Atti Soc. Tosc. Sci. Nat., Mem., Serie A, **92** (1985)
pagg. 351-374, tab. 1.

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BIOLOGY AND ECOLOGY OF GHAR DALAM CAVE, MALTA

Riassunto — *Biologia ed ecologia della Grotta Ghar Dalam (Malta).* Vengono riportati i risultati di studi e rilevamenti nella grotta di Ghar Dalam condotti dal 1979 al 1983. I più antichi dati sull'ecologia della zona sono ottenuti dai resti di industria e resti organici della parte superficiale del deposito, che si riferiscono agli ultimi 7.000 anni dal Presente. Altri dati sono ottenuti dallo studio degli strati a Cervo e in quelli a Ippopotamo rispettivamente risalenti al Pleistocene Superiore e Medio.

Summary — The results of bi-monthly faunal and ecological surveys of Ghar Dalam Cave, Malta, carried out by the author (1979-83) are listed and discussed. Further limited information on the cave's ecology during the past 7,000 years is obtained from artefacts and organic remains recovered from its superficial deposits (Neolithic to Recent), and from bat remains found in the Late Pleistocene *Cervus* layer. All other organic remains embedded in this and in the Middle Pleistocene *Hippopotamus* layer were introduced into the Cave through water action and probably are not of any Cave ecological significance.

Key word — Biology, Ecology, Pleistocene, Holocene, Ghar Dalam (Malta).

I. THE CAVE

Ghar Dalam is a natural water-worn cave in the Lower Coralline Limestone of Malta forming a 136 m long phraeatic tube with several lateral recesses. It bears 14° 31' 48" East of Greenwich and

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35° 50' 08'' North (Grid Ref. 496187, using grid in DSO sheet 3 Series M. 898 Ed. 1, Scale 1:25.000) and is situated about 250 m. from St. George's Bay, Birzebbuga, on the south east of the Island.

The Cave has only one opening to the outside: facing south west and standing about 6 m above the valley bed and 15.4 m above sea level (base of gate is Bench Mark 50'). Except for the outermost few meters and the innermost regions inaccessible to the general public, the Cave is lit artificially by electric light bulbs. Ventilation is by diffusion and smoking is not allowed inside the Cave.

The entrance is a natural arched opening measuring 8.4 m in width and 2.55 m in length. It was originally «walled up and provided with a doorway» (COOKE, 1893). The wall and the «narrow door» with iron bars (CATON-THOMPSON, 1923) were pulled down by Despott (SEGOND, 1930) and replaced by the present full length gate with iron bars in about 1929. Its vertical, round bars (2 cms diam.) are 15 cms apart, whilst its horizontal flat bars (1 cm thick) stand 84 cms from each other.

In 1980 the gate was fitted with a wire netting (diam. 5 cms) but this was partially removed in 1982 to allow free passage to any bats visiting the cave. Two meters beneath the entrance is a railed platform from where the visitor commands a good view of the entire Main gallery before being conducted along a railed path on the left to view the Cave at close quarters.

Access to the platform is by a wooden staircase. The landing is cemented in the central area only, being bounded on either side by patches of soft dusty soil. At the innermost end of the Main gallery (c. 80 m), four steps were cut in the rocks in 1928 to facilitate authorized access to the innermost cave system (DESPOTT 1928).

The temperature inside the Cave is confortably warm in winter and pleasantly cool in summer.

The site is a national monument and was initially opened to the general public «early in March 1933». It is now a major tourist attraction, having been visited by over 29,766 persons during the tourist boom in 1978-79. Its chief attraction are: the *Cave* itself with its large stalactites and stalagmites and peculiar limestone solution features; its Middle and Late *Pleistocene* deposits containing remains of a dwarf fauna (chiefly hippopotamus, elephants and red deer) and the overlying *Cultural layers* containing domestic animals remains and products of Man's culture dating back from the earliest phase of Maltese pre-history (c. 5, 200 BC) to present times (EVANS, 1971).

II. The deposits as a source of past ecological data

Most of the floor deposits that once filled up the Main Gallery to the level of the entrance, have long since been excavated. A stratigraphic sample wall and column and some remaining deposits reveal, however, that the sequence consisted of the layers recorded hereunder in the order of their deposition.

1. *Bone-free Clay layer* (Max. 180 cm)

This clay deposit represents the limestone detritus or product of solution of the cave rock. It was deposited when the Cave was still part of a subterranean tunnel extending to the opposite side of the present valley and running at right angles to an overlying river which gradually ate its way into the roof of the tunnel and discharged its river load within. This bone-free clay layer is consequently the lowermost Cave deposit. It infills the second broadening of the Cave floor (Lower Coralline Limestone) and also some of the lateral recesses in the outermost region. Baldacchino logged a maximum thickness of 180 cms (1934).

With time the river cut its way also beyond the tunnel floor, leaving the two distal ends of the tunnel perched high up, and on opposite sides of, the valley.

Rock features within the Cave indicate that the clay deposit (which is the product of erosion of the limestone, laid down during process of Cave formation) is the product of the action of water *percolating or seeping* in through fissures and parallel beddings planes (Shaw, 1951) rather than of a «vadose» stream *running through* the tunnel (Baldacchino, 1937).

No bone remains are known from this bed, hence the origin of the former name «Sterile Clay layer» by Celia Topp (1950). The occasional shell fragments which it contains were derived from the parent rock (Lower Coralline Limestone). The leaf-like impressions seen on splitting open the clay, are probably leaves introduced into the Cave by water action through rock fissures thousand of years ago. No trace of organic matter was found in the root-like impressions examined by Edwards (1935). Age: Late Lower Pleistocene and Early Middle Pleistocene.

