



BEEKEEPING

IN THE MEDITERRANEAN

FROM ANTIQUITY TO THE PRESENT



Edited by:
Fani Hatjina, Georgios Mavrofridis, Richard Jones

Front cover photographs

Part of a beehive lid. Early Byzantine period (Mesogeia plain, Attica. “Exhibition of Archaeological Findings”, Athens International Airport. Photo: G. Mavrofridis).

Beehive from a country house of the 4th century B.C. (Mesogeia plain, Attica. “Exhibition of Archaeological Findings”, Athens International Airport. Photo: G. Mavrofridis).

Traditional ceramic beehive “kambana” (bell) in its bee bole (Andros Island. Photo: F. Hatjina).

Back cover photographs

Stone built apiary of the 18th century from Neochori, Messinia, Peloponnese (Photo: G. Ratia).

Ruins of a bee house from Andros Island. Inside view (Photos: G. Ratia).

Walls of a mill house with bee balls from Andros Island. Inside view (Photo: G. Ratia).

Traditional pottery beehives and their bee boles: the ‘bee garden’, Andros Island (Photo: G. Ratia).

Ruins of a bee house (the ‘cupboards’) from Zaharias, Andros Island. Outside view (Photo: G. Ratia).

Bee boles from Andros Island (Photo: G. Ratia).

Nea Moudania 2017

BEEKEEPING IN THE MEDITERRANEAN FROM ANTIQUITY TO THE PRESENT

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Based on selected presentations of the
INTERNATIONAL SYMPOSIUM
of BEEKEEPING IN THE MEDITERRANEAN
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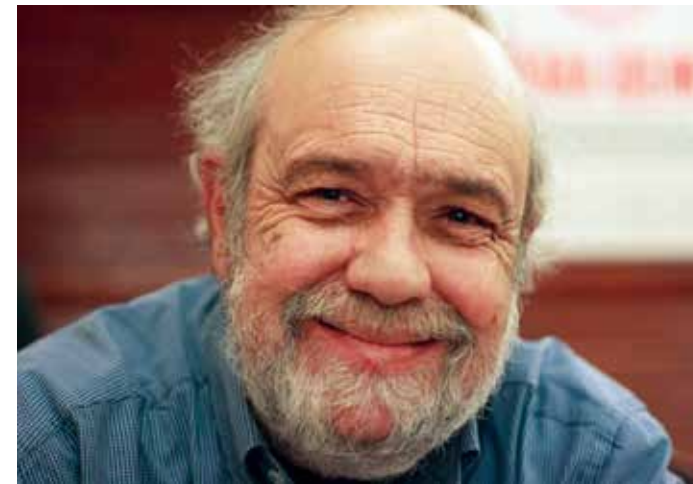


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DIVISION of APICULTURE
Hellenic Agricultural Organization "DEMETER"-GREECE

CHAMBER of CYCLADES

EVA CRANE TRUST - UK



Dedicated to the memory of Thanassis Bikos

Thanassis Bikos was a pioneer of the systematic research on traditional beekeeping in Greece. From the early 1990s until the end of his life he studied the traditional beekeeping aspects in most regions of Greece. The results of his research were continuously communicated through articles under the general title "Beekeeping Recordings" in the Greek Beekeeping magazine "Melissokomiki Epitheorisi" without missing relevant beekeeping symposia and congresses or the publication of articles in international journals. The vast volume of the primary material published is now a

valuable legacy for current and future researchers of the beekeeping tradition.

The creation of a museum of Greek beekeeping was a life dream for Thanassis, for which he gathered material for more than thirty-five years. After retiring from the Ministry of Rural Development and Food, where he served as an agronomist (at the Department of Apiculture), he dedicated his time to the realization of the museum idea, working on a voluntary basis for many years. Unfortunately, untimely death did not allow him to fully complete his work. However, he will always be with us.

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FOREWORD

More than 250 individuals simultaneously watched the first International Beekeeping Symposium on Cyclades by eight Cycladic islands the excellent presentations by 30 renowned experts from Greece and abroad. "Beekeeping in the Mediterranean from antiquity to the present" was completed by a collaboration between the Cyclades Chamber, the Eva Crane Trust and the Greek Agricultural Organization "DEMETER". The Symposium was very successful as highlighted issues of beekeeping in the region, history and topical concerns.

Important findings, historical and archaeological, presented by Israel, Turkey, Egypt, the Cyclades and the Mediterranean in general, covering 4.000 years course of beekeeping practice through the centuries and new findings in relation to the local bee races. Topical issues, concerns and practices were also presented in an attempt at broad coverage of all major issues facing modern beekeepers. As underlined by

the President of Chamber of Cyclades Mr. John Roussos "one such Symposium dynamics has three main objectives: to better inform all stakeholders, to improve networking of stakeholders and to develop common ideas and commitments for the beekeeping sector".

The abstract book of all conference contributions including the Greek translations of the abstracts can be found online (http://hellenic-bee-research.gr/wp-content/uploads/2015/04/Beekeeping-Symposium_Syros-2014_Abstract-book_5.pdf). However, several of the conference contributors were willing to prepare a detailed article based on their talk and that is how this book came to realization. We wish to thank all authors for their valuable contributions, as well as the funding bodies which make this publication possible.

The Editors
April 2017

PREFACE

BEEKEEPING IN THE MEDITERRANEAN FROM ANTIQUITY TO THE PRESENT

Richard Jones
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The Eva Crane Trust was established in 2000 by Dr Crane herself. It is a grant giving organization dedicated to continuing her work and interests.

The content of this symposium would have delighted Dr Crane. The contributors to the talks and to this book are learned academicians who are very informed on different beekeeping developments in the eastern Mediterranean. It is an area which can rightly hold the title the “cradle of beekeeping as we know it today”. Dr Crane recognised this in her work. By seeking out and recording beekeeping through the ages in the area she set the foundations and gave impetus and inspiration to many who have followed. By outlining Dr Crane’s work I hope to set the stage on which others, more expert than I, can show you how beekeeping developed in the region.

Eva Crane was born just over 100 years ago she went to University and studied mathematics and physics. She became interested in bees during World War II when she had her first hive. From then on she started gathering everything that was written on bees, bee products and bee science and then set about making that information available to everyone through her publications. Her books became, and still are, valuable textbooks for all who have any interest in bees, bee science and beekeeping.

Honey – A comprehensive Guide, published by Heinemann, London 1976.



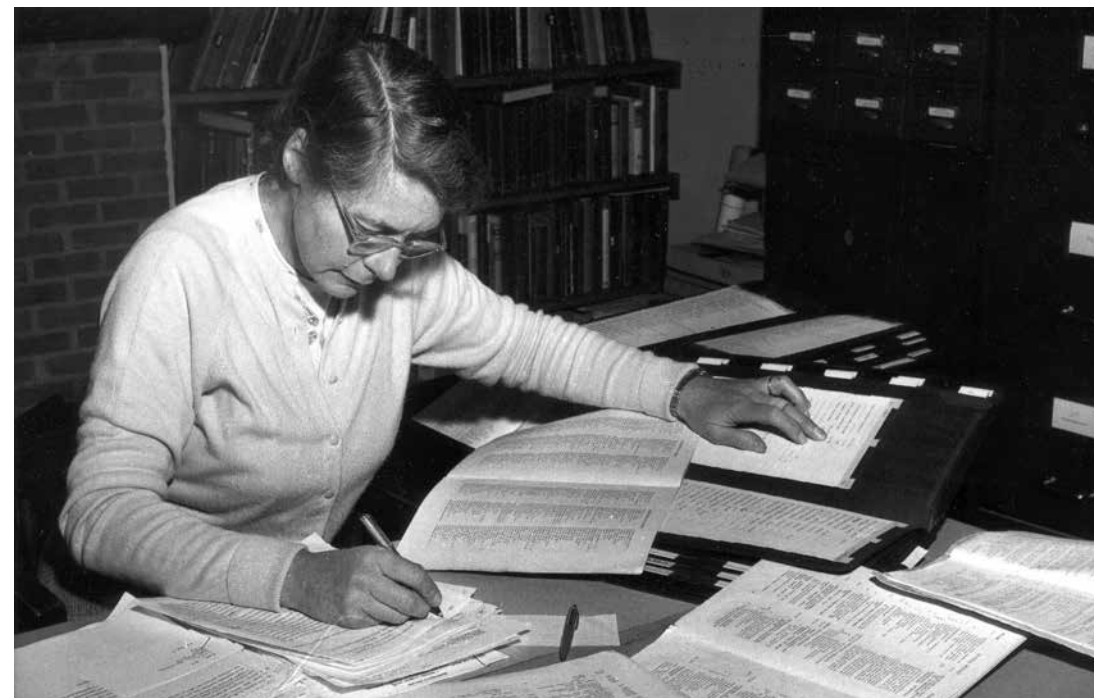
The Archaeology of Beekeeping, published by Duckworth, London 1983.

Bees and Beekeeping – Science, Practice and Resources, published by Heinemann, London 1990.

The World History of Beekeeping and Honey Hunting, published by Duckworth, London 1999.

These are but a few titles from a total of over 300 publications.

Dr Crane made visits to Greece and the islands in 1979, 1986 and 1995. She travelled with her friend Penelope Papadopoulou, affectionately known as Poppy,



who went to Crete to teach beekeeping but the men did not like being taught by a woman so she taught the beekeepers’ wives instead. When they became the better beekeepers the men were prepared, after all, to take lessons from a woman!

Dr Crane’s theories on the transmission of beekeeping techniques around the Mediterranean were based on:

- Evidence of excavated material.
- Written texts including those from Ancient times.
- Comparison of traditional beekeeping methods with what is done today.

All these sources indicate that the area, usually referred to as the Middle East, was probably the birthplace of beekeeping as we know it today. Until the 21st century, the earliest hives found had been in Greece and dated from the 5th century BCE. However, the recent (2008 onwards) discoveries at Tel Rehov in Israel show hives in an apiary from the time of King Solomon (circa 990–970 BCE). In these early historical times one of the quickest ways to travel was by boat using coastal routes, some of which had been established by the Phoenicians as early as 1500 BCE. The Greek Islands, at the centre of the then known world, would almost certainly have been a stop-off points in this transport network. Some of the islands’ inhabitants would have been sailors themselves and

many others would have had contact with the travellers, which in turn gave access to ideas and practices found in the wider world. These outside influences could affect all facets of life including beekeeping.

Wild bees gave a product for which there was a continual and increasing demand – honey. Therefore, to try and meet the demand human beings attempted to create/copy the nests used by the cavity nesting honey bee – *Apis mellifera*.

These nest sites (hives) were constructed out of whatever material was plentiful in the area. Upright cork hives were to be found in Sardinia, log hives in Tuscany, clay horizontal cannon hives in Crete and so on. The cannon clay cylinder hives on Crete open at both ends are similar to those seen in Egypt and elsewhere in the Middle East. The proximity of Crete to Africa would give credence to the theory that beekeeping using this type of hive may have spread northwards through the islands to the mainland. When these clay hives were placed on terraces between fields they were worked from the same end as the bees entered. The other open end became redundant and so by the time clay cylinder hives had developed on Syros they had a closed end.

In a publication of 1682 George Wheler described



a coiled straw hive (which could also be made out of willows) with flat sticks (top bars) which could be removed individually but “had to be separated one from another with a knife”. He saw the hive on Mount Hymettus. Many replicas of this hive have been created since using plant materials and pottery.

Advantages of top bar hives

- Top bars with correct spacing make it easy:
- To remove comb from the hive
- To check the combs e.g. for adequate stores
- To harvest just honey leaving brood to develop
- To manipulate colonies – change frames
- To carry out swarm control
- To divide colonies.

These are, in effect, moveable frame hives – at least it is the beginning of the moveable frame. In this form it only consists of a top bar not a rectangular structure. Also the bars are not inter-changeable as, due to the circular nature of the body of the hive, there is a long bar in the middle and the others reduce

in length as they are further from the centre.

The true moveable frame hive tends to be credited to Lorenzo Langstroth (1810 – 1895) and is easily dated to 1851 when it was first given publicity in English language books and journals. However, there are others who can lay very serious claim to its invention. In particular the Prussian Dr Johannes Dzierzon (1811 – 1906) developed a large moveable frame hive but he probably copied the ideas of the Ukrainian, Petro Prokopovych (1775 – 1850). Before that the Swiss naturalist Francois Huber (1750 – 1831) had created a frame observation hive. However, there is little doubt in my mind that the principles of a moveable frame structure were originally established in Greece.

Greece is often referred to as the “Cradle of Democracy”, it is also without doubt the Cradle of Modern Beekeeping as well!

When attending a conference in Nikiti in 1996 Dr Crane was both humbled and delighted when she



received an award. She was amazed that the people, who did not read English, knew anything about her – she was told “everyone in Greece loves Eva Crane”. She recalls this event in her book *Making a Beeline*, (page 238) published by IBRA, Cardiff, 2003. Her work continues through her Trust and a huge gallery of photographs she took on her visits all over the world, including her Greek visits, and many of her publications can be found on the website: www.evacranetrust.org.

The Trust wants to develop and continue the dissemination of information on the history of beekeeping and is prepared to consider funding such work.

Again details are to be found on the web site. As a direct result of the conference held on Syros a new book in English by George Speis has emerged: *Beekeeping on Andros*, and another publication telling of the discoveries at Tel Rehov in Israel is due shortly.

In conclusion I must add my own huge debt of gratitude to Dr Eva Crane for her work, her books and her photographs, for her kindness as a mentor but above all for being a dear friend.

BEEKEEPING IN PREHISTORIC GREECE

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Traces of beeswax on prehistoric potsherds have revealed that the harvesting of bee products by man has been practiced in Greece since the Middle Neolithic period¹ (c. 5500 BCE). However, it is difficult to ascertain whether beeswax was the product of wild or domesticated bees. The harvesting of wild honeycombs has existed since the time of hunter-gatherer groups: rock paintings from Spain, dating to the Mesolithic period, around 6000 BCE, depict such scenes².

It is known, mainly from pictorial evidence, that systematic apiculture (with beehives) was practiced in Egypt from at least c. 2400 BCE³, and the forms of these ancient beekeeping paraphernalia have remained unchanged until modern times. Iconography, textual evidence and organic residue analysis leave no doubt that honey and its derivatives were used in Bronze Age Greece, the countryside of which possesses an advantage in beekeeping. Nevertheless, remnants of Greek prehistoric beekeeping paraphernalia are rare, and only a handful of archaeological findings - mainly smoking pots - were until recently identified as such, not permitting the ascertainment of the existence of systematic apiculture (with beehives) in prehistoric Greece. However, recent research has shed new light on old findings in prehistoric strata. Here, I review all beekeeping paraphernalia from prehistoric Greece and I conclude that organized apiculture not only existed in prehistoric Greece, but it was as equally developed as it was in ancient Egypt⁴.

I would like to thank G. Mavrofridis for his invaluable help. 1 Decavallas 2007. For traces of beeswax on potsherds of later periods, see Tzedakis and Martlew 1999 for Middle Minoan IA (c. 2160-2000 BCE), and Evershed et al. 1997 for Late I Minoan (c. 1600-1450 BCE).

2 Crane 2000.

3 Kueny 1950; Crane 2000, 163-4.

4 Harissis and Harissis 2009.

Beehives

Before the wide distribution of the modern beehive (discovered in 1866 but not propagated in Greece until 1930), in no place did there exist only one type of beehive⁵. A great variety of forms and materials were in use, at least up until the 1960s. The existence of numerous types of beehives can be explained by the diversity of the environmental conditions, the availability of raw materials and different beekeeping practices. The same was true in antiquity; Varro, Virgil, Columella, Pliny and Palladius mention the different materials used for beehives: biodegradable materials such as bark, Ferula plant stems, woven wicker, hollowed logs, boards of wood, cow dung, sun-dried mud and other non-biodegradable materials, such as clay, brick or stone⁶. The evidence for ancient beekeeping in Greece is based substantially on the remains of ceramic beehives; hives made of perishable materials have not been preserved.

Two types of ancient ceramic beehives have been identified, the horizontal and the vertical one. The horizontal beehive, a tubular container, was probably widespread in the Mediterranean area in antiquity⁷. The oldest horizontal beehive known today, dating to the 10th - 9th c. BCE, was discovered in Tel Rehov,

5 As was the case in Crete (Rammou and Bikos 2000, 428-430; Nixon 2000) and elsewhere in Greece (Liakos 1999; Graham 1975, 75; Anderson - Stojanovic and Jones 2002, 366, no 34).

6 See Crane 2000, 203, table 24.1A. Hesychius, the lexicographer, reports six different names for beehives, probably indicating different forms and materials.

7 Jones et al. 1973; Jones 1976; Jones 2000; Anderson-Stojanovic and Jones 2002; Bonet et al. 1997



Fig. 1 A traditional horizontal beehive from Greece (photo H. Harissis, Collection of A. Bikos in the Geoponic Institute, Athens)

Israel⁸. Horizontal beehives, dating to the classical period, were found in many places in Greece, as in Attica, Isthmia, Crete, Euboea and on other Aegean islands⁹. Their dimensions varied, with a length of 40-60 cm and a mouth measuring 28-39 cm in diameter.

