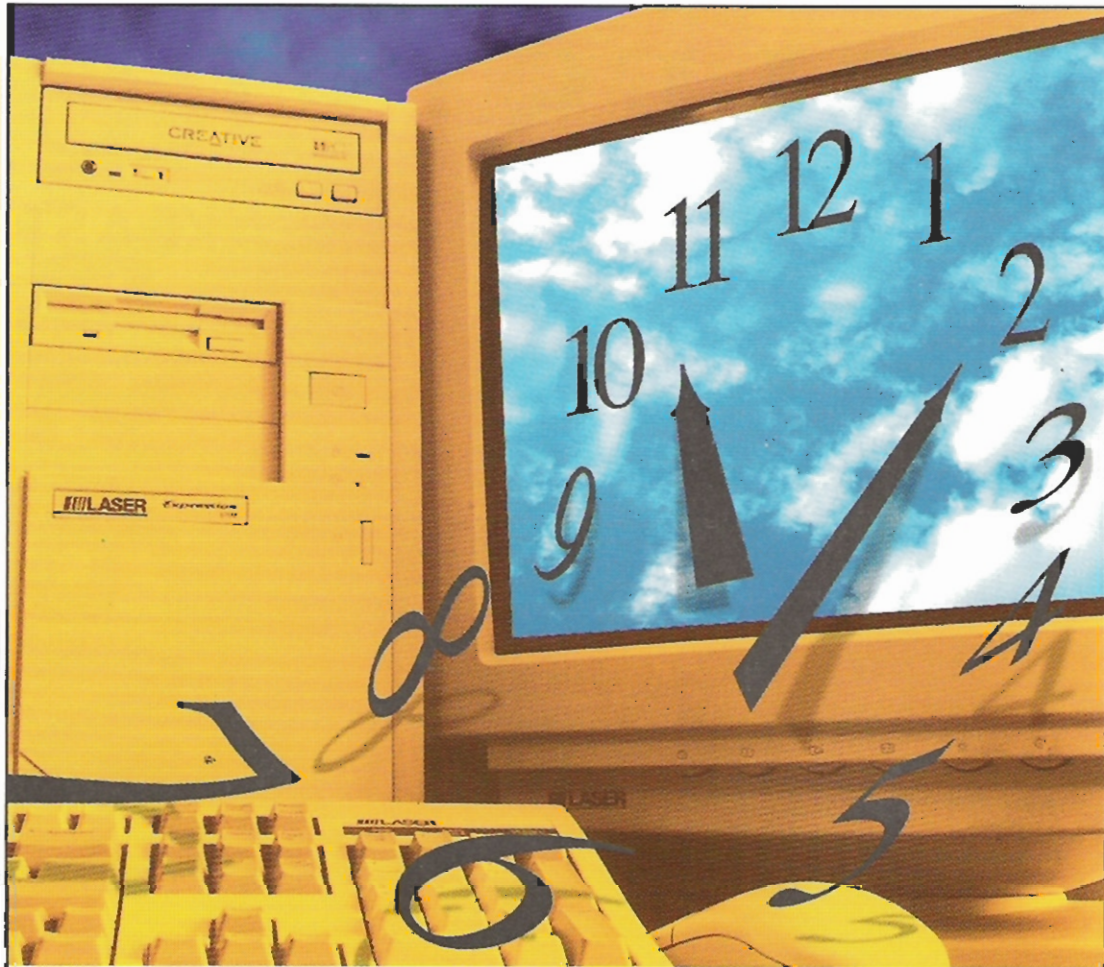
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