In the innermost reaches of the cave system (i.e. beyond 80 m), there is no clay and there are no water-borne deposits, but only boulders that have fallen off from the roof and patches of brick

red, terrarossa-like soil derived from roof fissures. A pyramidal mound of such soil on the edge of a large boulder beneath a rock fissure in the roof (noted by the author in 1980), is a clear indication of its source.

2. Hippopotamus *layer* (85-127 cm)

This is a water-borne deposit containing small pebbles (BALDACCHINO 1934) and remains of animals, chiefly *Hippopotamus* and, to a lesser extent, elephants, all of which were smaller than their present-day counterparts. Remains of the dormouse *Leithia cartei* (Adams) and of nine species of bats are also present.

In the outermost regions of the Cave, the deposit is a consolidated bone breccia, whilst further inwards, the remains are loosely embedded in clay. In the innermost regions beyond the Main Gallery, however, fossiliferous deposits are completely lacking.

Age: Middle Pleistocene.

As during the deposition of this layer the Cave was still part of the subterranean tunnel with a breach in its roof, and consequently in communication with the overlying river flowing at right angles to it, the organic remains embedded in this deposit probably carry no ecological significance in relation to the Cave. They were merely introduced through water action. On the basis of its predominant rodent fauna, STORCH (1974) labelled this level the «*Leithia cartei* stage».

3. *Pebble/Boulder layer* (c. 60 cm)

A layer of highly rolled, rounded or smoothly flattened white pebbles or boulders ranging from 3-35 cms in diameter, overlies the *Hippopotamus* layer and underlies the *Cervus* layer. It is indicative of enormous quantities of high powered waters flowing through the river bed at this particular time.

Age: Late Middle Plaistocene.

In the Pleistocene sequence at Mriehel (ZAMMIT-MAEMPEL, 1982), the Pebble bed contains many coloured pebbles and lies mostly at the base of the *Hippopotamus* layer, suggesting either an earlier age for the Mriehel deposit or else a softer unconsolidated *Hippopotamus* bed in that region to allow the pebbles to sink to its base.

4. Cervus *layer* (175-195 cm)

This is a water-borne red earth or soil deposit containing

numerous remains of dwarf deer and scanty remains of red fox, brown bear and wolf. Micromammalian remains, including those of the voles *Pitymys melitensis* (Bate) and *Pytymis pauli* Bate and five species of bats, are also present.

Age: Late Pleistocene.

It is thought that with the exception of bats, the water-borne deposits of this layer give no indication of the Cave ecology at the time of their deposition. They are, however, irrefutable evidence of the presence of such a fauna existing on the Island at the time and also, of the forceful penetration of the Cave by flood water carrying such remains.

As bats are cave dwellers, and as during this period part of the Cave could have been above the level of the river, it is possible that the bat fauna belonged to the Cave.

5. a) *Cultural/Pottery/Domestic animals layers: Prehistoric division (53-55 cm)*

A light brown deposit containing a number of thin (5 mm) calcareous sheets. It is separated from the underlying *Cervus* layer by a 20-25 mm thick horizontal calcareous sheet indicating the long lapse of time between the deposition of the two deposits. The deposit was laid down in situ.

At 20 cms above the *Cervus* layer — 30-35 cms beneath the base of the overlying very dark deposit — there is a 10-20 mm thick greyish green horizontal layer with a (? charred) brown black base (2-3 mm). It extends through the entire lenght of the stratigraphical wall and was thought to represent a prehistoric floor fire. Microscopical examination of the deposit, however, could not confirm the author's suspicion. A similar, but more circumscribed, layer stands about 10 cms above the preceeding one.

On the basis of its predominant fauna — the locally extinct Field mouse — this prehistoric division was labelled by STORCH (1974) as the «*Apodemus sylvaticus* stage».

There is no evidence of any organic remains or pottery in the exposed section of the sample wall, but past excavations have yielded pottery dating back from the earliest phase of Maltese prehistory (c. 5, 200 BC) to the Bronze Age (c. 2, 500-800 B.C.). The classification of Maltese prehistory into phases is based mainly on the development of pottery (TRUMP, 1972: 26).

5. b) *Cultural/Pottery/Domestic animals layer: Historic division*

A very dark reddish brown/blackish deposit containing remains (Max. 74 cm) of Man and his culture mixed with abundant remains of domestic animals. It was deposited *in situ* throughout the past few thousand years (Phoenician to Modern times).

The upper surface of this deposit formed the «floor» of the Cave when it was first discovered. On account of the abundant presence of remains of Black rat, STORCH (1974) labelled this division the «*Rattus rattus* stage».

Through these cultural deposits it is known that Ghar Dalam Cave offered some form of human habitation throughout prehistoric times and subsequently served also as an animal shelter. Tie-holes in the limestone wall on the left (Section 1 of Cave) can still be seen, and remains of sheep/goat, cow and pig were recorded from the Cultural layers («Superficial deposits») by COOKE (1893), DESPOTT (1916, 1923), BALDACCHINO (1938) and BOESSNECK and KÜVIER (1970). The latter authors (1970) recorded also remains of cat, pigeon and land turtle, whilst bones of horse/donkey were listed by COOKE (1893), DESPOTT (1916, 1923) and CATON-THOMPSON (1923). Remains of pigeon (*Columba melitensis*) described by LYDEKKER (1981) were originally recorded from the Cave by BATE (1916).