This type of beehive, ceramic or other, was widespread in traditional apiculture in Morocco, Egypt, Israel, Jordan, Syria, Lebanon, Iraq, Iran and the Arabian Peninsula¹⁰, as well as in Greece, Crete, the Aegean islands and Cyprus¹¹ (**Fig. 1**). The post-antique (traditional) Greek horizontal ceramic beehive was longer than the ancient one, with a length of 64-100 cm. However, its mouth measured 29-40 cm in diameter, just as the ancient one, tapering to a diameter of 19-23 cm at the back and usually had both ends open. Each end was sealed, either with a wooden lid and mud, or with a ceramic disc or stone plate and mud¹². One or more small holes allowed the bees to fly in and out from the front end, while the back end permitted harvesting of the beehive. Horizontal beehives were laid on their sides¹³ and stabilized by walls,

8 Mazar and Panitz-Cohen 2007.

9 Crane and Graham 1985, 150, table 1; Lüdorf 1998-1999, 72-75; Crane 2000, 199-200, table 23.2A.

10 Crane 2000, 167-8; 175, table 21.4A181-2, fig. 21.6a.

11 Jones et al. 1973, plate 85a; 85c; 85d; Crane 2000, 193-5, fig. 22.3a; fig. 22.3b. In Cyprus a testimony of 1801 for this type of beehive comes from travellers (Rizopoulou-Igoumenidou 2000, 393).

12 Crane 2000, 192; 387-8. Similar horizontal beehives with lids closing their ends were used till recently in Egypt (Kueny 1950, 88).

13 Crane 2000, 201-2; Lüdorf 1998-1999, 163-9, figs.



Fig. 2 Detail of a copy of a wall painting of the tomb of Rekhmire (c. 1450 BCE) in Egypt, depicting horizontal beehives (copyist Nina de Garis Davies in 1926, scale 1:1, 43.5X33 cm, Metropolitan Museum accession number 30.4.88, from Davies 1944).

rocks, or trees, and could be stacked, as is illustrated on an Egyptian wall painting in the tomb of Rekhmire (1475-1448 BCE) (**Fig. 2**). Bees attached their honeycombs to the interior roof of the hive, from which the combs hung down into the hive's interior. Sometimes, little wooden bars were positioned across the walls of the beehive to encourage the bees to build their combs parallel to the open end of the hive, which facilitates honeycomb harvesting. This practice is already mentioned in the 12th c. *Book of Agriculture* by Ibn al-Awwam¹⁴. During harvesting, the back lid was removed and the bees were driven by smoke from the back end to the front of the hive. Hives with only one opening at the front, such as those employed in recent times on some Aegean islands, required a more difficult harvesting procedure. A traditional practice, also known in antiquity, was to elongate horizontal hives by adding a bottomless cylindrical terra-cotta stem ("extension ring"), which was fastened between the lid and the end of the hive, which had projecting rims¹⁵. With this technique, the beekeeper could easily separate the extension ring from the main hive and harvest part of its crop without disturbing the inner parts; this entailed using less smoke, which was known to harm the taste of honey¹⁶. Additionally, the

43-9; Rotroff 2006, 129.

14 Ibn al-Awwam 2000, 1022.

15 Crane 2000, 210. Such a practice was widespread in various parts of the Mediterranean as in the Aegean, Malta, Morocco, Turkey, and Lebanon but also in Iran, Iraq, Pakistan and India (Crane 2000, 387-8).

16 Strabo's (9.399) and Lucianus' (*Navigium* 23.4)

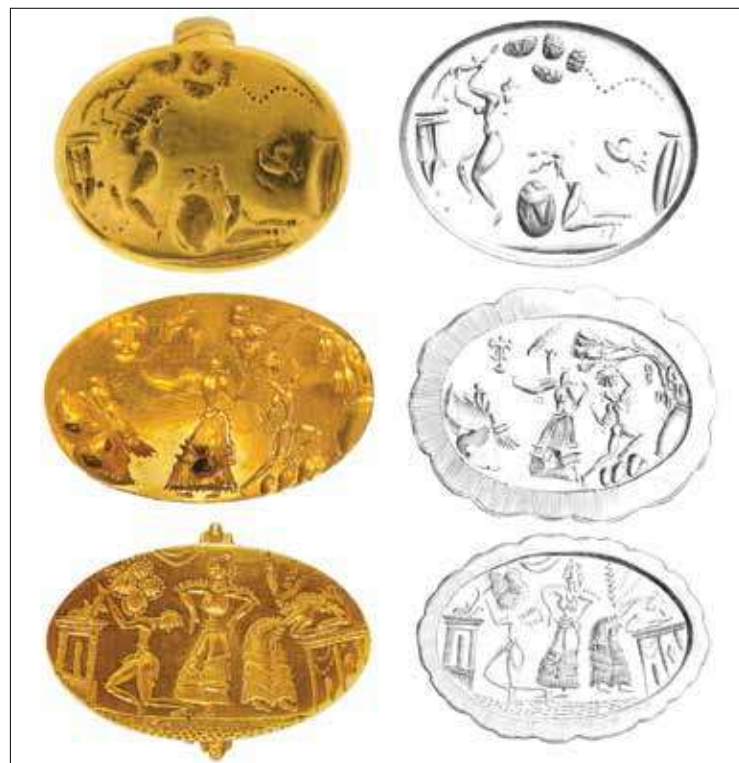


Fig. 3 Gold signet rings depicting apicultural scenes. 1st row: ring CMSII3, 114 from Kalyvia, Crete (Herakleion Museum no HME45). A horizontal beehive is depicted on the right and a swarm capture from a tree on the left; 2nd row: ring CMSI, 219 from Vapheio (Athens Archaeological National Museum no 1801). A horizontal beehive is depicted on the right and a big honey bee on the left; 3rd row: ring CMSI, 126 from Mycenae (Athens Archaeological National Museum no 3179). Stone beehives are depicted on the right and on the left and a swarm capture from a tree on the left.

extra space provided in the hive prevented swarming.

Archaeological data indicate that the form of the post-antique horizontal beehives in Greece has remained unaltered since at least the classical period¹⁷. As with post-antique hives, some ancient examples have one solid end that is either flat¹⁸ or curved¹⁹. The bees' flight hole is sometimes preserved in the solid bottoms of some ancient hives, but these holes were probably more commonly built into the lids of the hives. A consistent feature of ancient Greek beehives is their interior scoring, which is thought, by modern scholars, to have supplied the bees with a roughened surface onto which they could attach their honeycombs. The opinion that "the interior scoring is the only feature that distinguishes body sherds of beehives from other coarse wares"²⁰ is like a dogma in modern archaeology. Neolithic ceramic "beehives" have been recognized solely on the basis of interior

praise for the non-smoked honey is well known.

17 Crane and Graham 1985; Francis 2000 and 2001; Hayes 1983; Di Vita 1993; Crane 2000, 190-2; 198-202. 18 Rotroff 2006, 124-5.

19 Lüdorf 1998-1999, 142, fig. 22, no. B17.

20 Anderson-Stojanovic and Jones 2002, 349, no14.

incision on the sherds of "gougled bowls"²¹. It must be noted, however, that, as I will show below, the sole presence of scoring in the interior of potsherds does not necessarily mean the object was a beehive, since scoring was used for other prehistoric vessels too, as, for example, vessels used in the production of dairy products²² and even in cups²³.

It is probable that the Minoans of Crete had acquired the knowledge of Egyptian apicultural techniques and adopted the use of the horizontal beehive²⁴, but no certain archaeological findings of horizontal beehives exist from prehistoric Greece. However, there is pictorial evidence to support this. It has been proposed that ideogram *168 from Linear B, found exclusively in clay tablets from Knossos, depicts a prehistoric horizontal ceramic beehive²⁵. This, how-

21 Vitelli 1993, 185, fig. 40.

22 Morris 2014, 209; 218.

23 Poursat and Knappet 2005, 50.

24 In the tomb of Rekhmire, scenes with Cretans (Kef-tiu) offering gifts are depicted (Davies 1936), indicating that contacts between Minoan Crete and pharaonic Egypt were regular at that time.

25 Davaras 1986.

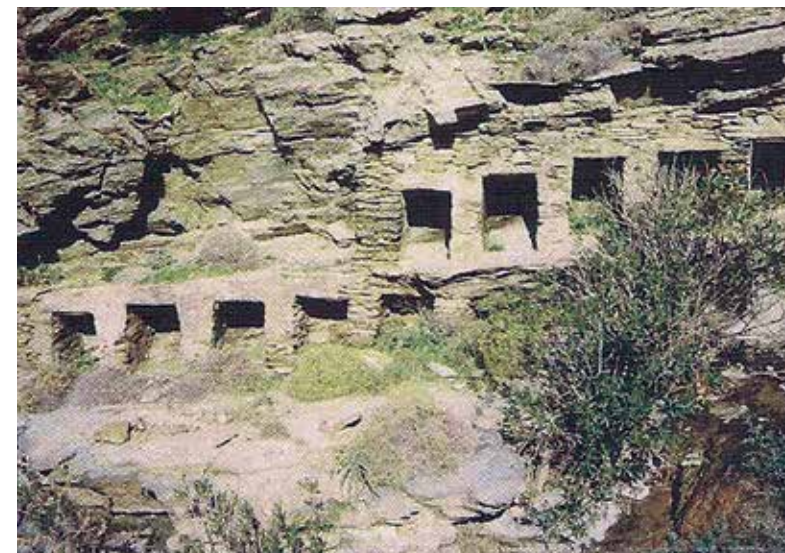


Fig. 4 Traditional stone beehives on the island of Andros, Greece (photo A. Bikos).

ever, is merely a speculation²⁶.

I have recently argued elsewhere²⁷ that a horizontal beehive, depicted in a vertical position, is represented on a gold signet ring (CMSII3, 114) found in a tomb (Tombe dei Nobili) in Kalyvia, Crete, dating to the Late Minoan IIIa period (c. 1400 BCE), where a capture of bee swarms from a tree is also represented (**Fig. 3**, 1st row). Similarly, a horizontal beehive and a bee swarm capture can be recognized on another gold signet ring (CMSI, 219), from Vapheio in Lakonia, mainland Greece, dating to the Late Helladic IIa period (c. 1500 BE), found in a tholos tomb (**Fig. 3**, 2nd row).

Besides these horizontal beehives, one can also notice another type of post-antique beehive on another gold signet ring: the stone hive that was widespread in the Aegean and the Ionian islands, as well as on mainland Greece (**Fig. 4**)²⁸. I believe that stone beehives, open at the front, are represented on a famous gold signet ring (CMSI, 126) from a tomb in Mycenae dating to LH II-LH IIIA1 (c. 1400 BCE) (**Fig. 3**, 3rd row), where vertically growing honeycombs in the interior of the hives are also depicted²⁹. The appearance

26 Vandenabeele and Olivier 1979, 281-2. This interpretation would contradict the textile interpretation by Dhoux 1975, who proposes 'loincloth', used as matrix.

27 Harissis and Harissis 2009; see also Crowley 2014.

28 Mavrofridis 2014b.

29 For more apicultural scenes on signet rings and seals from Minoan and Mycenaean periods, see Haris-

sis and Harissis 2009. 30 Crane and Graham 1985. Attica: Jones et al. 1973; Lawall et al. 2001; Ludorf (1998/1999). Isthmia: Anderson-Stojanovic and Jones 2002. Delos: Siebert, 1988, 763, fig. 31. Agathonisi: Trantafyllidis 2010, 40. Chios: Anderson 1954, 137; 142, fig. 5, no 28, 78; Jones et al. 1973, 399, no 27.

The second form of ancient ceramic beehive is a bucket/flowerpot-like container with a much shorter length than the horizontal variety. Its base is always solid and flat, and the rim broad and flaring. This is the upright (also called vertical) beehive. Archaeological findings in Attica, Korinthia, Delos, Agathonisi and Chios confirm that upright beehives have existed since the archaic/classical period³⁰ (**Fig. 4**). The most famous example is the 3rd c. BCE "Orestada" beehive from Isthmia, with horizontal handles and a flight hole cut into the lower wall³¹ (**Fig. 5a**, 3rd row, left). Post-antique upright ceramic beehives show the manner in which these hives functioned: laths or sticks ("top-bars") placed across the open mouth served as the attachment point for the honeycombs,

sis and Harissis 2009.

30 Crane and Graham 1985. Attica: Jones et al. 1973; Lawall et al. 2001; Ludorf (1998/1999). Isthmia: Anderson-Stojanovic and Jones 2002. Delos: Siebert, 1988, 763, fig. 31. Agathonisi: Trantafyllidis 2010, 40. Chios: Anderson 1954, 137; 142, fig. 5, no 28, 78; Jones et al. 1973, 399, no 27.

31 Kardara 1961; Kardara and Papadopoulou 1984; Crane 2000, 398; Anderson-Stojanović and Jones 2002, 355, no. 7, fig. 8; 371, fig. 17; Evershed and Dudd 2003; Mavrofridis 2013.

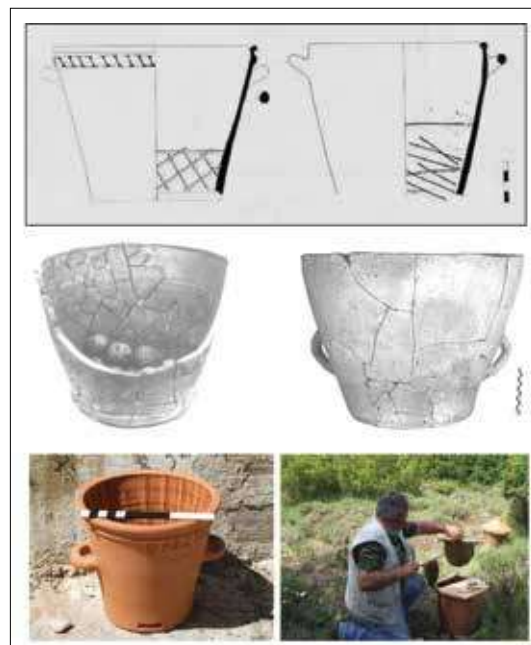


Fig. 5a 1st row: Minoan “upright beehives” from Kommos (left) and Nerokourou (right) (Melas 1999, plate CVIIb,c); 2nd row: Minoan clay beehive from Kato Syme, Crete (left) (Lembesi 1983, pl. 247c) and from Kondokéfalo, Karpathos (right) (Melas 1999, CVIIIa,c); 3rd row: a reconstruction of an ancient upright ceramic beehive from Isthmia (left) and its working principle with top-bars (right) (both photos G. Mavrofridis).

which hung directly down into the container without any attachment to its walls. The open mouth was then closed with mud or a ceramic lid or a flat rock to protect the bees from the rain and the heat. What's more, such a set-up rendered the removal of combs much easier and facilitated the apiarist in the continuous replacement of full bars with empty ones, thus increasing the production of honey³² (**Fig. 5a**, 3rd row, right). A hole near the base of the beehive allowed the entry and exit of the bees. The upright beehive with movable top-bars is correctly regarded by some authors as the forerunner of the modern beehive with “movable frames”³³. Such vertical beehives (“vraski”), with a height of 36 to 41 cm and a mouth measuring 35 to 41 cm in diameter, were in use up to recent

32 For a detailed description of the use of upright hives with movable top bars in 17th c. Greece, see Wheler 1682; Harissis and Mavrofridis 2012.

33 Georgantas 1957; Ifantidis 1983; Bikos 1998; Crane 2000, 457–460; Protosaltis 2000. Beehives with movable top-bars have also existed in N. Vietnam at least since the 19th c. (Crane 2000a, 400–2, fig. 49.4a).

times in Crete³⁴. The same type existed in Crete and in Attica since at least the 17th c. (“anastomo kofini”), in Kea (“ypseli”), in Kythera and in Peloponnesus³⁵. Since upright beehives with movable top-bars permit the close observation of bee habits, Aristotle's detailed knowledge of apiculture, as presented in his biological works, could be due to the existence of such beehives in his time³⁶.

No pictorial evidence exists for upright hives in prehistoric Greece. However, it has been argued that the upright type of ceramic beehive was in use since the Middle Minoan II period in Crete, and on the neighbouring islands of Kassos and Karpathos. Such a complete “beehive” (from the Middle Minoan III - Late Minoan I period) with inner surface scoring was found at Kato Syme Viannou in Crete³⁷ (**Fig. 5a**, 2nd row, left). The fact, however, that loom weights were found in its interior, perplexes its identification with a beehive. Another almost complete example comes from Kommos (height 18.3 cm, rim diam. 42 cm, bottom missing), dating to the MMII-LMI period³⁸ (**Fig. 5a**, 1st row, left). Scoring was present on the lower half. From Nerokourou, Crete, comes another almost complete beehive, missing only the base (**Fig. 5a**, 1st row, right) and three other fragmentary ones³⁹. Scoring was present in the interior of the vessels. Eleven fragments of coarse vessels with interior scoring, presumably belonging to upright beehives, have been reported from Sphakia in Crete⁴⁰. A further find from Kokkino Frydi near Zakros may be the base of an upright hive, dating to the LMI period⁴¹ (**Fig. 5b**, 2nd row, left). On the two neighbouring islands of Kasos

34 Zymbragoudakis 1979; Crane 2000, 397, table 39.A; Nikolaidis 1955; Harissis et Mavrofridis 2012.

35 Crete: Harissis and Mavrofridis 2012; Attica: Wheler 1682; Cyclades: Rocca 1790, ii, 465–6; Argos: Efthimiou-Hatzilakou 1981–2.

36 Harissis and Harissis 2012.

37 Lembesi 365, pl. 247c; interpreted as a smoking pot by Melas 1999, 487, pl. CVIIIa.

38 Watrous 1992, no 439, fig. 22; Melas 1999, 487, pl. CVIIb. Watrous (1982, 60 and 73 no 17, plate 19e:D) also reports a “beehive” fragment (he originally called it a “cup”) with interior incisions and a handle stump preserved at rim from Lasithi plain, dates to Early Minoan II-III period.