Up to the time of Despott's first excavations in 1916, the site was still being used by farmers as a cattle shelter. Its entrance was then walled up and a rubble wall ran across the Main Gallery (see CATON-THOMPSON 1925, pl. II fig. 2), presumably to prevent the animals from straying into the inner regions where they would get lost. The use of the Cave as a cattle shelter explains the abundant lumps of eel grass, *Posidonia oceanica*, encountered in the Cultural layers. The Maltese farmer still uses this marine plant (*Alka*) as a cheap but adequate bedding for his animals. The vertebrate remains found in the superficial deposits reveal that there has been a considerable change in the Cave fauna throughout the past 7,000 years. The vole *Pitymys melitensis* (Bate) and the toads *Bufo viridis* Laurenti 1768 and *Bufo bufo* (L. 1758) / *Bufo vulgaris* L., plentiful remains of which were recovered from the Cave deposits, have now disappeared both from the Cave and from the Island.

Pitymys melitensis, initially recorded from the upper Cave deposits by BATE (1920) as «*Arvicola melitensis*», has since been recorded also by DESPOTT (1923), CATON-THOMPSON (1923), BATE (1925,

1935 — when it was re-described as «*Pitymys*» — and by STORCH (1970, 1974). Abundant remains of *Bufo viridis* or *vulgaris* (identified by Boulenger) were recorded from Ghar Dalam Cave by DESPOTT (1923), BATE (1920, 1923, 1925) and BALDACCHINO (1934, 1937). The skink, *Calcides ocellatus tiligugu* Gmelin 1798, known locally as *Xahmet l-art*, and the common frog (*Żring*), *Discoglossus pictus* Otth. 1837, whose remains have also been recorded from the Cultura layer (BOESSNECK and KÜVIER, 1970), are still abundantly present in the Maltese countryside. The skink has never been sighted in the Cave but a single specimen of the common frog was noticed by the present writer (1967) in the clay pit or «window» in the Bone Breccia (Section II).

The Cultural layers yielded a large number of land shells. DESPOT (1916, 1923) recorded *Eobania vermiculata* Müll., *Helix aperta* Born *H. aspersa* Müll., *H. (Iberus) melitensis* Ferr. var. *despotti* Gatto, *Pomatias sulcatus melitense* Sow., *Cernuella caruana* Kob., *Rumina decollata* L., *Papillifera papillaris* Müller, *Chondrula (Mastus) pupa* Brug. and *Lampedusa (Lamellifera) oscitans* (FERUSSUC 1852). A few years later, BALDACCHINO (1934: XXVIII, 1935: XVIII) unearthed further land shells from the uppermost 1.35 m of the Cave deposit and added «*Clausilia pseudosiracusia* Gatto,... *Albea candidissima* Drap,... *Trachidea schembrii* Pfr. and *Oxychilus drapalnaldi* Beck».

Helix (Iberus) melitensis var. *despotti* (so called by Caruana Gati after its finder), is apparently extinct. The species was originally recorded only from the lowermost (Prehistoric) division of the Cultural layers of Ghar Dalam, but was subsequently found also in other prehistoric sites (BALDACCHINO 1937: XIX). The shel was figured and described more adequately by TRECHMANN (1938: 17-22; pl. 1 fig. 29).

Of all the above-mentioned shells, the author encountered only *Eobania vermiculata, Helix aperta, H. aspersa, Pomatias sulcatus melitense, Papillifera papillaris, Lampedusa (Lamellifera) oscitans, Chondrula (Mastus) pupa* and *Oxycilus* (s. str.) *drapalnaldi. Pleurodiscus balmei* POTIEZ and MICHAUD 1838, a species hitherto unrecorded from Ghar Dalam Cave, was also collected by the author.

The Ghar Dalam deposits have also yielded considerable information on the bat fauna existing on the Island from Middle Pleistocene to Modern times.

In 1893, Cooke recorded the find of «bat remains» from the very superficial layers. In 1923, Caton-Thompson encountered skeletal remains of «two species» of bats which in 1925 were identified as

those of *Rhinolophus* cf. *euryale* and *Myotis oxygnathus* (BATE 1925: 17). In 1970 and 1974 Storch published a list of the remains he encountered in each of the successive layers in the Cave. In it he recorded nine species from the Middle Pleistocene *Hippopotamus* layer (which he called the *Leithia cartei* Stage), five species from the Late Pleistocene *Cervus* layer (*Pitymys* Stage), three species from the *Apodemus sylvaticus* Stage of the Cultural layer (Holocene) and four species from the *Rattus rattus* Stage, which includes modern times.

Two of the recorded species were new to science: *Rhinolophus mehelyi birzebbugensis* from Middle and Late Pleistocene deposits and *Myotis ghardalamensis* which was limited to the Middle Pleistocene *Hippopotamus* layer.

Of the nine species recorded from the latter deposit, only two

TAB. 1 - *Bat fauna recorded from the Pleistocene and Holocene deposits of Ghar Dalam and present day records from Malta (after Storch 1974 and Bate 1925).*

	Hippopotamus (*Leithia cartai* Stage) Middle Pleistocene	*Cervus* layer (*Pitymys melitensis* Stage) Late Pleistocene	Domestic animals layer (Apodemus sylvaticus Stage) Holocene	Recent bat fauna, Malta (Rattus rattus Stage) Holocene
Rhinolophus hipposideros (Bechstein)	+	+	+	+
Rh. mehelyi birzebbugensis Storch 1974	+	+	—	—
Rh. blasii Peters	—	+	—	—
Rh. euryale Blasius	—	+	+	—
Myotis exiles Heller	+	—	—	—
My. ghardalamensis Storch 1974	+	—	—	—
My. bechsteine robustus Topal	+	—	—	—
My. capaccini (Bonaparte)	+	—	—	—
My. blythii (Tomes)	—	—	+	+
**My. oxygnathus*	—	—	+	—
Micropterus schreborsi (Kuhl)	+	+	—	—
Eptisicus paraglacialis Kormos	+	—	—	—
Pipistrellus pipistrellus (Schreber)	+	—	—	+
Vespertilio murinus L.	—	—	—	+

* « *A Myotis oxygnathus*» was recorded from the Cultural layer by Bate (1925: 17). Its remains are in the Ghar Dalam Museum

(*Rhinolophus hipposideros* and *Pipistrellus pipistrellus*) are represented in the list of today's bat fauna of the Maltese Islands. Of these two, only *Pipistrellus* has been sighted inhabiting the Cave in recent years.

The abundant bat fauna in Middle Pleistocene deposits probably reflects the abundant insect fauna of the period due to the great number of fresh water ponds and other ideal conditions for their multiplication then existing locally. Their remains, however, must necessarily have been introduced into the Cave through water action and in no way indicate the bat fauna of the Cave during that period.

III. Surveys of recent Cave biota

a) *Previous surveys.* No previous detailed long-term surveys of Recent Cave biota and ecology of Ghar Dalam has ever been carried out. References to its modern fauna are limited to accidental remarks in the *Annual Reports* of the Museum Department (e.g. Baldacchino 1934-35: XIX) or in other general publications relating to the Cave (e.g. Despott 1916: 268; Caton-Thompson 1923; Shaw 1951: 307).

b) *Present survey (1979-83).* For recording the position of organisms collected, the Cave was divided (from Cave entrance inwards into the following regions or Sections:

I. Platform region (0-4 m): Natural light, fresh air, cobwebs; very loose earth on either side of cement platform;

II. Railing - Bone Breccia - Stratigraphic sample wall region (4.0-25.3 m): Natural light, fresh air, clay, red soil deposit at distal end;

III. Sample Wall - end of domed region of Main Gallery (25.3 m-59.0 m): Region of large stalactites and stalagmites;

IV. Cave branch on right side at end of domed gallery (59-77 m): Semi-darkness, not accessible to the public;

V. Low roof region connecting Main Gallery to Steps (59-79 m): No organic remains, distal end of acess to general public, last electric light bulb.

Steps (79-80.4 m)

VI. Crawling region (few meters): Only most external part partially lit.

VII. «Double floor» region: Blocks with parallel upper and lower surfaces, water pools, brick red soil patches on ground, tufa on ceiling.
VIII. Lateral recesses/branches on right (in region 17.5 m from steps: Passage low, some passages D-shaped and communicate, total darkness;
IX. Distal end of Cave: Perpetual darkness, smoothly rounded convex floor meeting low arching roof in rock fissures.

In order to take into account seasonal variations in cave ecology, Ghar Dalam was visited over the period 1979-83 as follows: bimonthly from September 1979 until July 1981 and more sporadically afterwards. The innermost region was visited in March 1969, August 13th and September 22nd, 1980.

Observations on the innermost cave system

The common belief that the Cave extends to and communicates with the sea at St. George's Bay, Birzebbuga is absolutely unfounded. The innermost cave system has no opening to the outside. Ventilation of this region is solely by diffusion through the narrow, low entrance (steps) and after about 45 minutes in the innermost parts of the Cave, breathing becomes somewhat heavy.

Seepage of water was found to be a prominent feature on the «double floor» region of the Cave system. It gave rise to the formation of water pools on its brick red soil and to tufa, stalactitic thorns and very peculiar stalactitic structures on its ceiling (Helectitis).

In September 1980, the pools were crystal clear and no insect larvae were present. Two midges (Ceratopogonidae) were noted persistently hovering over the water pools (alighting at times on the fallen boulders), but the ecological significance of this is not known.

The tufa covering most of the arched ceiling of Section VII is about 1 cm thick and rippley in appearance due to the overlapping layers of lime. At one particular site in the central region of Section VII, the tufa surface bears a small number of peculiar stalactitic structures (Helictitis). These are less than a centimeter in height, have a relatively wide base (0.3 mm diam.) and a pointed, hooked, distal end directed upwards and towards mid line of Cave in all the observed units. No evidence of any rock movements, side draughts or other causes were found to explain this apparent anomaly.

The sound of water dripping into the inner Cave system is clearly audible from the inner parts of Section V, where stalactitic activity

is also present as indicated by the glistening tips of the stalactitic thorns hanging from the flat roof. The large stalagmite to the *left* of the Main Gallery is also active all the year round and shows a rusty ferruginous pigment on its recently-deposited waxy white apex. This large stalagmite, standing 35.25 m (Section III) from the Cave entrance, has its base still embedded in red soil (*Cervus* layer). A shelf-like broadening of its diameter (giving the stalagmite a characteristic conical mush-room appearance), marks the level of its emergence from the original soil deposit.

The 10 cm thick layer spreading from its base towards the centre of the Cave, overlies the upper parts of the red soil layer. It suggests a prolonged period of tranquillity and dry warm conditions inside the Cave at the time of the formation of this sheet at the close of the Late Pleistocene.