39 Kanta and Rocheti 1989, 101–272; Melas 1999, 487, pl. CVIIb–e.

40 Nixon 2001. A photo of the sherds can be found in <http://crete.classics.ox.ac.uk/U451/U451L2.html> (visited in 03/01/2015).

41 Chrysoulaki 2000, 585, fig. 3Ç.

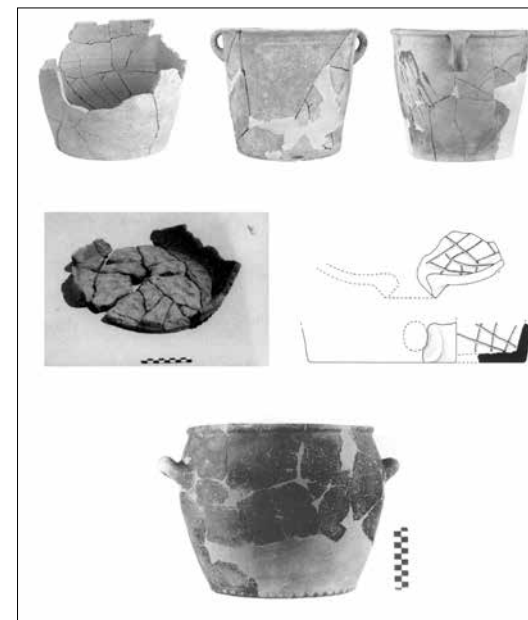


Fig. 5b

1st row: “beehives” from Malia (Poursat and Knappett, 2005, plate 13 no 222, 223, 225);

2nd row: (left) “beehive” from Zakros (Chrysoulaki 2000, 585, fig. 3Ç), (right) “beehive” from Mochlos (Smith 2010, 66 (IIb.579), fig. 26);

3rd row: “beehive” from Chania (Hallager 2003, 241–3, fig 51 no 8).

and Karpathos, thirteen MM - LMI period sites produced numerous fragments of pottery, mainly wall pieces and a few base fragments, with interior scoring believed to belong to beehives⁴². Two belly pieces have a horizontal handle attachment. They have been compared⁴³ with “basins” or “open hole-mouthed jars”, fragments of which have been discovered at many sites, such as that of Palaikastro⁴⁴ (MM-LMI), in Lasithi⁴⁵ (EM-MMIII) and in Mallia⁴⁶ (MMI-II). These (five

42 See Melas (1985, 105), who reports potsherds from “beehives” from nine sites on the plain of Afiartis, in the south Karpathos and from two sites from Lefkos, on western Karpathos. From Kasos, he reports beehive fragments from four sites located at Khelatros.

43 Melas 1985, 105.

44 Melas refers to a wide-mouth jar, 33cm in height with two vertical handles and finger impressions on the plinth, repeated inside round the bottom, but with no hole from Palaikastro (Bosanquet 1923, 65, fig. 52).

45 Watrous 1982, 73 no 17, plate 19e:D.

46 Chevalier et al. 1975, 79f, plates XXVIII:6–7, XXIX:1–

in total) objects (“cuves”) from Malia (**Fig. 5b**, 1st row) with vertical handles with a height of about 34 cm, a diameter between 40 and 46 cm, and a capacity of 29 to 35 litres have interior incisions, and hence have been considered beehives⁴⁷, although this hypothesis was rejected by the excavators⁴⁸. An almost complete (restored) example of a similar “beehive” comes from a Minoan site in Kondokéfalo, Karpathos (**Fig. 5a**, 2nd row, right). It was found on the floor of a storeroom/kitchen along with various other pots. It is 31.5 cm high and its mouth measures 45.6 cm in diameter. It has two vertical loop handles halfway up its walls and a small hole through the centre of its bottom. It has deep cross incisions (scoring) that cover the entire inner surface⁴⁹. The scoring bears no resemblance to that found in Greco-Roman beehives: it looks more like a diagonally incised draughtsboard rather than the fine combing typical of later ceramic hives, and so its identification with a vertical beehive has been disputed⁵⁰. The appearance of a spout in the lower wall close to the base, on a fragmentary basin with interior crosshatched incisions, from Mochlos (**Fig. 5b**, 2nd row, right), which dates to LMIIb⁵¹, has led to the suggestion (although not by the excavator) that this basin could be a beehive⁵². I believe that the relatively large diameter of the spout (approximately 5 cm), being twice as large as the known post-Minoan examples, which measure 1–3 cm⁵³, renders it rather unsuitable for a bee entrance. A “large jar” that dates to LMIIIB with an estimated base diameter of 26 cm, rim diameter of 32 cm, a height of about 30 cm, with incised diagonal grooves on the interior lower body, and with two horizontal handles attached to the upper body found in Kastelli, Chania in Crete (**Fig. 5b**, 3rd row), was characterized as a probable upright beehive⁵⁴. No hole in any of the walls existed, but the larger part of the lower vessel and base were missing. A body fragment of a similar vessel, which dates to LMIIIC, was found at the same site. Another LMIIIC

2, XXX:5–6; Poursat and Knappett 2005, 50, fig 6 no 1, plate 13 (222, 223, 225), plate 46 (222, 226).

47 D'Agata and De Angelis 2014, 353, plates CXb, CXle, CXIIa.

48 Poursat and Knappett 2005, 50: “rien au Quartier Mu, ne soutient une telle interprétation.”

49 Melas 1999, 488, pl. CVIII c, d.

50 Barnard and Brogan, 2003, 56; Christakis 2005, 68; 68; Kanta 2012, 176; Moody 2012, 254.

51 Smith 2010, 66 (IIb.579), fig. 26.

52 D'Agata and De Angelis 2014, 355.

53 Anderson, Stojanovic and Jones 2002, 349.

54 Hallager 2003, 241–3, fig 51 no 8.

basin with internal incisions, found at Knossos⁵⁵, has also been ascribed to the list of probable vertical bee-hives⁵⁶.

Again, it must be emphasized that the sole presence of scoring in the interior of potsherds does not necessary link them to a beehive, since scoring, as mentioned above, was used for other types of vessels, too. Scoring on ceramic surfaces is useful for providing adhesion, not only for honeycombs, but also for any material that was intended to line the interior surface of the vessel. It can also be used for abrasion or grinding. According to a hypothesis⁵⁷, interior scoring helped the firing of thick-walled vessels. Post-antique beehives from Greece only rarely have interior incisions, and, in any case, interior scoring at the top facilitates comb construction only in the case of horizontal hives, while for upright hives, interior scoring serves no useful purpose for the bees⁵⁸. Hypotheses claiming that internal scoring in upright hives was an unconscious habitual practice that remained from the construction of horizontal hives or that it can be explained as an attempt to imitate wicker baskets⁵⁹, are rather weak. The modern archaeological dogma of “interior scoring makes beehive” has produced some conclusions that, from the point of view of beekeeping, are completely absurd, as, for example, considering vessels with a very small, inadequate volume, to be upright beehives⁶⁰. Several other, more reliable, diagnostic features of beehives have been proposed: a capacity of 40-50 liters, although some hives are nearly twice as large and some basket hives (skeps) are only half the size; vestiges of beeswax on the inner wall and entrance hole(s) for the bees, commonly measuring 1-2 cm across⁶¹. A flight hole cut into the lower wall represents a much better diagnostic feature of hives than interior incisions. However, it is completely unknown, owing to their highly fragmentary condition, if any of the above-mentioned interiorly incised potsherds had one. The small hole through the centre of the bottom of the vessel from Kondokefalo, was considered to be an entry point for bees⁶², and it was assumed that the vessel was laid upside down⁶³ so that the bees could exit and enter from the hole. Indeed, the two vertical handles set

55 Warren 2007, 331 P2648, fig. 6.

56 D'Agata and De Angelis 2014, 355.

57 Melas 1985, 105.

58 Mavrofridis 2014a.

59 D'Agata and De Angelis 2014, 352.

60 Mavrofridis 2014a, 18.

61 Crane and Graham 1985

62 Melas 1999, 488; Melas and Karantzali 1996.

63 Melas 1999, 488.

on the lower body are only practical when the vessel was in an upside-down position. If, in fact, this was the case, the hypothesis for the existence of top-bar upright hives in Minoan times cannot be supported. But ethnographic parallels of such upside-down placed hives, contrary to the claims of its discoverer, do not exist. It is possible that this vessel was indeed a top-bar upright hive, similar to the traditional Cretan “vraski”, positioned some distance from the ground (on stones), and not upside down, so that the bees could exit from the bottom hole⁶⁴. In this case, however, one should explain the low position of the handles. The above-mentioned “jar” from Chania, with handles on the upper body, could also be a prehistoric “vraski”. Nevertheless, in the absence of organic residue analysis proving the presence of wax or propolis, neither of the above-mentioned vessels can be identified as beehives with absolute certainty.

Since areas at different altitudes or latitudes provide florescence at different seasons, and those with different rainfall or soil support different bee-plant species, in order to increase the production of honey, ancient beekeepers used to transport their hives according to the local florescence. Migratory beekeeping (also called transhumance or pastoral beekeeping) was practiced either by land (transporting the hives with animals, like mules as recorded for Spain by Pliny *HN* 21.73- 78⁶⁵) or by sea (transporting the hives by boat). Migratory beekeeping with mules or boats was practiced in 3d c. BCE Egypt: beehives were placed on boats that sailed along the Nile in search of regions with florescence⁶⁶. The same practice was recorded in Egypt almost two thousand years later (in 1740)⁶⁷. Celsus (ap. Columella *Rust.* 9.14.19-20) explained the general principles and precautions of transporting hives and recorded the migratory beekeeping that was practiced in Greece (Peloponnesus, Attica, and Euboea) and in Sicily (Hybla). Columella (*Rust.* 9.14.19) also reports migratory beekeeping by boat from the Cyclades to Skyros in the Aegean. In Greece, migratory beekeeping by boat was a wide-

64 Mavrofridis 2006.

65 By the late 1800s trains were used, and after the 1900s road vehicles of various types and sizes performed this task (Crane 2000, 347).

66 Newberry 1938. For the transportation of beehives by land, see *P. Cair Zen*. III 59467 (*SB* 6989).

67 Maillet 1735. *Description de l'Egypte*. Paris, vol ii. p. 24; Pococke 1743. *Description of the East I*, 210; Savary 1787. *Letters on Egypt* 2nd ed. vol. ii, 207 (all reported by Newberry 1938 who certifies that he observed the same practice on the Nile in 1890).



Fig. 6 A Minoan ceramic model of “a boat transporting honeycombs” (photo G. Giannelos from Marangou L. (ed.) 1992. *Minoan and Greek Civilization from the Mitsotakis Collection*. Cycladic Art Museum, Athens, 106).

spread apiarian practice until recently⁶⁸. In 1790, Della Rocca recorded the transportation of beehives along the coasts of Asia Minor⁶⁹. Beehives from Arnai in Chalkidike, Northern Greece, were transferred to Mount Athos in springtime⁷⁰. Also, in Chalkidike, until 1960, small boats loaded with beehives circumnavigated the gulfs⁷¹. In Ios, Cyclades, they transported the beehives with fishing boats⁷². Similar accounts exist also for France, Belgium, China and Japan, America and Romania⁷³. In China, the boats transporting the beehives had marks on their hull in order to indicate the increase of draught due to the increase of weight from honey accumulated in the beehives during the voyage. Precisely the same strategy is described by Pliny (*HN* 21.43) in Hostilia in Italy, where Roman apiarists loaded their beehives in boats and travelled along the river Po to exploit the rich florescence. That the Minoans transported beehives by boat can be deduced by the discovery of a pottery boat model (of the Middle Minoan I period) carrying honeycombs in its cargo hull⁷⁴ (**Fig. 6**). Because it was found in a human grave, it was interpreted as a symbol of an “after death voyage”, but its purpose could be simply to denote the activities of the grave’s occupant during his lifetime.

Hives most suitable for migratory beekeeping

68 Crane 2000, 347-352. For Greece, see Typaldos-Xydias 1927.

69 Della Rocca 1790.

70 Gaitanou-Giannou A. (unpublished notes 1930) in Kyrou 2000, 377. See also Eckert 1943 (reported by Petropoulos 1957, 356).

71 Papagelos 2000, 199.

72 Rammou and Bikos 2000, 423.

73 Crane 2000, 349.

74 Davaras 1984, table 6a-b, fig. 1.



Fig. 7 Greek skeps (photo H. Harissis, Collection of A. Bikos in the Geoponic Institute, Athens).

were light, but sturdy, such as those made of wooden boards or the woven wicker beehives⁷⁵. A bell-like wicker beehive (skep) was widespread up until recently in Greece, especially in the Chalkidike peninsula⁷⁶ (“epistomo kofini”), in Europe and other parts of the world⁷⁷ (**Fig. 7**). However, its existence in ancient Greece has been questioned and it has been suggested that the skep came to the Mediterranean in the 12th c. from Northern Europe⁷⁸. Nevertheless, I believe that a skep appears in a 6th c. mosaic in Jordan (Madaba)⁷⁹, depicting the fourteenth Idyll of Theocritus with bees stinging Eros as he steals honey from a woven beehive⁷⁹. The Grammarian Philoxenus of the 1st c. BCE (fr. 531) and Virgil (*G.* 4.33) call the beehive a woven vessel⁸⁰. The description of Petronius (*Sat.* 39.14) of a round as an egg beehive (*quasi ovum corrodutata*) confirms, in my opinion, the existence of skeps in Roman times⁸¹.

Ideograms *134 and *190 of Linear B, are dome-shaped with three horizontal dashes crossing or flanking each side of the dome. It has been proposed that they could represent woven beehives⁸². I believe that symbol 7 from the disk of Phaistos (which Evans

75 Crane 2000, 219; Georgandas 1957; Rammou and Bikos 2000, 430.

76 Leontidis 1986, 40.

77 Crane 2000, 219-21; 232-6; 241-57; 265.

78 Crane 2000, 183; 219.

79 Piccirillo 1993.

80 Κυψέλη· πλεκτόν Αγγείον. The beehives mentioned in the Attic *Stelai* (*IG* 3, 426,56) were considered, by Pritchett (1956, 260), to have been made of wicker.

81 It could correspond, however, as has been suggested to me by G. Mavrofridis, to a vertical woven beehive.

82 Melas 1999, 489; cf Melena 2014, 140.

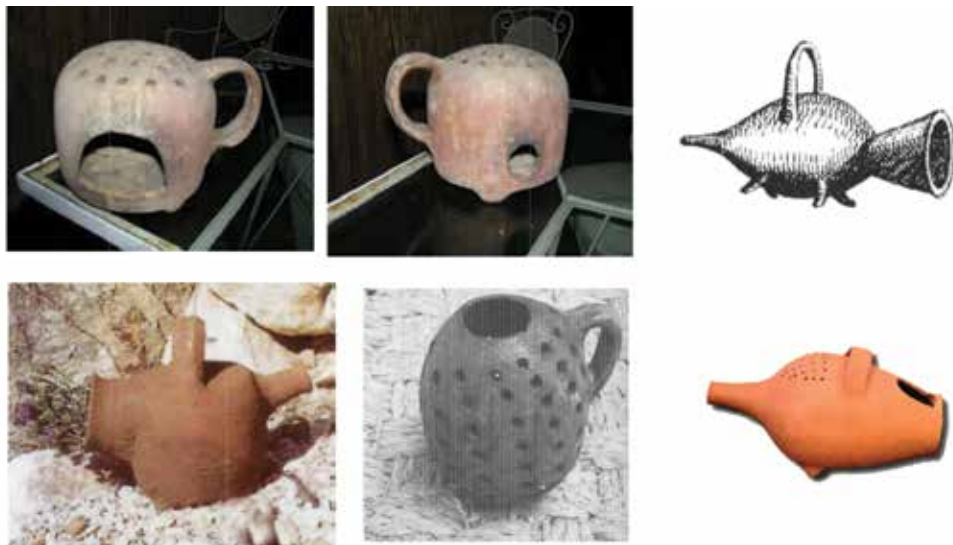


Fig. 8 Different types of post-antique beekeeping smoking pots from Greece.

1st row: (left and middle) traditional smoking pot without a nozzle (photo http://epoptisf.blogspot.gr/2009/10/blog-post_09.html), (right) Syros island Greece (Della Rocca 1790, v. ii, pl.11); 2nd row: (right) Lesbos (Koutri 1999, 320), (middle) Tunisia (Crane 2000, 342, fig. 34.2b), (left) Paros island (Bikos 2008, 312, fig.15).

identifies with a “woman’s breast”⁸³ can also be recognised as a woven beehive. The same interpretation has been proposed for ideogram *179 of Linear B⁸⁴.

In conclusion, although no certain archaeological examples of prehistoric beehives exist - as is also the case for Egypt, for which, however, we know for certain from pictorial evidence that beekeeping in hives did exist - several principally pictorial indications point to the conclusion that apiculture with beehives of various types (horizontal, stone hives and possibly upright hives and skeps) was probably practiced in the Late Minoan/Helladic period in Greece. So far, the earliest beeswax residue dates to the Late Minoan IA period and comes from lamps and conical cups found in Mochlos in Crete⁸⁵. The fact that in prehistoric Crete beeswax was used for lighting, which necessitated great quantities of beeswax, implies organized beekeeping and not occasional wild honeycomb hunting⁸⁶.

83 Evans 1921-1935, v. i, 651, no 1. Davaras (1986, 40 no.13) mentions the opinion of L. Pomerance that the Phaistos Disc sign 24, the so-called “Lydian tomb”, could represent a woven beehive.