Another large stalagmitic column, standing 44 m from entrance and on *right* side of the Cave, is also of great palaeoecological significance. It is c. 2.40 m high and carries deep flutings in the region between 65 and 112 cms from apex. A large number of subfossil land shells (chiefly *Papillifera papillaris*, whose colour bands are still faintly visible) stand crowded together attached to the troughs of these flutings. In its lower parts, the column is markedly stratified with calcareous/stalagmitic horizontal sheets alternating with softer red soil deposits 5-10 cms thick.

Two of the stalagmitic layers (5.0 cms and 8.5 cms thick) standing respectively 112 and 145 cms from apex, form prominent horizontal projections that have their counterparts as stalagmitic levels of attachment on the right cave wall of this inner region and on the other stalagmitic column. The sheets must have once been very extensive and they have a similar significance to the sheet protruding from the base of the left column. Attempts are being made to have these sheets dated.

The lower sheet carries embedded in its under-surface a very large number of land shells — mostly *Rumina decollata* L. — in a very good state of preservation.

In May 1981, the occasional dripping of the water in the inner cave system turned into a continuous trickle and increased dripping was noticed in Section IV and V (a burst pipe over hundred meters up the road could have accounted for the increased flow). Total rainfall was 497.3 mm for 1979, 580.6 mm for 1980, 394.6 mm for 1981, 767.5 mm for 1982 and 701.7 mm for 1983.

Very marked dripping activity noted in January/February 1982 with noticeable seepage of fluid through the fissure in Section IV resulted in flooding of channels in this region and in Section III. Though odourless, the liquid was frothy and analysis revealed elevated *Escherichia coli* counts indicating gross contamination with sewage. Source of contamination was subsequently located and plugged.

IV. Faunal and floral list of Ghar Dalam Cave, Malta (1979-83)

The following faunal and floral list records the organic life encountered at Ghar Dalam during the author's survey (1979-83). A few additional records made by the author in 1967 and 1969 are also included (but the date of the observations are clearly stated). The *Roman numerals* following species name indicate Section of Cave where the organism was sighted, a *bracketed numeral* indicates that the specimen was found dead in the Section stated, and a cross (+) that it was associated with spiders' webs. An asterisk (*) marks a new record for the Maltese Islands. Date of sighting is also recorded.

Phylum: ARTHROPODA	
Class: **Insecta**	
Order: Dictyoptera	
Family: Polyphagidae	
Polyphaga aegyptiaca L.	II, July 1980
Order: Hemiptera	
Family: Lygaeidae	
Gon. et sp. indet.	I*, Nov. '82
Order: Lepidoptera	
Noctuidae	
Hypena oxytalis Hübner	(I)*, Aug. '80; II, Sept. '79 (II), Oct. '79; III, Oct. '79 July '80, Aug. '80; V, Oct. '79
Oecophoridae	
Agonopteryx thapsiella (Zeller)	(I)*, May '80; II, Sep. '79, Aug. '83; IV, Sept. '79, July '80; V, Sept. '79, May '80, July '80
Tineidae	
Proterospastis merdella (Zeller)	I*, larval case with moth coll. Oct. 1979

Tinea murariella Staubinger	I*, larval case with moth, Coll. Jan. 1981
Order: DIPTERA	
Muscidae	
Musca domestica L.	I, Dec. '81
Rhagionidae	
**Vermileo* sp. (larva)	I, Mch. '81 (buried); I, Mch. '82 (wriggling at surface)
Ceratopogonidae	
**Forcipomyia* sp.	VII, Sept. '80
Calliphoridae	
Calliphora vicina Robins de Voidy	(II), Sept. '79
Tipulidae	
Limonia (Limonia) nubeculosa Neigen	(I)*, (II), Sept. '79; IV, VII, May, Aug., Sept. '80; V, May '80 (large numbers)
Order: HYMENOPTERA	
Andrenidae	
Andrena agilissima italica War.	I, July, Aug. '80; April 1890; (I)*, Sept. '80
Mutilidae	
Ronisia barbara brutia Pet.	I, July '80, Apr. '83; (I), Sept. '80
Anthophoridae	
Anthophora acervorum (L.)	I, Mch. '80, Feb. '83
Order: COLEOPTERA	
Silphidae	
Silpha olivieri Bedel	I Aug. '80
Carabidae	
Carabus morbillosus Fabricius	(I), Dec. '81, Mch. '83
**Pristonychus (Sphodroides) picicornis (Dejean)*	I, Dec. '80; (I), Mch. '83
Scarabaeidae	
Pentodon bidens Pallas	(II), Sept. '79
Thorectes intermedius Costa	(I), Oct. '79
Tenebrionidae	
Alphasidae melitana Ritter	(I), Aug. '80, Mch. '83
Curculionidae	
Otiorhynchus lugens Germ	(I)*, Aug. '80
Class: **Crustacea**	
Order: ISOPODA	
Armadillidium sp.	(I), Nov. '82, Jan., Mch. '83

Order: DIPLOPODA	
Julus sp.	I, Oct. '79, Jul. '80, Jan. '81, Nov. '82; I, Mch. '80, Jan. '81
Class: **Arachnida**	
Order: SCORPIONIDA	
Euscorpio carpathicus (L.)	(I), Jan. '83
Order: ARANEAE	
Linyphiidae	
**Aulacocyba subitanea* (O.P.-C.)	I, Jan. '83
Pholacidae	
Pholcus phalangioidae (Fuossillin)	I, May '82
Phylum: MOLLUSCA	
Class: **Gastropoda**	
Eobania vermiculata (O.F. Müller)	*(I), (VII), Sept. '80; I, Nov. '82*
Pomatias sulcatus melitense Sowerby	(VII), Sept. '80; (IX), Mch. '69
Chondrula (Mastus) pupa (Bruiguire)	(VII), Sept. '80
Lampedusa (Lamellifera) siracusana oscitans (Ferussac)	(I), Nov. '82; (IX), Mch. '69
Helix aperta Born	(I), common
Helix aspersa Müller	(I), common
Papillifera papillaris (O.F. Müll.)	I, Nov. '82
Pleurodiscus balmei Potiez & Michaud	(I), Nov. '82
Oxychilus (s. str.) *draparnaldi* (Beck)	I, Jan. '83
Phylum: CHORDATA	
Class: **Amphibia**	
Discoglossus pictus Otth.	II, July 1967
Class: **Mammalia**	
?*Mus musculus* (Skeleton)	(IX), Mch. '69
Rattus rattus L.	(I), June '82; III, Dec. '81; (I), Feb. '83
Pipistrellus sp.	III, 1980
Flora	
Blue groen algae	
**Anacystis montana* (Lightf.) Dr. Daily	I
**Schizotrix calcicola* (Ag.) Gem.	V

Pappus (Compositae)	I, July '80, Feb. '82
Triticum aestivum (introduced as rat poison, but germinated)	I, II, Jan. '83
Ceratonia siliqua L. (pods)	I, II, IV
Ceratonia siliqua L. (seeds)	I, II

V. Observations and notes on records

1. *Lepidoptera*

An account of the Lepidoptera of Ghar Dalam has been given elsewhere (Zammit-Maempel, 1983).

2. *Diptera*

Periodically, house flies and carrion flies enter the Cave to take refuge from inclement weather or to escape the heat of summer. They tend to remain in Section I and only rarely penetrate into Section III. None were found in the innermost regions of the cave-system.

In September 1980, two midges (Ceratopogonidae) were noticed hovering persistently over waterpools in Section VII.

Crane flies were ubiquitous in the inner Sections. Small groups were noted in Sections IV, VII, VIII (in May, August and September 1980) and large numbers in Section V (May 1980). In the latter region, a swarm of them covered an area 2.5 m x 1 m, with a density of over 36 per sq. meter. Captured sample specimens were all identified as *Limonia (Limonia) nubeculosa* Neigen.

It was observed by the present writer that when not disturbed, the insects all hung perpendicularly from the ceiling by *one* of their front legs. With their wings folded and their body suspended in this fashion, they resembled miniature chinese lanterns. They did not seem to be disturbed by the continuous flow of visitors' heads passing some 45 cms beneath them. When a bright light was shone to within 30 cms from them, they did not fly but merely assumed a more horizontal position by gradually getting attached to the ceiling: first by two, then four and ultimately by all legs. A number of conical pits were noted in the soft earth or dusty soil on the left side of the Cave entrance (just beyond the cement platform). These are formed by a species of *Vermileo*, whose longish larva is buried 1-2 cms underneath the surface (beneath the inverted conical

pit). Its presence is betrayed by occasional particles of dust thrown up by the larva in attempts to capture small creatures that crawl down the conical pit. This is the first record of the genus from the Maltese Islands.

A single larva noticed (March 1982) wriggling at surface of dusty soil beneath Cave entrance, was also identified (BMNH) as a *Vermileo*. The adult has not been sighted. All larvae were collected in March.

3. *Hymenoptera*

A number of cylindrical, burrows (some almost vertical others horizontal), 18-50 mm deep, were noted in Section I and in outermost region of Section II of the Cave. The vertical/oblique burrows tended to be more closely spaced (60 instead of 30 in an area 40 x 50 cm) and wider (10-15 mm instead of 5-10 mm) than the horizontal ones. All burrows have a hardened inner lining so that the whole structure, when embedded in very soft soil dust, can easily be unearthed as a complete unit. The ones examined had a rounded, slightly bulbous lower end. Many of the units unearthed in April 1983 bore within them a single, winged, dead *Anthophora acervorum* at their lower end.

The burrows were unbranched but the bulbous lower end (int. diam. 12 mm) of one particular vertical specimen (int. diam. 7 mm) that had a dead insect within, bore an oval window at its side (7 mm x 5 mm, longer axis vertical. This probably represent a broken horizontal tunnel. Though *Anthophora acervorum* is seriously suspected of being responsible for the formation of the burrows, it is not known with any certainty which insect is actually responsible. *Anthophora acervorum, Ronisia barbara brutia* and *Andrena agilissima italica* were all found associated with the burrows, but none of them was actually seen digging it.

Anthophora acervorum, the presumed originators of the burrows, invariably make their first appearance in the Cave in mid February each year. Very marked activity in May 1979, March 1980 and February-April 1983. The insects were seen entering burrows head first and emerging (often several minutes later) again head first. They were also entering the tiny honeycomb weathering pits in the Lower Coralline Limestone walls and roof of Section I of the Cave. No activity was noticed in Sept.-Oct. 1979, May, July, August 1980, Dec. 1981 and February 1982.

A number of *Ronisia barbara brutia* were noted (July-Aug. 1980) crawling over the vertical burrows in Section I. Further specimens noticed in April 1983 crawling just outiside gate. The species is said to be parasitic on bees which might explain their presence on or close to, the burrows. The females of this species are wingless and consequently greatly limited in their movements to and from the Cave. The Maltese Mutilidae formed the subject of a paper (1966) by Invrea.