84 Proposed as a likely depiction of an omphalos-like woven beehive by P. Faure in a letter of 1971 (Vandendaele and Olivier 1979, 287).

85 Evershed et al. 1995.

86 Morse 2000; Mavrofridis 2006.

Smoking pots

Just as modern apiarists do, ancient apiarists smoked the bees in order to pacify them (Pl. *Phdr* 91 C; Arist. *Hist. an.* 623b; Plin. *HN* 11.15.45; Verg. *G.* 4.228; *Geoponica* 15.5, 15.6)⁸⁷. This practice is already depicted on a relief from an Egyptian temple (where horizontal beehives are present as well), which dates to c. 2400 BCE⁸⁸, and on wall paintings of the Egyptian grave of Rekhmire, of 1450 BCE⁸⁹ (**Fig. 2**). The most primitive technique of smoking the bees was with torches, a practice used until recently in certain regions of Greece⁹⁰. However, smoking pots of a particular shape are needed in order to avoid burning the bees or the beehives (made of flammable materials such as wood or wicker) and to be able to direct the smoke more accurately onto the bees⁹¹.

The simplest smoker consisted of an open vessel holding the fuel, such as a general use container, and

87 Kukules 1951, 354.

88 From the sun-temple of Neuserre, Abu Ghorab (Crane 2000, 163-4, fig. 20.3a).

89 Davies 1944; Crane 2000, 164, fig 20.3b).

90 Loukopouos 1983, 398. For the same practice in other countries, see Crane 2000, 54; 59; 341.

91 Crane 2000, 341.



Fig. 9a Prehistoric smoking pots from Greece. 1st row: (left) smoking pot from neolithic Sesklo, Thessaly (photo H. Harissis), (middle) Early Bronze Age smoking pot from Macedonia, Greece (photo Y. Patrikianos from Grammenos, 2004), (right) Early Helladic smoking pot from Archontiko, Macedonia (Papanthimou 1997, fig.11); 2nd row: (right) smoking pot from Zakros, Crete (photo G. Papadakis, Herakleion museum), (middle) Smoking pot from Zakros (Davaras 1987, Sitea Museum 4522), (left) smoking pot(?) from Knossos (Ashmolean Museum - a similar one exists in Herakleion Museum No. 7742); 3rd row: (middle) Early Bronze Age III smoking pot from Olympia (photo G. Fafalis from Hatzis, 2008), (left) Early Helladic/Middle Helladic period smoking pot (?) from Palamari, Skyros (Skyros Museum. The findings of Palamari. Hellenic Ministry of Culture. 11th Ephorate of Classical Antiquities. 2005, photo 4), (extreme left) tripod brazier from Karpathos (Melas 1985, plate 103).

the smoke was directed onto the bees by blowing the smoke towards them, a process which placed the bees at risk as smoked dizzy bees or queens could fall into it⁹². I shall call such an open smoker, a type I smoking pot. An example of a type I smoking pot can probably be seen in the above-mentioned depiction of c. 2400 BCE from Egypt, with an inscription above it that reads: “to create a current of air”⁹³. Another example is depicted on a wall painting of Rekhmire’s tomb (**Fig. 2**). A vessel from the prehistoric (Early Helladic/Middle Helladic period) settlement of Palamari in Skyros⁹⁴ could be identified as a type I smoking pot (**Fig. 9a**, 3rd row, left). But any open vessel with traces of burning that is usually labelled as “brazier” or “incense burner” could have served as a bee smoker of type I. Like the “tripod brazier”, dating to the Late Minoan III period, that was found in a tomb at Vonies, in Karpathos⁹⁵ (**Fig. 9a**, 3rd row, extreme left). A LMIIIB brazier “made to hold coals” from Chania⁹⁶ could also be a type I smoker. A more sophisticated, “semi-closed” smoking

92 Della Rocca 1790, v. ii, 260 no 1; 496.

93 Crane 2000, 164, fig. 20.3a.

94 Skyros Museum. *The findings of Palamari. Hellenic Ministry of Culture. 11th Ephorate of Classical Antiquities*. 2005, photo 4.

95 Melas 1985, 39, 74 no 1040, plate 103.

96 Hallager 2003, 245, 241 fig. 51, no 19.

pot (type II), invented probably in order to reduce the above-mentioned risk, is an earthenware container closed from all sides except for a big aperture on the top, which served to put the burning material inside, and several small holes in order that the air required to keep the smoker alight could enter (**Fig. 8**, 2nd row, middle).

However, the safest for the bees and, at the same time, the most effective for controlling the direction of smoke, is the smoking pot which I shall call type III. It is characterized by two large side apertures (or nozzles) and several small holes in the walls, while it is closed at the top. The basic functional and constructional principle of this type III smoking pot is given by Columella (*Rust.* 9.15.5): “This vessel [an earthenware smoking pot] has handles and is shaped like a narrow pot in such a way that one end of it is sharper through which the smoke may issue through a small aperture, while the other end is broader and has a rather wider mouth, so that the coals can be blown upon through it. When a pot of this kind is applied to a hive, the smoke is conveyed to the bees by the movement set up by the breath.” In this type of smoker, several small holes need to be made in the side walls of the container in order to keep supplying the air necessary for continuous

burning⁹⁷. Many smoking pots incorporated a handle to be used when the pot became too hot to hold. The type II and III smoker characterizes most post-antique smoking pots, as can be seen in pictures of post-antique smoking pots from Greece and elsewhere (**Fig. 8**). An example of a type III smoking pot is the one from the Aegean island of Syros (**Fig. 8**, 1st row, right), which Della Rocca used in the way described by Columella, but when he wanted to smoke the bees heavily, he could alternatively blow through the small opening and direct smoke onto them from the large opening⁹⁸. A variant of a type III smoker is the post-antique one shown in fig. 8 (1st row, left and middle), which has two openings (a large one, which served to place the burning material inside, and a smaller one for the exit of smoke), but has no nozzle.

It appears that type III smoking pots already existed in prehistoric times, since such smoking pots were found in Neolithic and Bronze Age strata in Northern and Southern Greece (**Fig. 9a** and **9b**). Fragments of tubular vessels, which, as has been suggested, might have been smoking pots, have been found in Franchthi Cave in Argolis⁹⁹. The smoking pot, from the “altar” east of Pelopion tumulus in Olympia, dating to the Early Bronze Age III period (**Fig. 9a**, 3rd row, middle), is, in principle, similar to that of the type III used in traditional beekeeping on the Aegean islands and in Crete (**Fig. 8**, 2nd row, left)¹⁰⁰. In 1908, Tsountas published his finding of a perforated ceramic vessel from the Final Neolithic settlement of Sesklo in Thessaly, which he identified as a smoking pot for bees¹⁰¹ (**Fig. 9a**, 1st row, left). Albeit without a nozzle, it indeed fulfils the basic properties of the type III smoker described above. A similar smoking pot (wrongly characterized as a “portable brazier used to carry lighted coals”), dating to the Early Bronze Age, was found in Axiohori, Macedonia, Northern Greece (**Fig. 9a**, 1st row, middle). The two above-mentioned smoking pots resemble, in principle, another Early Bronze Age type III smoking pot from Macedonia (**Fig. 9a**, 1st row, right)¹⁰². These smoking pots, as far as I know, constitute the world’s oldest apicultural vessels. A Middle Minoan II (c. 1900 BCE) beekeeping smoker

97 Della Rocca 1790, v. ii, 496.

98 Della Rocca 1790, v. iii, 384.

99 Vitelli 193, 179; 187 no 6.

100 Rambach 2002, 194, fig. 29, no 114 with references.

101 Tsountas 1908, 274, fig. 198.

102 Papaefthmiou-Papanthimou 1994, 8:90, photo 11; Papaefthmiou-Papanthimou 1997; Papaefthmiou-Papanthimou 1998, 122:855, fig. 163.



Fig. 9b 1st row: smoker from Enkomi (Karageorghis 1972); 2nd row: (left) “smokers” from Ayia Irini, Keos (Georgiou 1986, plate 20, no 169, 170), (right) smoker from Phaistos (Levi 1976, plate 149e); 3rd row: smokers from Phaistos (Levi 1976, plate 149b, i, d).

was found in the gorge near the Zakros “palace”¹⁰³ (**Fig. 9a**, 2nd row, middle). It is an open cylindrical vessel tapering at one end, rounded, in which there are rows of holes above and a large circular opening below. It has one handle on top, four feet below and a collared socket at its other end. The fabric is coarse and there are signs of burning inside. Similar vessels with burn marks were found in “oikia H, room Y” (Middle Minoan II-III)¹⁰⁴ and in the “House I, room 14”¹⁰⁵ (Late Minoan I, c. 1500 BCE) (**Fig. 9a**, 2nd row, right and 3rd row, right) of the nearby Zakros town. The last item, of coarse fabric, is a cylindrical vessel tapering to rounded end, in which have been cut a large circular opening on one side and a number of rectangular slots all over the end. Below this, two stout handles

103 Platon 1962, 166; Davaras 1989; Evely 2000, 364, Fig. 144, no 6; 365 with comments.

104 Dawkins 1903, 258, fig. 35; Evely 2000, 365.

105 Hogarth 1900-1, 141, fig. 51; Evely 2000, 365.

are attached to one side, and four small feet (in two pairs) to the opposite one. Midway between the handles and feet and nearer the large open end are two more pairs of cut-out slots. The smoking pot from Zakros’ gorge has the nozzle on the side. The smoker from the town has no nozzle but its pointed front end, which has many holes, could serve as a nozzle, a fact that was verified by an archaeological experiment¹⁰⁶. The smoking pots from Zakros have been compared to the items from the “House of Sacrificed Oxen from Knossos termed “Ariadne’s Clew (ball of thread) Box” by Evans¹⁰⁷ (MMIII-LMI) (**Fig. 9a**, 2nd row, left) with marks of discoloration from smoke¹⁰⁸. The comparison, however, is disputable¹⁰⁹. Several tubular objects, four from Phaistos (MMIIA period) and two from Ayia Irini, Keos (periods vi-vii corresponding to LMI period) were proposed as possible smokers. The vessels from Ayia Irini are both tall cylinders (35 cm and 28 cm) with a hollow base, slit sides and a vertical loop handle attached to one side (**Fig. 9b**, 2nd row, left and middle). However, neither had traces of burning nor stub feet a fact that makes dubious their usage as smokers¹¹⁰. The pieces (“vasi a corna e unguentari”) from Phaistos¹¹¹ (**Fig. 9b**, 2nd row, right and 3rd row), with marks of burning¹¹², stood vertically on large plates with a fitting for the opening on the wider end¹¹³. The so called corns at the side could actually be feet and this renders the hypothesis of a smoker probable. Another oblong clay tube, semi-circular in section, with a flat base, ascribed to the Late Bronze Age, was found in a tomb in Enkomi, Cyprus¹¹⁴ (**Fig. 9b**, 1st row). One end is closed and rounded while the opposite one is open. There are three perforations along its long sides, three along its upper part and three along its closed end. A small portion of the upper part is missing. The dimensions are: length 37 cm, width 11 cm, height 14 cm. This object could have indeed functioned as a bee smoker¹¹⁵.

106 Stamataki et al. 2009.

107 Evans 1928; 304, 308-309, fig. 176f, 179a, b; Davaras 1989, 4-5, fig. 3, pl. 1^ε. An identical object exists in Ashmolean Museum.

108 Georgiou 1986, 42.

109 Evely 2000, 498, 499 fig 201 no 3 who supports the use for threads; Chapouthier 1941, 7.

110 Georgiou 1986, 42, plate 11, 20.

111 Levi 1956, 53, 101, 306, 396, plate 149e.

112 Georgiou 1986, 42.

113 Herakleion Museum 10190, 10723, 18451; Georgiou 1986, 42.

114 Karageorghis 1972; Davaras 1989.

115 Davaras 1989.



Fig. 10 Vessels from the private house of Knossos (Evans 1935, 95, fig. 109).

Although not very probable, it cannot be excluded that all known examples of prehistoric beekeeping smokers from Greece were used exclusively for harvesting wild honey. It has been suggested that the smokers from Zakros were suitable only for horizontal beehives¹¹⁶, thus indicating systematic apiculture, whose existence in the Late Minoan period was already hinted at above while reviewing the evidence of beehives. However, the Zakros smoker raises the chronology of the existence of systematic apiculture to an earlier period, the Middle Minoan period. To this period dates a unique beekeeping toolkit that was found in Knossos, which I will examine below.

Beekeeping paraphernalia from the “Snake Room” in Knossos

In 1930, Arthur Evans discovered a private house, located near the walled-pits (“kouloura”) of the west court, southwest of the “North-West Treasury House”¹¹⁷ of the Minoan “Palace” of Knossos. This little room opened onto a passage-way. By the entrance of the little room stood a large jar (pithos), 71 cm in height and about 30 cm wide, which was a repository for what appears to have been a complete set of clay

116 Suggested by A. Bikos (in Stamataki et al. 2009).

117 Evans (1935, 94) by mistake writes “South-West Treasury house”.

vessels and other utensils dated to the Middle Minoan IIIb - Late Minoan II period (**Fig. 10**). Both the jar itself and its contents were broken. This is how Evans describes the findings¹¹⁸: "North of the line of the Koulouras the outer enceinte wall enclosed a closely set conglomeration of houses, in their later shape dates to the very beginning of the late Minoan Age, and practically corresponding in their duration with that of the later Palace. The Late Minoan structures here to a certain extent intruded on the line of the o. i enceinte wall, parts of two houses having been obviously domestic continued west of it. [...] the most remarkable discovery in this region was a room of a private house, belonging to the same LMII period, containing a complete set of utensils - some of them coiled round with serpents moulded in clay - designed for a domestic snake cult of a type more primitive than that in which it was taken over by the Minoan Goddess as Lady of the Underworld". Evans called the particular room the "snake room" and devoted a special section to this "unparalleled discovery which throws new light on the most primitive stratum of Minoan cult"¹¹⁹. However, recently, I was able to suggest a completely different hypothesis concerning their nature and usage¹²⁰.

Among the vessels found in the room, some are perforated (No 1, 2, 3, 10 in **Fig. 10**). One of them (No 2 in **Fig. 10** and **Fig. 11** left) has a big opening at the top, a large tubular opening on either end and many small holes on the sides. Due to its snake-like handles, it is generally identified as paraphernalia for a snake cult¹²¹. But it could have been, instead, a smoking pot since it has many features in common with type III smoking pots, mainly the two tubular openings, which enable the beekeeper to blow on the fuel in the pot through one of them so that the smoke could emerge from the other. It has a unique feature of two nozzles. The handles, which are necessary for all smoking pots, were snake-like for decorative purposes. Another perforated vessel, with a height of 11.2 cm (No 3 in **Fig. 10** and **Fig. 11** right), has only one opening at the top and many small holes on the sides. It is probably a smoking pot too, but of a type II (**Fig. 8**, 2nd row, middle)¹²². We should not be surprised by the use of different types of smoking pots within the same region, since such practices are not uncommon: it is reported that in 1985, six or seven different styles of

118 Evans, 1935, 76.

119 Evans 1935, 155-156, fig. 118; 119.

120 Harissis and Harissis 2009.

121 Nilsson 1950, 90.

122 For a photo, see Crane 2000, 342, fig 34.2b.



Fig. 11 The vessel No 2 (left) (Evans 1935, 155, fig. 119) and No 3 (right) from the private house of Knossos here identified as smoking pots (photo Y. Patrikianos from Dimopoulou - Rethe-miotaki 2005, 101).

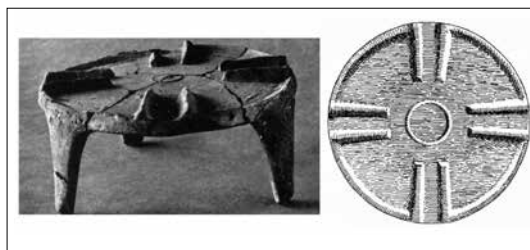


Fig. 12 (left) Object No 8 from the private house of Knossos, here identified as a honeycomb press (Zervos 1956, no 603), (right) The same vessel in ground plan (Evans 1935, 149, fig. 115a).

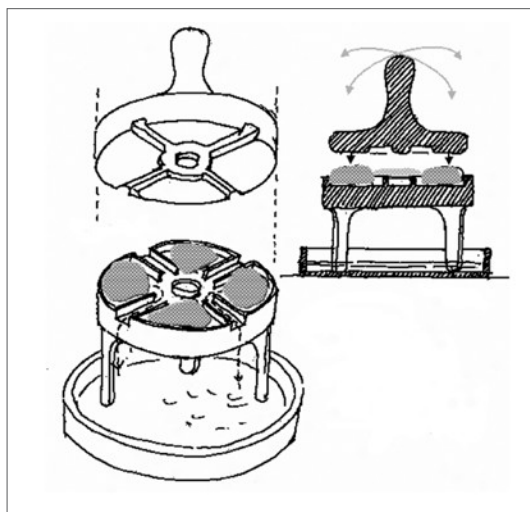


Fig. 13 The suggested function of vessel No 8 from the private house of Knossos for honey separation (drawing V.A. Harissis).

smoking pots were in use simultaneously in Crete¹²³.