The winged males are much rarer than the females. The only male specimen noted throughout this survey was in late Sept. 1980, when it was seen fluttering its wings whilst crawling over the burrows — probably in search of a female. When approached, it made no attempt to fly off, but was easily captured.

In May 1980, the area of the sub-vertical burrows in Section I was found littered with dead bodies of *Andrena agilissima italica*, whilst in July and August 1980 more specimens, both alive and dead, were noted also in other areas close by. Though *Andrena* is known to burrow, its relationship to the burrows at Ghar Dalam is not clear.

4. *Arachnida*

Three or four species of spiders were initially collected from Sections I, II, III, and V of the Cave (1979) but as they were not properly preserved, identification was not possible. No further specimens were located inside the Cave prior to 1982, when a *Pholcus phalangioides* (Fuessillin) was collected from just within the cave entrance. In January 1983, a very small specimen, *Aulacocyba subitanea* (O.P.-C.) (Linyphiidae) was noticed suspended from a thread in Section I beneath the left arch of the entrance. This species is quite a frequent visitor of European caves (Pers. comm. P.D. Hillyard, BMNH) but it is a new record for Malta.

Amongst the insects found trapped in spiders' webs in Section I were: *Otiorhynchus lugens, Ronisia barbara brutia* (♀) [how?], *Hypena oxytalis, Agonopteryx thapsiella* and *Limonia (L.) nubeculosa.* A number of larval cases of Tineid moths were also found suspended from such webs or from web filaments attached to wall. Three different species were involved: *Proterospastis merdella, Tinea murariella* and another species whose larva was lost prior to maturing into an adult. The description of *P. murariella's* larval case and its association with spiders' webs in caves were not previously known to science and have been recorded elsewhere (ZAMMIT-MAEMPEL 1981).

In Section II and V, the isolated webs were thick sheets (2-3 cms x c. 2 cms) spread between two or more lumps of red soil or rock protuberances, with the spider lurking somewhere underneath. A few were of the silver-collar type — funnel shaped with a central opening.

One small web was located in the innermost region of a recess (Section IV) that is in permanent darkness. Another web (with spider) was bridging a cavity in the rock wall 79 m from entrance, just beneath the last and innermost 60 Watt electric bulb in Section V (close to patch of *Schizothrix calcicola* growth). None of the webs in Section II-V contained entrapped insects and no webs were detected in Sections VI-IX, of which VII and IX are in permanent darkness.

5. *Gastropoda*

In this survey, dead landshells were recorded from Sections I, VII and IX. Living specimens were found solely in the outermost region (I) of the Cave: a young specimen of *Eobania vermiculata* from the platform area, specimens of *Papillifera papillaris* from outside the arched entrance as well as from within it, and a single specimen of the black-bodied, markedly carnivorous *Oxychilus* (s. str.) *draparnaldi* from a patch of blue green algae just within the Cave.

6. *Mammalia*

Round about 1929, the present iron gate with the 2 cms thick vertical bars placed 15 cms apart and horizontal ones 84 cms distant from each other, was set up to block the main entrance from unauthorised visitors. Prior to that, the Cave was protected from poachers by a narrow iron door with iron bars (Caton-Thompson in Murray, 1923: 8; 1925, pl. II, fig. 1). Bats on the wing can easily manoeuvre the bars of modern gate on their way in and out of the Cave, for as late as 1935, the capture of three specimens from inside Ghar Dalam is recorded (Baldacchino 1935: XIX).

When in 1950/51, Shaw visited the Cave, however, he was informed by the attendants that none of them had ever seen a bat inside the Cave (Shaw 1951: 307). The present writer too, never witnessed a sighting, though in late 1980, one of the guides reported

seeing «a small bat» (*Pipistrellus*) taking off from a central rock fissure in Section III.

In 1980, during the author's absence from the Island, a wire netting (diam. 5 cms) was put up by the Museum authorities over the entire gate. As this could possibly interfere with the free movement of bats entering or leaving the Cave, the author had it removed (Febr. 1982) from the upper parts of the gate.

A very marked diminution of bats on the wing is a noticeable feature throughout the whole Island in recent years. Bats are said to be still numerous in another case less than 100 m down the road from Ghar Dalam, but sightings at Ghar Dalam during the past decade have dwindled down to a single specimen (1980).

No trace of bat droppings was discovered during the present survey notwithstanding the presence of *Agnopteryx thapsiella* which is said to feed on bat detritus. Several isolated blackish grey, well-formed foecal pellets (11.4 mm x 4.5 mm) were observed in innermost cave-system (Section VII) where they formed black smudges in water pools. The size of the droppings suggests rats rather than bats. Rats are very common (*Rattus rattus*) and are baited with poisoned wheat grain inside the Cave. A number of poisoned animals were recovered from Section I (June 1982) and Section III (Dec. 1981).

7. *Cave Flora*

Wheat grain soaked in 2½% zinc phosphate and 5% Warfarin are periodically scattered about the Cave to poison any rats that visit the site. A number of these grains do sometimes germinate and develop into an etiolated plant, but they never reach maturity. An occasional pappus blown inside the Cave by the wind, does also sometimes develop into a small plant at the edge of Section I. Pods and seeds of the carob tree (*Ceratonia siliqua* L.) are easily introduced by human agency, as such trees are abundant outside cave entrance. None of these seeds is known to have ever germinated within the Cave. The ripe pods are edible and were extensively used as human food throughout the food shortage of World War II, but they are now used chiefly as animal fodder.

A lump of discernable but matted, slimy fragments of a pod on a ledge 1.75 m above ground level in the innermost region of Section IV (inaccessible to the general public) poses a problem as

it suggests regurgitated material by some bird or animal. Two similar lumps just beneath Cave entrance could represent material chewed by humans and subsequently discarded.

Green blue algae

There are two main visible patches of Blue green algae developing on the Lower Coralline Limestone roof and rock face of Ghar Dalam. These have been identified for the author (July 1980) by Dr. Francis Drouet of the Academy of Natural Sciences, Philadelphia, as *Anacystis montana* (Lightf.) Dr. and Daily and *Schizothrix calcicola* (Ag.) Gem. Both are new records for the Maltese Islands.

The *Anacystis montana* patch lies mainly (1981) 4-5 m from Cave entrance (Section II) covering several square meters of rock face on the right side of the Cave and roof. Here it forms a matted area which in some places reaches a thickness of almost 1 cm. The growth periodically dries up and shrivels, leaving only a thin pigmentation. Patches of light green pigmentation of the rock wall on the left, mark the incipient inward extension of the algal growth into Section III. Sections I and II receive strong natural light but no direct sun.

There is no record when these patches had their origin, but the author recalls the main patch of the roof on the right side of Section I/II being present in 1967 when he took over the curatorship of the site.

The *Schizothriz calcicola* growth, the main patch of which in 1981 measured 195 cms x 155 cms, is located at the very end of Section V (79 m from the Cave entrance), but extends also to the roof of Section VI. It lies just beneath the last electric bulb (a 60 Wat 'Lucei') which dangles a few centimeters from the rock face.

Electric power in the Cave is switched on only during visiting hours (0800-1630 hrs in winter, 0730-1330 hrs in summer). Light is often switched off also when there are no visitors.

The author does not recall the presence of this inner patch in 1967 and it is not mentioned by FORRESTER (1973). Its appearance is probably related to the very large number of visitors entering the Cave during the tourist boom in the late seventies.

So far no measure has been taken to suppress any of the algal growths, but all attempts to exterminate a similar (?) algal growth in another Maltese historical site — Hal Saflieni Hypogeum, ex-

cavated in Globigerina Limestone — have not yet yielded permanent results.

General comments and conclusion

The whole character of the local extinct Pleistocene fauna unearthed from the water-borne cave deposits reveals that the climate, vegetation and size of the 'Island' were very different from what they are at the present time. In addition, animal remains and artefacts embedded in the Cultural or Pottery layer capping the Pleistocene, water-borne deposits indicate that there has been a considerable change in the ecology of Ghar Dalam, even since the arrival of Man on the Island about 7,000 years ago.

The Cave is now no longer a form of human habitation, nor is it used as an animal shelter. At the beginning of World War II, the site was requisitioned for refugees from the surrounding area and utilized for a short period as an 'Air Raid Shelter'. This is probably the time when the roughly engraved crosses on the right side of the Cave (Section I/II) were etched in the limestone wall and roof, and when 'FURTU 1941' was scratched on the large stalagmite. The Cave was subsequently taken over by the R.A.F. who stored in it wooden boxes (each containing two cans of four gallons per can) of 100 octane aviation fluid (Pers. comm. Capt. R. Bonello, Officer i/c Cave dump throughout World War II, 10th January, 1983). The vole, field mouse, toad, frog and skink — whose remains are abundantly present in the superficial deposits of the Cave — have all now disappeared from it. It is not possible to obtain any information on the insect fauna of the Cave in ancient times as no traces of these have been found in the Cultural/Pottery layer to date.

The bat fauna recorded from the Late Pleistocene *Cervus* layer (*Pitymys melitensis* Stage) has been included in this study as these micromammals could have been inhabitants of Ghar Dalam and are not just remains introduced into the Cave through water action.

This long term survey of Ghar Dalam's cave biota and ecology lasted almost four years and involved several visits to the Cave. During these excursions a number of important observations and collections were made. Of particular interest are the new records made from the Maltese Islands (marked in the Faunal and Floral list) and

the discovery of a larval case (from which later emerged in captivity the moth *Proterospastis merdella*) in association with a spider's web within the Cave. The case of this moth was not previously known to science and its association with caves is also a new record.

The present day fauna of Ghar Dalam is most abundant in Section I and to a lesser extent in Section II. Both regions are very well illuminated by natural light from the semi-circular entrance of the Cave and are well protected from rain, wind and direct sunlight. Such conditions represent a happy medium between the outside world and the cave environment proper.

Although some of the specimens recorded in the faunal list are occasionally or generally encountered in caves, none of them is a species or variety developed through living inside Ghar Dalam.

ACKNOWLEDGEMENTS

Dr. F. Drouet (Academy of Natural Sciences, Philadelphia, USA), Dr. D. John (Department of Botany, British Museum Nat. Hist.), Stephen and James Schembri (Malta), Drs. G. Robinson, R.P. Lane, Hutson, P.D. Hillyard and various other members of the Department of Zoology, BMNH, London helped with the identification of the fauna and flora of the Cave. Dr. P.J. Schembri (Malta) most obligingly critically read the manuscript.

Their help is gratefully acknowledged.

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(ms. pres. il 31 dicembre 1985; ult. bozze il 15 gennaio 1986)