Another utensil found in the jar is a circular object (height 10 cm, diameter 25 cm), divided into four parts by four channels and standing on three legs (No 8 in **Fig. 10** and **Fig. 12**). I consider Evans' hypothesis of a vessel for food offering to snakes ("snake table")¹²⁴, to be improbable, and certainly unprovable. It could, however, be a honeycomb press (**Fig. 13**). Combs could have been placed in the four compartments between the channels and then manually pressed with a wooden board (not preserved). Pressure would result in honey escaping through the four channels and flowing into vessels (or a big dish) placed below the edge of each channel (such vessels could be the jugs No 18, 19, 20 and 22 in fig. 10 that Evans calls milk-jugs for snake offerings). A press with channels for the flow of honey was used by traditional beekeepers in Cyprus¹²⁵ and in Greece¹²⁶ (**Fig. 14** and **15**).

The three "cylinders" or "tubes" (height 28 cm and exterior diameter of base 9.6 cm) (No 4, 5, 6 of **Fig. 10** and **Fig. 16**) found in the "snake room", have two pairs of cups, symmetrically attached to their sides. Evans suggested that these cups were "made to contain some kind of drink offering to snakes" and labelled them "cylindrical snake vessels"¹²⁷. I believe, however, that the cups were used as receptors for the excess liquid content of the tube. More specifically, I propose that these vessels served as wax extractors from the combs once honey was extracted¹²⁸. The

123 Crane 2000, 342.

124 Evans 1935, 76, 149, fig 115b; Nilsson 1950, 90.

125 Nikolaidis (2000, 135) reports that the traditional comb presses were similar to those for grapes.

126 Loukopoulos 1983, 400-1, fig. 53. The simplest vessel for wax extraction from the comb was a ceramic strainer into which the comb was placed, and with manual pressing the honey was separated from the wax (see for an example see Crane 2000, 483, fig. 46.1b). For such a Neolithic perforated vessel from the Northern Aegean, see Decavallas 2007.

127 Evans 1935, 142, fig 111; Nilsson 1950, 90.

128 In a perforated dish from Knossos, Faure (1999, 171-2) recognizes a honey extractor. He compares it with similar objects from Troy and Neolithic Switzerland. By putting the comb in the vessel and by applying pressure, the honey spilled from the holes while the wax remained in the vessel. Melas (1999, Plate CVIIIe) presents a completely different conical vessel, which he considers to be a honey extractor. The vessel from the Knossos "Snake Room" (fig. 11. right) which here I recognized as a smoking pot, could alternatively be a vessel to separate honey from wax, like the one used by traditional apiarists

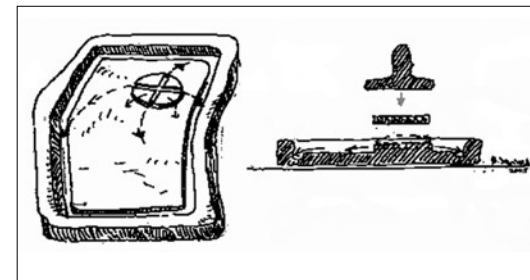


Fig. 14 A traditional basin for pressing honey combs from Cyprus and its working principle (drawing V.A. Harissis based on a photo by Rizopoulou-Igoumenidou 2000, 404).

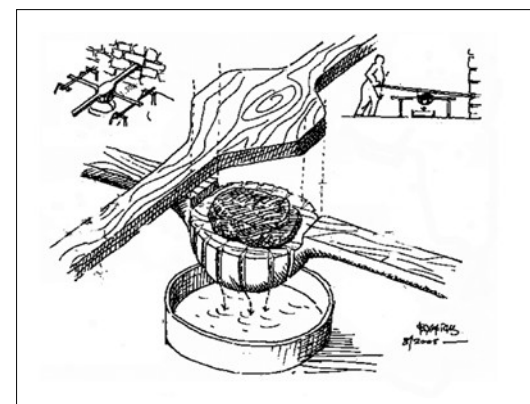


Fig. 15 A traditional honey extractor, as described by Loukopoulos 1983, 400-1 (drawing V. A. Harissis).

extraction of wax from the remaining elements of the comb (pollen, brood) is achieved, as Pliny (*HN* 21.83-84) and Columella (*Rust.* 9.16.1) recommend, with the use of boiled water. The wax, being lighter than the other comb components, floats in boiled water and is collected from the surface. The same principle was used by traditional beekeepers in Greece¹²⁹. Thus, I suppose that combs were placed in these Minoan containers and the vessel was then filled with boiled water. The heating of the water was probably done by placing little water jugs (such as No 9 and 23 in fig. 10) over a fire alight in vessel No 7 in fig. 10, which in Poland (for a photo, see Crane 2000, 483, fig. 46.1b). However, the small diameter of the opening (insufficient for placing the combs) argues against this hypothesis. Traditional beekeepers used to place the combs inside a simple linen sac. By applying pressure on the sac the honey seeped out of the sac and was separated from the other comb components that remained in the sac.

129 Liakos 1996, 371-2.



Fig. 16 Cylindrical vessels from the "snake room" of Knossos, identified here as wax extractors (photo Y. Patrikianos from Dimopoulou-Rethemiotaki 2005, 100).

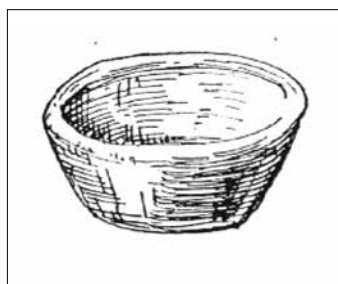


Fig. 17 A traditional vessel for beeswax (Vrontis 1939, 236).

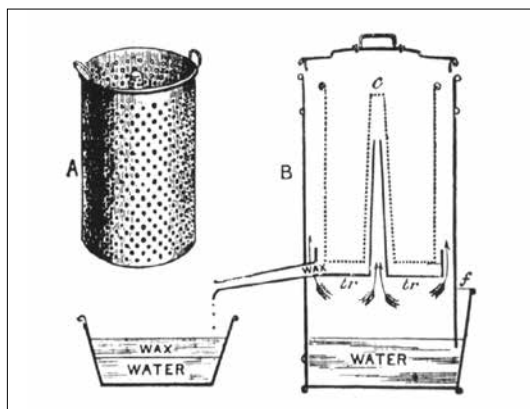


Fig. 18 The "Gerster Wax Extractor" (Cheshire 1888). (A) Depicts the strainer pot where the combs are put and corresponds to the main body of the cylindrical Minoan vessel. The pot is placed on a tray (tr) which was filled (through f) with boiled water passing through the opening of the main cone (c) into the comb strainer. Through the holes of the strainer the wax and the water flow into a dish, just like the cups of the Minoan cylindrical vessel.

had traces of ash. Filling the tube with boiled water forced the molten wax to rise to the surface, and by deliberately overflowing the container, the wax was gathered in the cups¹³⁰. The wax, after cooling, was removed from the cups, having taken their hemispherical form. The form and the diameter of the cups resemble both traditional and Byzantine vessels, used for the same purpose¹³¹ (**Fig. 17**). Based on the same principle (molten wax rising to the surface of boiled water), two metal wax extractors, the "Gerster Extractor" (**Fig. 18**) and the "Mountain Gray Extractor", were in use in the 19th and 20th c. respectively¹³².

Some other vessels (No 11, 12, 15, 16 in **Fig. 10** and **Fig. 19**) from the same room resemble the dish containing honey combs depicted in the mural from the tomb of Thanuro in Luxor (1448-1420 BCE) (**Fig. 20**) as well as in another mural from the 18th Dynasty tomb of Kenamun¹³³. This dish, in turn, resembles the traditional comb-dish from Kashmir (**Fig. 21**)¹³⁴ and the two dishes, one on top of the other, which can be seen on the wall painting from the tomb of Rekhmire, sealed with mud and containing combs (**Fig. 22**). A similar dish with traces of a honeycomb found in a tomb in Deir-el-Medina, West Bank in Upper Egypt, dates to c. 1350 BCE¹³⁵.

Object No 1 in fig. 10 (**Fig. 23**), with a height of 14.5 cm, has been identified by Evans¹³⁶ as "three sections of a naturally formed wild honeycomb with a snake coiling round the vessel with a grub in its mouth". I have proposed an alternative interpretation: that of a rather sophisticated hornet trap - hornets being the worst enemy of bees in Southern Greece and the Aegean islands¹³⁷. Several kinds of hornet traps were used by traditional beekeepers in Greece, but all of them had the same working principle: bait attracted the hornets to enter a box or a bottle from which they could not escape¹³⁸. Della Rocca says

130 A similar practice was traditionally used by apiarists in Cyprus (Filotheou 1980; Rizopoulou-Igoumenidou 2000, 404).

131 Vrontis 1939, 206. These wax cups are called "kyparia" in Chalkidike and in Paros (Papagelos 2000, 198).

132 Crane 2000, 497, fig. 46.7d.

133 Metropolitan Museum accession number 30.4.71, *Egyptian wall paintings*. The Metropolitan Museum of art's collection of facsimiles, 1983, 107.

134 Crane 2000, 165.

135 Crane 2000, 166, fig. 20.3d.

136 Evans 1921-1935, v. iv, 154-5, fig. 118a,b.

137 Reras 2001, 24.

138 Speis 2003, 121-122.



Fig. 19 Honeycomb dishes from the upper shelf of the "snake room" in Knossos (Evans 1935, 95, fig. 109).

that beekeepers used "bottles with baits"¹³⁹ against the hornets. Aristotle (*Hist. An.* 627b) reports a way of attracting hornets with a piece of meat placed in a dish and then killing them by throwing the meat into the fire¹⁴⁰. I believe that the Knossos vessel was deliberately made to resemble honeycombs in order to "deceive" the hornets to enter the vessel. The vessel was probably placed near the beehives, and when several hornets were trapped inside, the beekeeper would pick it up from its snake-like handle and throw it into the water, thus drowning the hornets.

Vessel No 14 in fig. 10 could be an upright beehive, since it resembles one and was found among other beekeeping paraphernalia¹⁴¹. Similarly, vessel No 10 in fig. 10 could be another type of smoking pot. The jar itself was probably used for storing honey, a practice that we hear about in the myth about Glaukos, the son Minos, the King of Crete, who was drawn into a jar full of honey (Apollodorus *Bibl.* 3.17). Honey stored in big jars is represented in the previously mentioned Egyptian relief dated to c. 2400 BCE¹⁴² and on wall paintings of the tomb of Rekhmire¹⁴³.

The existence of smoking pots, a honey extractor, wax extractors, comb-dishes, a honey jar and a probable beehive in this room suggests that it is an apiarist's storage room, and not a room associated with a "snake cult". Given the plethora of apicultural paraphernalia gathered together, one is entitled to conclude that these utensils were used for the production of significant quantities of honey and beeswax, which could only have been derived from a large number of domesticated bees, and not just

139 Liakos 2000, 333.

140 Reras 2001, 24.

141 I consider its use as a honey container improbable.

For pictures of stone vessels supposed to be Minoan honey containers, see Melas 1999, 488, pl. CVIII f,g.

142 From the sun-temple of Neuserre, Abu Ghorab (Crane 2000, 164, fig. 20.3a).

143 Crane 2000, 164 fig. 20.3a; 165 fig. 20.3b.



Fig. 20 A comb dish depicted on a wall painting (detail) of Thanuro tomb in Luxor (1448-1420 BCE) (copyist C. K. Wilkinson 1926, scale 1:1, 45x76 cm, Metropolitan Museum accession number 30.4.91, photo N. Davies 1936, plate XXXIV).



Fig. 21 Traditional comb dishes from Kashmir, India (photo E. Crane from Crane 2000, 282, fig. 29.5d).



Fig. 22 Comb dishes depicted on a wall painting of the tomb of Rekhmire (Davies1944).

from occasionally collecting wild honey from limited and isolated wild bees' nests. The fact that the vessels were put in an empty honey jar means that this beekeeper's toolkit was destined for transportation in the jar where the honey extraction took place, not at the beekeeper's house, but somewhere in the countryside where the beehives were usually kept, as they are nowadays. Traces of wax and/or honey residue on these vessels from the private house in Knossos would, of course, help to confirm their use in beekeeping. I believe, however, that there is enough available evidence to reach the conclusion, already anticipated by the pictorial evidence from golden signet rings, that in prehistoric Greece, from the Middle Minoan/Helladic period and onwards, systematic apiculture was practiced.



Fig. 23 Perforated vessel No.1 from the "snake room", identified here as a hornet trap (photo Y. Patrikianos from Dimopoulou - Rethemiotaki 2005, 101).

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THE IRON AGE APIARY AT TEL REḤOV, ISRAEL

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Introduction: Honey and Beekeeping in the Ancient Near East: a Short Survey

The importance of honey and beeswax in the Ancient Near East can be inferred from Egyptian, Canaanite, and Hittite sources. Textual and pictorial sources from ancient Egypt are of particular interest¹. The *Story of Sinuhe*, attributed to the Middle Kingdom (20th century BCE), alludes to the abundance of honey and oil in his place of residence in the Land of Canaan; Thutmose III recounted carrying off 430 honey jars as booty following his conquests of Canaan in the 15th century BCE; in another text, he mentions 264 honey jars collected as tribute. Depictions of horizontally stacked cylindrical beehives arranged in rows, along with honey production, are known in five wall paintings and reliefs from Egypt, dating from the mid-3rd millennium to the mid-1st millennium BCE. In the most detailed representation, in the 15th century BCE Tomb of Rekhmire, there are three rows of beehives and beekeepers are shown collecting honey. In Egyptian texts, honey is mentioned as a sweetener used by the elite and also appears in offering lists and in connection to medication and ointment production. Honey jars were bestowed as royal gifts. Beeswax was ascribed with magic powers in Egypt, where it was also used as a marine sealant, in the lost-wax metal-casting method, in medicine production, and more.

In 14th–13th centuries BCE texts discovered in the Canaanite city of Ugarit in northern Syria, the word for honey is *nbt*, and in Akkadian it is *nūbtu*—the counterpart of the biblical term *nofet* (see, e.g., Psalm 19:11: "... sweeter than honey and the honeycomb"; the word "honeycomb" is a translation of the Hebrew

1 Neufeld 1978: 225–238; Serpico and White 2000: Kritsky 2007, 2010:11–14, 2015.

phrase, *nofet tsufim*). Honey is mentioned in Ugarit in administrative, literary, and ritual texts. In the latter, it appears as one of the foods offered to the gods (attention the biblical prohibition to burn honey on altar, Leviticus 2:11). The bee plays a unique role in Hittite myths and, in Hittite law, severe punishment was dealt out to bee-swarm and hive thieves². Yet no apiary was discovered in the Ancient Near East, perhaps since the hives were made of perishable materials, located outside the settlements and were not preserved. In Classical Greece and the Hellenistic period hives were made as fired pottery cylindrical vessels; they are known from various sites, but never found *in situ* in an organized manner as in the Tel Reḥov apiary³.

In the Hebrew bible, the word "honey" is mentioned fifty-five times, sixteen of which as part of the figurative expression "land flowing with milk and honey." It is widely accepted that the term honey (in biblical Hebrew דבש, *dvash*) refers to a syrup that was extracted from fruit such as dates and figs, since honey that is explicitly bees' honey is mentioned only twice, both times in connection to wild bees (Judges 14:8–9; 1 Samuel 14: 27). Furthermore, there is no biblical mention of beekeeping as a branch of production. However, a textual study conducted by Tova Forti maintains that a considerable number of the occurrences of the word "honey" do, in fact, refer to bees' honey⁴. This conclusion is supported by the

2 Hoffner 1974: 123–124; Crane and Graham 1985: 31–34; Simon 2014: 717–719.

3 Crane and Graham 1985: 31–39; Anderson-Stojanović and Jones 2002

4 Forti 2006; 2010.

unique discovery of the Tel Reḥov apiary, dated to ca. 900 BCE. This is the only apiary to be found in an archaeological site in the ancient Near East and the Eastern Mediterranean world. In this article, I discuss this exceptional discovery of an industrial apiary and its implications to the early history of beekeeping.

The Tel Reḥov Apiary

Tel Reḥov (Arabic: *Tell eṣ-Ṣarem*) is located in the Beth-Shean Valley in north-east Israel, 5 km south of Tel Beth-Shean, close to the main north–south route traversing the Jordan Valley and a route leading west to east from the Jezreel Valley toward Transjordan (Fig. 1). The mound is located close to fertile land and water sources. Excavations between the years 1997–2012 revealed exceptional architecture and abundance of finds mainly from the 10th–9th centuries BCE (Strata VI–IV)⁵. The city was one of the largest in biblical Israel during the 10–9th centuries BCE.

The apiary was discovered in the heart of a well planned and densely built urban quarter of Stratum V, Area C, near the northwestern corner of the mound (Figs. 2–3)⁶. About thirty beehives were uncovered, each individual hive was made of unbaked clay mixed with straw and shaped as a hollow cylinder measuring ca. 80 cm in length and 40 cm in diameter, with a ca. 4 cm thick wall, and a volume of ca. 56 liters (Figs. 4–7). One end of the cylinder was closed by a clay wall with a small 'flying hole' (about 2–4 cm in diameter) in its center that allowed the bees to enter and exit the hive, keeping unwanted animals away. The opposite

5 The excavations were directed by the author on behalf of the Institute of Archaeology of the Hebrew University of Jerusalem and sponsored by Mr. John Camp (USA.). Dr. Nava Panitz-Cohen was the supervisor of the main area (Area C) throughout the seasons and is a co-editor of the final report. For earlier summaries, see Mazar 2008, 2013; 2015; 2016; Mazar et al. 2005; final report: Mazar and Panitz-Cohen (eds.), in press. The research and publication of the apiary was supported by a grant of The Eva Crane Foundation. The present article is based on a Hebrew article published in *Igeret, Bulletin of the Israel Academy of Science*. Much of the present English version is based on translation by Inbal Sammet of the latter article (included in Mazar 2016).

6 Mazar and Panitz Cohen 2007; Bloch et al. 2010; Mazar and Panitz Cohen in Mazar 2016: 25e–35e. Detailed report will appear in Mazar and Panitz-Cohen (editors), Volume II, Chapter 14, in press.

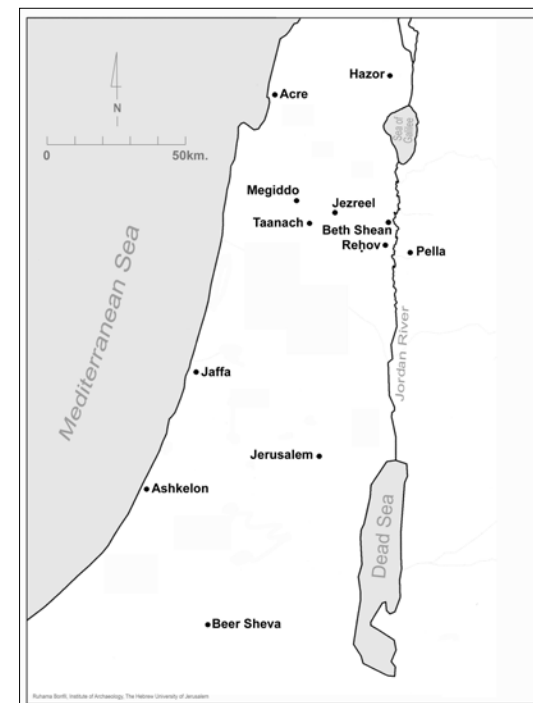


Fig. 1 Location map of Tel Reḥov.



Fig. 2 General view of Tel Reḥov (western part) looking south. Area C where the apiary was discovered is in the front part of the picture.



Fig. 3 Vertical view of Area C. The apiary is seen on the upper right corner among the city's buildings.



Fig. 4 General view of the apiary, looking east. The destruction layer that seals the apiary is seen at the back.



Fig. 5 The eastern row of hives.

end of the cylinder was fitted with a portable clay lid with a handle that could be removed to allow honey extraction from the honeycombs (**Fig. 6**). The hives were arranged in three parallel rows, each at least three-tiers high. They were installed in an area that had been deliberately lowered and surrounded by walls on at least three sides. The beehive rows were separated by broad aisles (1.85 and 1.2 m wide) intended to facilitate honey collecting; they were built with the hive lids in the central and eastern rows facing each other. Altogether, thirty hives were uncovered in the bottom tier, but there must have been many more, as the rows were not preserved entirely, and we can reconstruct twenty hives in the bottom tier of the eastern row alone. If all three rows were of identical length, we may assume that the apiary contained about sixty beehives in the bottom tier; since there were three tiers of hives, the apiary could comprise about one hundred eighty hives. The uncovered remains and the proposed reconstruction (**Fig. 7**) indicate a well-planned apiary that was industrial in nature.

The apiary was destroyed violently and suddenly. An 80 cm thick destruction layer containing fallen mud-bricks and charred wood beams covered the beehives and crushed their upper parts (**Figs. 4, 5**). The hives were no longer used in the subsequent stratum (IV) of the 9th century BCE when new structures were built over their ruins.

Natural Sciences Research

Four natural sciences studies have been conducted in relation to the Tel Reḥov apiary.

The first was a chemical analysis of the beehive walls⁷. The analysis of the lipid assemblage extracted from two hives pointed to a high correlation between the extraction mixture and the lipid composition that is characteristic of heated beeswax. This constituted the first scientific proof that the installations we discovered were indeed beehives.

The second study focused on identifying pollen found in the soil extracted from the beehives⁸. This 7 Mazar et al. 2008. The study was undertaken by Dr. Dvorah Namdar jointly with a team of researchers from the Weizmann Institute of Science, the Faculty of Agriculture of the Hebrew University in Rehovot and the Volcani Institute.

8 Weinstein-Evron and Chaim 2015. The study was conducted by Prof. Mina Weinstein-Evron and Sylvia Chaim of the University of Haifa.



Fig. 6 Hives as found in three tiers. In the lowest hive a clay lid was preserved.

provided evidence of a variety of plants, which does not differ from the modern-day flora in the Beth-Shean Valley. The representation of *Ziziphus* pollen and pollen representing a variety of herbaceous plants that must have grown nearby is noteworthy.

The third study was dating the apiary using ¹⁴C dates measured on charred grain. The samples came from large quantity of charred grain found flowing from a storage jar in the eastern part of the apiary, and charred grain found in destruction layer in the western part of the apiary. Eleven measurements from three samples were measured, providing a range of calibrated dates between 968-862 BCE (1 sigma or 68% probability) or 970-840 (2 sigma or 95% probability). Few dates from additional contexts from the same stratum in Area C enable to narrow the time span of this stratum to 926-896 (1 sigma or 68% probability) or 970-847 (2 sigma or 95% probability)⁹. Based on dates from the previous and later strata (dated to the 10th and 9th centuries respectively) we concluded that the apiary was in use during the last decades of the 10th and early decades of the 9th centuries BCE, that means the end of the Solomonic era (if indeed it was an historical era) and the early kings of the Northern Kingdom of Israel.

⁹ The dates from the apiary were published in Bloch et al. 2010; Mazar 2016: 44-45. Details will be presented in Mazar and Streit, in press. For additional dates from Stratum V measured before the apiary was discovered see Mazar et al. 2005.

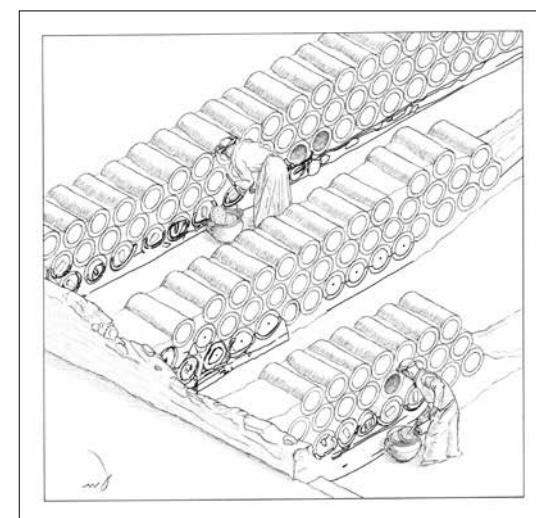
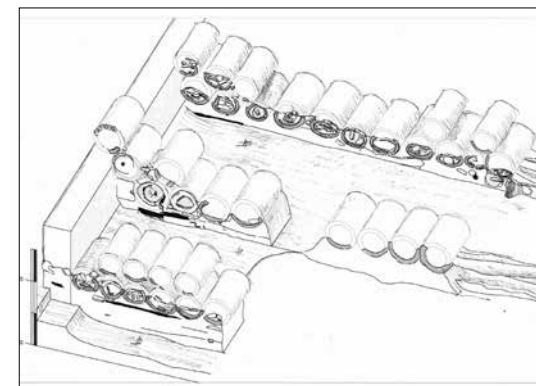


Fig. 7 a: Isometric view of the apiary as found; b: Artist reconstruction of the apiary (drawing: Ana Iammim).

The fourth and most fascinating study focused on lumps of black material found in one of the hives. These were suspected to be remains of charred honeycombs that had burned during the destruction of the apiary in conflagration. A first clue to this identification was the remains of a bee in one of these lumps that was observed during the excavations. Prof. Guy Bloch of the Institute of Life Sciences of the Hebrew University of Jerusalem, assisted by Ido Wachtel, used an electron microscope to establish that these were indeed the remains of honeycombs and bees: bee's eyes, muscles, legs, and wings could be identified (**Fig. 8**). To date, these are the only ancient bee remains that have ever been discovered in the Ancient Near East. In a joint study with Professors Stefan Fuchs of the Goethe University in Frankfurt and Tiago Franco of the University of

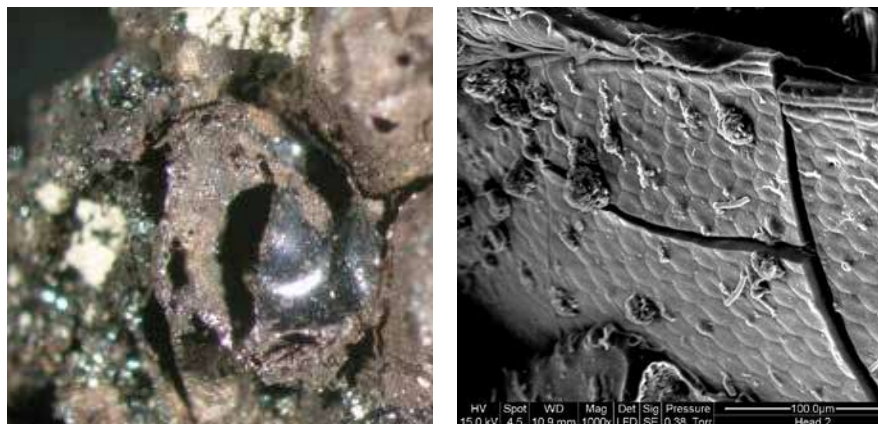


Fig. 8 Bee's parts as photographed in electron microscope. a: eye; b: wing.

São Paulo University in Brazil the sub-species of the bee was identified by measuring the size and shape of the wing's veins (Bloch et al. 2010). The evidence was consistent with the anatomy of the sub-species *Apis mellifera anatoliaca* (Anatolian honey bee), and unlike that of the *Apis mellifera syriaca* (Syrian honey bee), which is typical of the Southern Levant. The Anatolian Honey bee is particularly productive and easier to raise for commercial purposes than the aggressive Syrian bee, and is presently at the base of the Turkish honey industry—the second largest in the world. This bee is adjusted to the climatic conditions of Turkey: cold temperatures and high humidity in the mountainous areas and severe heat conditions in the Central Anatolian plateau during the summer. Could this honey bee have been indigenous in Israel in the Iron Age? This is not probable. Another possibility is that the beekeepers of Tel Reḥov imported bee swarms from Anatolia, a minimal distance of about five hundred kilometers (see further below).

Discussion

The use of cylindrical beehives made of unbaked or fired clay, hollow tree trunks, or wickerwork is well known from traditional societies across the Mediterranean basin and eastern Asia¹⁰. Until recently, it was common in Egypt to build walls to a height of ten or more tiers of beehives¹¹. Similar hives are known in the entire Eastern Mediterranean and Middle East including northern Iran, the Gulf and eastern Africa (**Fig. 9**).¹² This form, which imitates a

hollowed tree, represents a tradition that lasted more than 4500 years. In many places, it was customary to build beehives near houses or even in basements below a raised ground floor¹³.

Based on ethnographic evidence, we may assume that each hive of this type could yield 3–5 kg of honey and 0.5–0.7 kg of beeswax annually, depending on their maintenance level, collection methods, and annual precipitation. If we reconstruct at least 100 hives in the Tel Reḥov apiary, the yield would have been about 500 kg of honey and 50–70 kg of beeswax per year. This amount exceeded the producers' private consumption, creating tradable surplus, which turned the apiary at Tel Reḥov into a profitable enterprise; this explains its careful spatial organization and industrial nature.

The discovery of Anatolian bees at Tel Reḥov raises the question whether it is plausible that bee swarms have been imported to the Beth-Shean Valley directly or indirectly from one of the Neo-Hittite states in southern Turkey that existed during this period, such as Sam'al, Carchemish, Que, Gurgum? And if so: what was the route of such a trade? We suggested trade along the Phoenician coast perhaps by ships, through port towns like Tyre or Akko. In contrast, Simon suggested that the swarms arrived through the Orontes Valley, via inland Syrian commercial centers (such as the kingdom of P/Walastin)¹⁴. There is no archaeological evidence for such trade except a single Neo-Hittite seal impression from Hazor

¹⁰ Crane 1983; Kritsky 2010.

¹¹ Kritsky 2010: 15, Fig. 1.9, reproduced in Mazar 2016: 39.

¹² For examples see Neufled 1978: 243–247; Kritsky

2010: 16–19.

¹³ Kritsky 2010: 18, an example from Venice, Italy.

¹⁴ Simon 2014.



Fig. 9 A modern clay hive, village of Nahf, Lower Galilee, Israel. A: general view

B: detail of hive with honeycomb.



Stratum Xa¹⁵ and the vague biblical allusions to horse trade between Egypt and Kue (Cilicia in modern-day southern Turkey), involving Solomon's merchants (1 Kings 10:28).

If we are correct in concluding that the bees found at Tel Reḥov originated in Anatolia, we have to address the question why anyone would take pains to import bee swarms of a particular sub-species over such a long distance? Economic activity of this sort required knowledge, skills, and far-reaching commercial ties extending to the Neo-Hittite kingdoms located in modern-day Turkey. Importing bees swarms from such a distance raises many questions. It would be essential to prevent the Anatolian queens from mating

¹⁵ Ben-Tor, Ben-Ami and Sandhouse 2012: 79, Fig. 2.39, 132 Fig. 2.11:12.

with the local Syrian honey bee drones. How this was done? Did the ancients had the required knowledge in bees biology so that they could maintain Anatolian bees along a considerable time? Perhaps new swarms had to be brought annually. In any case such a trade would have required vast knowledge and experience in beekeeping and international economic ties¹⁶.

The only parallel for similar operation is a text inscribed on a memorial stele of Shamash-resh-ušur, an Assyrian governor of Suhu on the mid-Euphrates region (modern-time south-eastern Syria), dating to the first half of the 8th century BCE (a century and a

¹⁶ I thank Dr. Yossi Slabezki from the Faculty of Agriculture of the Hebrew University in Reḥovot and the Volcani Institute for advise concerning beekeeping and bee's biology.

half later than the Tel Reḥov apiary)¹⁷. Shamash-resh-ušur recounts rearing honey bees and boasts of being the first among his ancestors to have done this. His inscription says, among other things:

"I am Shamash-resh-ušur, the governor of Suhu and the land of Mari... Bees that collect honey, which none of my ancestors had ever seen or brought into the land of Suhu, I brought down from the mountain of the men of Habha, and made them settle in the orchards of the town 'Gabbar-built-it'. They collect honey and wax – and I know how to melt the honey and wax – and the gardeners know too."

(Dalley 1984: 203).

According to this account, the bees were brought from Habhu, identified as a place in the vicinity of the Zagros Mountains in Iran or the eastern Taurus Mountains, about four hundred kilometers north of his seat. It is possible that in this case, too, the imported bees were Anatolian. This text sheds light on the plausibility of importing bees from faraway during the Iron Age.

The significance of the apiary is also evident from the cultic rituals that were carried out within its confines. Two finds attest to this practice: a four-horned altar decorated with two naked female figures (perhaps fertility goddesses) flanking an incised tree (Fig. 10) and a richly decorated tall chalice with petals. The cult practices must have been intended to increase the yield of the apiary. The affiliation between cultic practice and industry was common in the ancient world as attested in several cases such as copper-mining sites (in Timna in southern Israel and in Cyprus) and in olive oil industry (at Tel Migne-Ekron). Remarkably, the biblical laws forbid burning offerings containing honey on altars (Leviticus 2:11); could it be that this was a common practice, as might have been conducted at the Tel Reḥov apiary, which was proscribed in a later period because it was regarded as foreign?

A storage jar bearing the inscription *Inmš*, meaning Belonging to Nimshi was found in the apiary. The name *nmš* (Nimshi) also appears in an inscription from the subsequent 9th century BCE stratum at Tel

Reḥov, as well as on a jar from a 10th–9th centuries BCE occupation layer at Tel 'Amal, situated 6 km northwest of Tel Reḥov¹⁸. Nimshi is mentioned in the Bible as the father or grandfather of Jehu, founder of the dynasty whose rise to power ensued the fall of the Omride dynasty in 842 BCE (1 Kings 19:16; 2 Kings 9:2, 14, 20). The threefold recurrence of the name in the same region during the same time period leads to the assumption that the Nimshi family was one of influence and prominent status at Tel Reḥov, which may have also been the family's seat, being the largest and most significant city in the region during this period. Moreover, we suggest that the Nimshi family may have also been the one to build the apiary and profit from it.

One of the questions raised by the discovery is why was the apiary located within the confines of the densely built and populated city? Experts estimate that a traditional beehive of the type found at Tel Reḥov consists of 10,000–15,000 bees at the peak of activity. If indeed there were 100 active hives, the number of bees in the city would have reached a million to a million and a half! How is urban life maintained under these conditions? This question is not a simple one to answer. Written sources (particularly Roman and Talmudic ones), as well as ethnographic observations, show that, indeed, bees have been often raised near dwellings and that their residents apparently grow accustomed to living in proximity to apiaries. Since beehives were considered as production facilities of valuable commodities, safeguarding and maintaining them must have been important factors that led to their positioning close to dwellings within the city limits. It appears that only a centralized royal or municipal governing body or a powerful local family (such as the Nimshi family at Tel Reḥov) could have initiated such an enterprise, set it up, and imposed it on the city's inhabitants. This has implications for our understanding of the social and economic systems in this early stage of the Israelite Monarchy.

As to the economic value of the apiary's products, I raised the hypothesis that the beeswax, rather than the honey, was a major high value product. Beeswax was crucial for the 'lost-wax' metal casting method. As we now know, the large scale copper mines at Khirbat en-Nahas in Fainan, at the foot of the Edom mountain range of Jordan, and in Timna in the Arabah Valley, were operating on an unprecedented scale during the 10th and first half of the 9th centuries, 18 Ahituv and Mazar 2014 inscription No. 5; Mazar 2016: 90, fig. 82.



Fig. 10 A pottery altar with four horns found in the apiary.

which correspond with the activity of our apiary¹⁹. Could it be that industrial apiaries of the type found at Tel Reḥov served a copper industry that existed somewhere in the Kingdom of Israel? Biblical tradition tells of the splendid copper utensils installed in Solomon's temple in Jerusalem: "The king had them cast in the ground in the plain of the Jordan between Sukkoth and Zarethan" (1 Kings 7:46). Sukkoth and Zarethan are identified as sites in the central Jordan Valley, 15–35 km south of Tel Reḥov. Even if the story does not faithfully reflect historical reality, it may echo a historical memory about a metal industry that existed during that period in the central Jordan Valley, not far from Tel Reḥov. While this is an intriguing hypothesis, it cannot be proved.

It is difficult to assess how long the beehives were in use. They did, however, meet their end in a fierce conflagration, and structures that were completely different in plan were constructed on their ruins in the subsequent stratum (Stratum IV, 9th century BCE). The destruction of the apiary and the fact that it was not subsequently reconstructed indicate that it was considered extraneous to the city's life. We do not know who or what the agent of destruction and

19 Levy, Najjar and Ben-Yosef 2014; Ben Yosef 2012.

conflagration was. Evidence from a paleo-magnetic study conducted by Dr. Erez Ben-Yosef indicates a possibility that it was an earthquake that destroyed the area of the apiary, starting fire and bringing down the mud-brick walls surrounding the apiary. As mentioned above, radiocarbon dates from this area point to a date at the close of the 10th century or the beginning of the 9th century BCE²⁰. In any event, it seems that many commoners in the city were happy to see the apiary in flames.

Tel Reḥov apiary is a unique archaeological find; its interdisciplinary exploration involves research in the fields of natural sciences and ethnography, combined with the study of textual and iconographic sources from the Ancient Near Eastern, as well as biblical sources. These intertwine create a comprehensive picture, telling the tale of an aspect of ancient economy that was until recently obscure.

20 Previously we attributed this destruction to the conquest of the city by Shoshenq I (biblical Shishak) ca. 920 BCE (Bruins, Van der Plicht and Mazar 2003). However later excavation seasons have indicated that this was a local destruction, not found elsewhere in the city.

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Abbreviations

BASOR Bulletin of the American Schools of Oriental Research.

JNES Journal of Near Eastern Studies.

PNAS *Proceedings of the National Academy of Sciences of the United States of America.*

THE QUEST FOR THE PERFECT HIVE: ANCIENT MEDITERRANEAN ORIGINS

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Abstract

Humans in the Mediterranean region have been interacting with bees for 8,000 years, as documented by rock wall paintings in Spain. Tantalizing evidence has suggested that large quantities of beeswax were used for lost wax casting of a variety of objects found near the Dead Sea dating to 3500 BCE. The oldest archaeological evidence of providing honey bees with artificial cavities (the first human-created bee hives) is found in Egypt's Fifth Dynasty of the Old Kingdom. These Egyptian reliefs illustrate that beekeeping at this time was already a complex process, supporting the hypothesis that beekeeping's origin was much earlier. These first documented hives were horizontally stacked tubes constructed from dried mud. Depictions and inscriptions from Egypt's Middle and New Kingdoms suggest that by this time, beekeeping was an occupation controlled by the state. As beekeeping spread throughout the region, the materials used to build beehives expanded to include wood in the form of hollowed-out logs or boxes made from cut boards, cork, earthenware, woven wicker, or fennel stalks. By the end of the Middle Ages, the necessary innovations that led to rational beekeeping were in practice in the Mediterranean region.

Humans have been interacting with honey bees long before we developed beekeeping. Chimpanzees have been observed to tear into wild colonies of bees to get to the honey and the grubs. It has also been observed that they will modify branches to aid in the robbing of the bees, and even to carry the modified sticks around with them. The chimpanzees' dense covering of fur helps to protect them from the many stings that their robbing may have elicited. It seems probable that our ancestors would have indulged in



Fig. 1 The rock wall painting of honey hunting in Bicorp, Spain.

this behavior as well, and if this behavior developed before humans and chimpanzees diverged some 6–7 million years before present, then our association with bees would have begun even before we became *Homo sapiens*¹.

The oldest direct evidence of our interactions with bees comes from a rock wall painting in eastern Spain near Bicorp. This Mesolithic painting, which dates back approximately 8,000 years, shows a honey hunter suspended from a rope and robbing a wild colony while bees swarm around him or her (**Fig. 1**). Robbing bees is not beekeeping; rather, it is an opportunistic activity carried out to take advantage of a calorie-rich food².

True beekeeping requires us to provide the bees with an artificial cavity in which they can build comb, rear their young, and produce honey. When this was

¹ Boesch et al. 2009.

² Kritsky 2010, p. 11.



Fig. 2 The beekeeping bas-relief from Newoserre Any's sun temple.

first discovered is unknown, but there is indirect evidence that large quantities of beeswax were being used around 3500 BCE in what is now Israel. In 1961, over 400 objects were found under a mat in a cave near the Dead Sea. Among these objects were copper vessels that were made using the lost wax casting process, which involves making a beeswax model of a desired object and pressing it into a mold made of moist sand or clay. The clay mold was heated to melt and burn away the wax, and molten copper would then be poured into the mold to produce a copper version of the wax model. However, the use of beeswax does not document that beekeeping was being practiced, as the wax could have been obtained by robbing wild colonies³.

The first direct evidence of beekeeping dates back to the 5th Dynasty of ancient Egypt, around 2450 BCE. About a century after the construction of the Great Pyramid, Pharaoh Newoserre Any built his sun temple, Shesepibre (the Delight of Re). In 1898, in a room adjacent to the central obelisk, Ludwig Borchardt discovered what he called "The Chamber of the Seasons" because it contained reliefs of activities that occurred at specific times of the year, and one of the reliefs he found is the oldest evidence of beekeeping (**Fig. 2**)⁴.

The bas-relief, from left to right, shows four scenes: a beekeeper working with the hives, three men pouring honey into vessels, two men further processing honey (this scene is mostly missing), and a beekeeper sealing honey in a vessel for storage. The hives being used were horizontal tube hives that were slightly tapered at the ends. The entire relief is

described in detail in Kritsky⁵.

The beekeeping relief in Newoserre Any's sun temple does not shed light on the origins of Egyptian beekeeping. It does show that beekeeping was well established during Egypt's Old Kingdom, and given its illustration in the temple, that beekeeping was an important occupation. There is considerable archaeological evidence that beekeeping's status remained high throughout Egypt's history. In the British Museum in London is a Middle Kingdom scarab with the title of "Chief Beekeeper" inscribed on its base⁶. In the New Kingdom tomb of Rekhmire, an 18th Dynasty vizier, there is a painting showing the harvesting of round honey combs from large horizontal hives, the crushing of the comb, the pouring of the honey into large vessels, and the subsequent sealing of the honey in diamond-shaped vessels (**Fig. 3**)⁷.

One of the most famous beekeeping reliefs in Egypt is from the 26th Dynasty tomb of Pabasa. This relief shows the beekeeper with his hands held up in praise, facing a swarm of honey bees and a series of horizontal hives (**Fig. 4**)⁸. These horizontal hives are more similar to the hives carved in the Old Kingdom relief from Newoserre Any's sun temple than they are to the hives from Rekhmire's tomb. They also document the continued value that the Egyptians placed on honey and honey bees, and the type of hives that were being employed at the time.

There is considerable evidence that beekeepers

⁵ Ibid, p. 9–13.

⁶ Martin 1971.

⁷ Kritsky 2015, p. 29–32.

⁸ Ibid, p. 47–53.



Fig. 3 New Kingdom beekeeping painting in Rekhmire's tomb.



Fig. 4 The beekeeping relief in the 26th Dynasty tomb of Pabasa. Photograph by Gene Kritsky.

were organized into an administrative structure in ancient Egypt. Several specific beekeeping titles have been documented, ranging from beekeeper through chief beekeeper, overseer of the beekeepers, and overseer of the beekeepers of all the lands, and including sealers of honey, collectors of honey, and temple beekeepers. The implied hierarchy of the titles and the existence of a scene showing beekeeping activities being supervised by the vizier (essentially the prime minister, who in turn answered to the pharaoh) document that beekeeping was a state-run enterprise that was important to Egyptian society⁹.

Horizontal hive beekeeping was not restricted to Egypt in the ancient world. At Tel Rehov, in present-day Israel, Amihai Mazar and his colleagues from the Hebrew University in Jerusalem discovered beehives dating to between 800–900 BCE (Mazar and Panitz-Cohen 2008). These hives were somewhat similar in proportion to the hives illustrated in Rekhmire's tomb. Whether the similarities represent an exchange of beekeeping practices between Egypt and Tel Rehov is unknown, but Tel Rehov is mentioned in Egyptian reliefs going back to the 18th Dynasty, and the town remained loyal to Egypt during the reign of Seti I in the Nineteenth Dynasty, when other towns were rebelling. It is also mentioned in the relief of Shoshenq I's campaign of victories in Palestine at Karnak Temple in Upper Egypt¹⁰.

By 400 BCE, horizontal pottery hives were widely used in Greece (Fig. 5). The interior of these hives was incised with patterns of grooves to aid in the attachment of the comb to the hives. The pottery lid of the hive included a small bee entrance, and was affixed to the hive body with a stick fastened to the front of the hive with rope or leather thongs tied around the lip of the hive¹¹. Pottery extension rings

⁹ Ibid, p. 76–77.

¹⁰ Ibid, p.43–44.

¹¹ Jones et al. 1973.



Fig. 5 400 BCE pottery beehive from Greece. Photograph by Gene Kritsky.

would be placed between the hive and the lid if the hive needed to be enlarged. As in Egypt, the origins of beekeeping in Greece likely date to long before these hives were made. A small pottery smoker (Fig. 6) found in Sesklo, a Neolithic village in central Greece, dates to at least 3300 BCE. However, hives were not found at the site and the smoker (if that was its actual purpose) may have been used for robbing bees.

No hives survive from Ancient Rome, but Roman authors did record that horizontal hives were constructed of local materials. Varro¹², writing in the second century CE, recorded the following:

Some build round hives of withies (wicker) for the bees to stay in, others of wood and bark, others of a hollow tree, others build of earthenware, and still others fashion them of fennel stalks, building them square, about three feet long and one foot deep, but making them narrower when there are not enough bees to fill them, so that they will not lose heart in a large empty space. All such hives are called *alvi*, 'bellies,' because of the nourishment (*alimonium*), honey, which they contain; and it seems that the reason they are made with a very narrow middle is that they may imitate the shape of the bees. Those that are made of withies are smeared, inside and out, with cow-dung, so that the bees may not be driven off by any roughness; and these hives

¹² Varro 1934.



Fig. 6 A small pottery smoker from Sesklo. Photograph by Gene Kritsky.

are so placed on brackets attached to the walls that they will not be shaken nor touch one another when they are arranged in a row. In this method, a second and a third row are placed below it at an interval, and it is said that it is better to reduce the number than to add a fourth. At the middle of the hive small openings are made on the right and left, by which the bees may enter; and on the back, covers are placed through which the keepers can remove the comb. The best hives are those made of bark, and the worst those made of earthenware, because the latter are most severely affected by cold in winter and by heat in summer.

Varro's account is the possibly the earliest record of square or box hives being used, but that does not suggest that round horizontal hives had fallen out of favor. Illuminated manuscripts over the next thousand years document that beekeepers were using horizontal boxes, upright boxes, horizontal round hives, and upright hives made of cork. Wicker skeps were likely in use in more northern regions^{13,14}.

These various hives were not simply an end in themselves. Eva Crane argued that modern beekeeping developed in stages starting with rectangular box hives, tightly fitted upright box hives, the use of bars, the use of frames, and ending with the careful spacing of the frames in the hives¹⁵. The horizontal hives used by the ancient beekeepers of the Fertile Crescent and Greece were the precursors of the rectangular box hives described by Varro from ancient Rome. Hives made from boards were in use

¹³ Crane 1999.

¹⁴ Kritsky 2010.

¹⁵ Crane 1999.

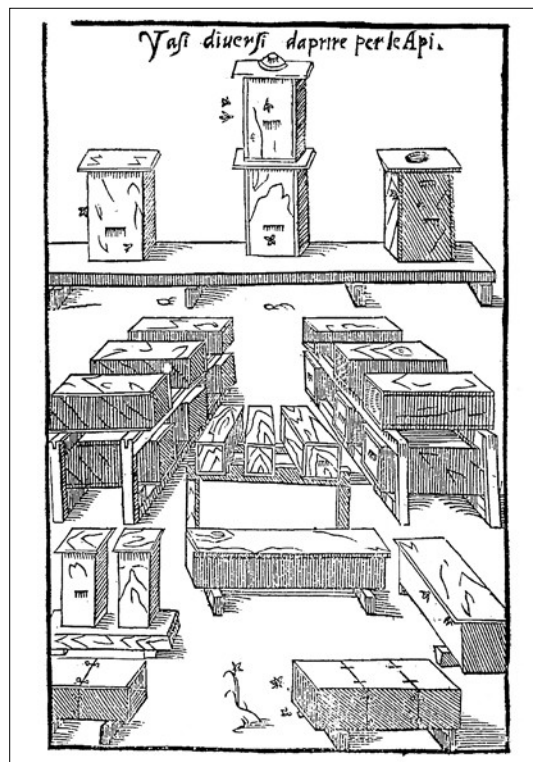


Fig. 7 Upright and tightly fitted box hives as illustrated in 1596.

by the 11th century and beekeepers in Italy stacked tightly fitted boxes in the 16th century (Fig. 7)¹⁶, satisfying the second stage as described by Crane¹⁷.

The oldest use of bars was by the Greeks, whose hive was illustrated by Wheler in 1682 (Fig. 8)¹⁸. The Grecian hive was a basket hive that tapered from a wider opening at the top to a narrower base. Across the top were placed wooden slats to which the bees attached their comb. The bees treated the inward-sloping sides of the basket as the bottom of the hive and did not attach the comb to the sides of the basket, making it a simple process to lift the bar and the attached comb from the hive. This was being practiced by the 17th century, but when it began is a matter of speculation. Pots of the same shape as the basket illustrated by Wheler were known dating back to 400 BCE. However, there is no unequivocal evidence that suggests that upright pottery hives

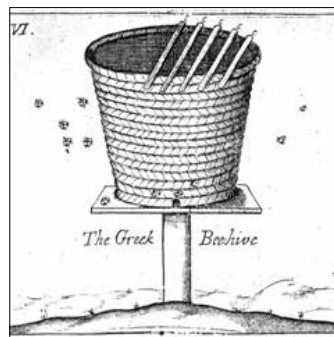


Fig. 8 The Greek hive as illustrated by Wheler in 1682.

date that far back¹⁹. Regardless of when the use of bars began, their use was not widely known outside of the Mediterranean region until the 17th century. A frame for use inside a hive was described by a beekeeper known as J.A. in 1683, but they were not in common use until the 19th century. Innovative beekeepers in the Ukraine, Germany, France, England, and the United States incorporated frames in a variety of hives, before L. Langstroth incorporated the critical spacing in 1851 that resulted in the moveable frame hive^{20, 21}.

The first three innovations that were required for the development of modern beekeeping -rectangular box hives, tightly fitted upright box hives, and the use of bars- were developed by Mediterranean beekeepers whose knowledge of bees dated back to antiquity. Even though the use of frames and spacing developed in other parts of the world, the first steps towards modern beekeeping had a Mediterranean origin.

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Wheler, G. 1682. *A journey into Greece*. W. Cademan and others, London.

16 Gallo 1596.

17 Crane 1999.

18 Wheler 1682.

19 Crane 1999.

20 Crane 1999.

21 Kritsky 2010.

KINGS AND QUEENS OF THE BEES IN THE LITERARY AND THE SCIENTIFIC TRADITION

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The subject of this paper has its origins in the presentation two of the authors had made at the three-day conference on beekeeping held at Nikiti, Greece in 1996 in honour of Dame Eva Crane.

We had presented an excerpt from the *Synagoge* (Collection) by the 4th century AD mathematician Pappus Alexandrinus who, while discussing the isoperimetric problem, makes an extended reference to bees and the hexagonal cells that they construct. The fact that Pappus mentions a queen of the bees aroused the interest of Dame Eva Crane who wondered whether Pappus was implicitly contradicting Aristotle who, notoriously, speaks of a king of the bees. In our publication we claimed that Pappus was simply using a literary *locus communis*, the comparison of industrious people to bees, imitating classical authors and specifically Xenophon, and was in no way interested in the biology of bees¹.

In the present paper we wish to stress in more detail the difference between the literary tradition on the one hand and the scientific tradition within which Aristotle was working on the other. We argue that Aristotle attempted to describe the biology of bees as accurately as was possible with the restricted means at his disposal, and that he did not make any conjecture that was not based on the observations of the beekeepers who were his main sources. On the contrary, literary references to bees belong in a

1 Gousiaris, A. and M. Deliyannis, "Το ισοπεριμετρικό πρόβλημα και η μέλισσα. Πάππος ο Αλεξανδρεύς", in Η μέλισσα και τα προϊόντα της, Αθήνα, ΠΤΙ ΕΤΒΑ 2000, σ. 104-111. We sent a translation of our paper to Dame Eva Crane who graciously incorporated our conclusions in her book (Crane 2000, p. 569, 590).

tradition dating back to Homer and the writers who follow it are not interested in the biology of the bees but in the beauty and persuasiveness of their work. We claim that literary references to bees do not always reflect accurate scientific or practical knowledge but literary influences and should therefore not be taken at face-value as indicators of such knowledge. We try to corroborate this claim by tracing the most common literary *topoi* related to bees, with special reference to the gender of the queen, from Homer to classical literary prose-writers like Xenophon and Plato. We go on to discuss the rift between the scientific and the literary tradition that was made explicit in the Hellenistic period and which applies even to didactic poetry. Finally, we argue that the bee-related literary *topoi* of Greek literature were passed on to Virgil and through him to early modern authors such as Shakespeare who used them for literary purposes although they were at odds with contemporary knowledge of bees.

Bees in the literary tradition before Aristotle

Man's very ancient relationship to bees is attested by archaeological findings worldwide. The invaluable properties of honey and wax were appreciated early on and men soon turned from honey-gathering to beekeeping. However, the people who could handle bees were always a small minority. Non-beekeepers could only watch from a distance. What they saw was a disciplined community with a hierarchical organisation and division of labour, producing two invaluable goods.

The great usefulness of wax and honey induced people to ascribe divine properties to the bees. Greek mythology is full of stories with bees, the most well-

known being the bees that fed Zeus when, as an infant, his mother Rhea had hidden him on Mount Ida. Moreover, the order and productivity of the apian community was the origin of a rich literary tradition of metaphors relating the beehive to human societies. In the first extended simile of the *Iliad*, Homer (8th cent. BC) compares the Achaean warriors leaving the ships to attend an assembly to a swarm of bees leaving their hive in search of flowers:

From the camp the troops were turning out now, thick as bees that issue from some crevice in a rock face, endlessly pouring forth, to make a cluster and swarm on blooms of summer here and there, glinting and droning, busy in bright air.

Like bees innumerable from ships and huts down the deep foreshore streamed those regiments toward the assembly ground.

Iliad II 86-93, trans. Robert Fitzgerald

Hesiod (7th cent. BC), for whom women are descendants of Pandora (whose name he glosses as "she who received gifts from everyone" in *Works and Days* 81-82) compares them to drones, who live at the expense of the industrious bees:

For from her is the race of women and female kind: of her is the deadly race and tribe of women who live amongst mortal men to their great trouble, no helpmeets in hateful poverty, but only in wealth. And as in thatched hives bees feed the drones whose nature is to do mischief - by day and throughout the day until the sun goes down the bees are busy and lay the white combs, while the drones stay at home in the covered hives and reap the toil of others into their own - even so Zeus who thunders on high made women to be an evil to mortal men, with a nature to do evil.

Theogony 591-602, trans. G. Evelyn-White

Drones are mentioned again in *Works and Days*, as useless members of a community:

Both gods and men are angry with a man who lives idle, for in nature he is like the stingless drones who waste the labor of the bees, eating without working;

Works and days 303-306, trans. G. Evelyn-White; the passage is also cited by Plato, *Laws* 901a

It is clear from these passages that grammatical gender does not influence the poets' use of bees in their similes. In the passages from the *Iliad* and the *Theogony* the (grammatically) feminine bees are compared to warriors or industrious men, whereas the (grammatically) masculine drones are compared to idle women. In the passage from *Works and Days* drones are compared to lazy men. The deciding factor is not grammatical or biological gender but the image of the swarming army in Homer's case and the contrast between industrious and idle people, regardless of whether they are male or female, in Hesiod's.

These two passages are also important because this is where we encounter for the first time the two commonest *topoi* referring to bees in ancient Greek literature: the bees as an army on the one hand, and the drones as useless and burdensome members of a community on the other².

We see soldiers compared to bees again in Aeschylus (525-455 BC). Now, however, the bees, just like the army, have a leader:

For all the men-at-arms, those who urge on steeds and those who march along the plain, have left the city and gone forth, like bees in a swarm, together with the captain of the host³.

(*Persae* 126-129, trans. Herbert Weir Smith)

The same simile of the Persian king as king of the bees is found in Xenophon (430-354 BC), who uses it to stress Cyrus' innate leadership qualities:

"Listen to me," he said, "O king! For king I take you to be by right of nature; even as the king of the hive among the bees, whom all the bees obey and take for their leader of their own free will; where he stays they stay also, not one of them departs, and where he goes, not one of them fails to follow; so deep a desire is in them to be ruled by him. Even thus, I believe, do our men feel towards you. Do you remember the day you

2 Brock (2013), p. 159.

3 The fact that Aeschylus uses this simile specifically for the Persian army and king might reflect Persian notions of the natural superiority of the monarch. On this, see Brock (2013), p. 160 and n. 133.

left us to go home to Persia? Was there one of us, young or old, who did not follow you until Astyages turned us back⁴?

(*Cyropaedia* 5.1.24-25, trans. H. G. Dakyns)

Xenophon uses this simile again to refer to a Greek leader:

When the people came to discover that their hero was not dead, they crowded round his house this side and that, like a swarm of bees clinging to their leader.

(*Hellenica* 3.2.28, trans. H. G. Dakyns)

And once again in the *Oeconomicus* where, however, the king-bee has become a queen-bee, the soldiers have become maidservants and the hive stands for a well-run household presided over by a good wife:

"And what sort of works are these?" she asked; "what has the queen-bee to do that she seems so like myself, or I like her in what I have to do?"

"Why," I answered, "she too stays in the hive and suffers not the other bees to idle. Those whose duty it is to work outside she sends forth to their labours; and all that each of them brings in, she notes and receives and stores against the day of need; but when the season for use has come, she distributes a just share to each. Again, it is she who presides over the fabric of choicely-woven cells within. She looks to it that warp and woof are wrought with speed and beauty. Under her guardian eye the brood of young is nursed and reared; but when the days of rearing are past and the young bees are ripe for work, she sends them out as colonists with one of the seed royal to be their lead-

er [...]Think you, my wife, it is through some such traits of forethought seen in their mistress-leader that the hearts of bees are won, and they are so loyally affectioned towards her that, if ever she abandon her hive, not one of them will dream of being left behind; but one and all must follow her."

(*Oeconomicus* 7.32-38, trans. H. G. Dakyns)

A comparison of the three passages of Xenophon shows that the writer is not interested in whether the bees have a male king or a female queen or whether the bees themselves are male or female. He is simply employing a literary convention already sanctioned by Homer, Hesiod and Aeschylus, adapting it according to the needs of each specific work. This view is supported by the fact that in the passage of the *Oeconomicus* following the one just cited the wife answers:

It would much astonish me (said she) did not these [king]'s works (τα του ηγεμόνος έργα), you speak of, point to you rather than myself. Methinks mine would be a pretty guardianship and distribution of things indoors without your provident care to see that the importations from without were duly made.

(*Oeconomicus* 7.39, trans. H. G. Dakyns)

In the same work Xenophon also uses the drone-simile first attested in Hesiod, but not to refer to people but to weeds that live at the expense of plants in a field and should be pulled out:

'What if weeds are springing up, choking the corn and robbing it of its food, much as useless drones rob bees of the food they have laid in store by their industry?'

'The weeds must be cut, of course, just as the drones must be removed from the hive.'

(*Oeconomicus* 17.14)

Plato (428/427 or 424/423 – 348/347 BC), a contemporary of Xenophon whose philosophical writings are also noted for their literary value, uses the same literary conventions when, in the *Republic*, he mentions leaders who are nurtured by the state like king-bees in the hive:

For we will say to them that it is natural that men of similar quality who spring up in

other cities should not share in the labours there. For they grow up spontaneously from no volition of the government in the several states, and it is justice that the self-grown, indebted to none for its breeding, should not be zealous either to pay to anyone the price of its nurture. But you we have engendered for yourselves and the rest of the city to be, as it were, king-bees and leaders in the hive. You have received a better and more complete education than the others, and you are more capable of sharing both ways of life.

(*Republic* 520b-c, trans. Paul Shorey)

And, in the *Statesman*:

But, as the case now stands, since, as we claim, no king is produced in our states who is, like the ruler of the bees in their hives, by birth pre-eminently fitted from the beginning in body and mind, we are obliged, as it seems, to follow in the track of the perfect and true form of government by coming together and making written laws.

(*Statesman* 301d-e, trans. Harold N. Fowler)

In the *Republic*, dangerous or useless members of society are compared to drones who should be excised from the polity, like drones from a hive:

May we not say that this is the drone in the house who is like the drone in the honeycomb, and that the one is the plague of the city as the other is of the hive? [...]And God has made the flying drones, Adeimantus, all without stings, whereas of the walking drones he has made some without stings but others have dreadful stings; of the stingless class are those who in their old age end as paupers; of the stingers come all the criminal class, as they are termed.[...]These two classes are the plagues of every city in which they are generated, being what phlegm and bile are to the body. And the good physician and lawgiver of the State ought, like the wise bee-master, to keep them at a distance and prevent, if possible, their ever coming in; and if they have anyhow found a way in, then he should have them and their cells cut out as speedily as possible.

(*Republic* 552c-564c, trans. Benjamin Jowett)

In these passages, Plato's references to king-bees and useless drones may reflect beliefs current in his time but also adherence to the time-honoured literary conventions mentioned above.

The scientific tradition: Aristotle on the generation of bees

Aristotle (384-322 BC), Plato's pupil and founder of the fact-based scientific method (Lesky 1966, p. 547) had written works intended for a wider public (the so-called "exoteric" or "published" works), of which only the titles survive (cf. Lesky 1966, p. 552ff.). These works had literary merit enough for Cicero to praise the "golden river" of their author's language. The works that have been transmitted to us, however, are based on his teaching at the Peripatos, were composed over a long period of time as new evidence became available and were not considered stylistically accomplished and therefore were only appreciated by a narrow circle of specialists (Norden 1983, p.1). Moreover, these works belonged in a scientific, not a literary tradition. According to Peck (1943, p. xvi) "[Aristotle's] work was a continuation and an expansion of what had been begun by previous scientific workers. Those to whom he most frequently refers by name are three: Anaxagoras, Empedocles, and Democritus, besides several references to theories which can be traced in the Hippocratic treatises". It comes as no surprise, then, that in his discussion of bees we find no elements of literary conventions, but only theories based on evidence collected "on the field" and culled mainly from beekeepers.

Aristotle's most extended references to bees are found in his *Histories of Animals* (HA) and *Generation of Animals* (GA). In the former, where he mainly describes the behaviour of bees, he repeatedly refers to beekeepers, an indication that they were his main source of information. Some such instances are:

... when the beekeeper started killing them, other bees came out to attack him... (HA 623b15); beekeepers call this "dusting" (HA 623b30); when beekeepers remove the combs they leave food for the bees (HA 626a1); beekeepers chase away the frogs (HA 626a10); beekeepers chase wasps (HA 627b5); this warns beekeepers that a storm is coming (HA 627b5); when beekeepers realise this, they spray the beehive with sweet wine; some beekeepers recognise

4 For the persistence of this *topos* cf. Shakespeare *Titus Andronicus* act 5, Scene 1:

Brave slip, sprung from the great Andronicus,
Whose name was once our terror, now our comfort:
Whose high exploits and honourable deeds
Ungrateful Rome requites with foul contempt,
Be bold in us: we'll follow where thou lead'st,
Like stinging bees in hottest summer's day
Led by their master to the flowered fields...

their own bees when they are at pasture because they have sprinkled them with flour (HA 627b15).

Aristotle's systematic collection of evidence from beekeepers led him to several correct conclusions about the behaviour of bees. For instance, he accurately describes cell size, bee castes, the division of labour in the hive, the construction and use of the combs, the collection of propolis and pollen, wax moths, the existence of pillaging bees, swarming and its preparation, beekeepers' harvesting techniques, wintering, bee diseases and their cures, bees driving away and killing drones in difficult circumstances, enemies of the bees, the behaviour of the bees near and far from the hive, the unwillingness to collect leftover honey, the transportation of dead bees outside the hive, the ability of bees to use their sting to defend themselves against large animals (HA 623b-627b). Most importantly, he was the first to describe flower constancy as well as the dance of the bees, although he was unaware of its function⁵ (HA 624b).

Naturally, since the means of observation at the disposal of Aristotle and the beekeepers who were his sources were limited, he also reached many erroneous conclusions. He mentions, e.g., that bees do not inhale air (HA 487a); that they collect honey instead of producing it (HA 553b, 554a, GA 759a – although HA 623b seems to suggest that they do produce it); that there are unproductive hives “with bad leaders and many drones” (HA 625a), that in windy weather bees carry a small stone as ballast (HA 625a); that when bees harvest thyme they add water before sealing the comb (HA 627a); that a hive may have two or more kings (HA 554b); that bees live six to seven years (HA 553b).

His gravest error, however, is thought by many to be his inability (or unwillingness) to realise that the queen bee is actually female⁶. It is true that in GA and HA Aristotle refers to the leaders of the bees as kings (“*basileis*” or “*hegemones*”). A closer look at what he actually wrote, however, shows that he does not believe that they are male either. Moreover, his failure to recognise queen bees as female does not stem

5 The function of the bee-dance as a means of communication was elucidated in the 1940s by Max von Frisch, a discovery that earned him the Nobel Prize in 1973.

6 For a detailed discussion and a convincing refutation of these accusations see Mayhew (2004), pp. 19–27.

from bias but from his refusal to accept anything not corroborated by observation.

Aristotle mentions the generation of bees in HA553a17ff. where he says that not everyone agrees on how bees reproduce: some say that they do not copulate but collect their young (γόνον) from flowers; others say that they only collect the young of the drones, whereas bees are born from the kings (whom some call “mothers” because they give birth; cf. 553b17 where he again reports that kingless hives perish because, according to some, kings contribute to the generation of bees), because drones can be born even without the presence of the king, whereas bees cannot; and others say that they copulate, and that bees are female and drones male.

The main discussion of the generation of bees, however, is found in GA759a-760b. Here, Aristotle begins by admitting that “the generation of bees is a great puzzle” and announcing his conclusion that bees are possibly generated, like some fishes, without copulation, a conclusion, as he says, based on “the *phainomena*” (ἐκ τῶν φαινόμενων, 759a11). He goes on to analyse these *phainomena*, while at the same time discussing other current theories and rejecting them as impossible. He thus rejects the notion that bees do not give birth but collect their offspring from flowers, on the grounds that (a) if this offspring grew spontaneously on the flowers it would grow into bees regardless of whether the bees took it to their hives or not, which is not the case; and (b) if bees collected offspring generated by some other animal, it would grow into the generating animal and not into a bee. He thus reaches the conclusion that bees generate their offspring themselves.

He then addresses the question of how this offspring is generated and by which of the three subkinds into which he has classified the bees, i.e. the worker bees, the kings and the drones⁸. The possibilities are: (a) each kind generates its own kind, or (b) one kind generates all the others. Here Aristotle, in “a remarkable piece of analysis”⁹ arrives at the correct solution, guided by the evidence culled from 7 Rendered as “what appears to be the case” by Barnes (1984), as “appearances” by Peck (1943).

8 In HA 623b8-14 Aristotle classifies insects that build combs in nine genera; six gregarious: the bee, the king of the bees, the drone who lives among the bees, the wasp, the anthrine and the tenthradon; and three solitary: the small siren, the large siren and the bombylius who is the largest of them all. On this subdivision of bees see Mayhew (2004) p. 20 n.4.

9 Peck (1943), p. ix.

beekeepers. This evidence amounts to the following: (a) drones are born even if there are no drones in the hive; (b) worker bees are not born if there are no “kings” in the hive; from this he deduces that bees give birth to drones and that kings give birth to kings and worker bees. The question whether this is done with or without copulation and if with copulation then between which of the subkinds is more problematic, because there the evidence is lacking. His beekeeper sources have never observed copulation between any of the subkinds (GA 759b23 “none of them has ever been seen in the act of copulation” trans. A.L. Peck). He therefore concludes that bees and “king-bees” generate without copulation, “something parallel to what we find occurs with certain fishes” (GA759b28, trans. A.L. Peck)¹⁰. As to the gender of these generating animals, their morphological characteristics lead him to conclude that they are neither male nor female, or that they are both: “although, as far as generating is concerned, they are female, yet they contain in themselves the male as well as the female [factor], just as plants do” (GA 759b29-31, trans. A.L. Peck). On the other hand, he knows that copulation has often been observed among the insects most closely related to the bees, i.e. the wasps. Thus, he has no difficulty accepting that the leaders of the wasps generate by copulation. This, however, does not lead him to the conclusion that they are female either.

In HA 628a17 we read “the leader, the so-called mother-wasp” (Balme’s translation of “ο ηγεμών η καλουμένη μήτρα”, where the Greek word for “leader”, or “king”, is masculine, and the same word that Aristotle uses for the leaders of the bees). In the subsequent discussion he uses the terms “kings” and “mother-wasps” interchangeably for the leaders of the wasps. In GA 761a6-8 he says that the “so-called mother-wasps” generate by copulating with each other, and that this copulation has often been observed. And a few lines above (GA 761a3-5), he states that the only difference between the generation of bees and that of similar animals such as hornets or wasps is that bees generate without copulation. And, in his only departure from observation-based argument, he ascribes this difference to the fact that hornets and wasps “contain no divine ingredient as 10 Jan Swammerdam, who “was the first to describe the egg-laying function of the queen, and the anatomical differences between queen, worker and male larvae and nymphs” did not realise that queens copulate and, like Aristotle, concluded that bees do not copulate, and that “the male Bees eject their sperm in the same manner as Fishes, who only shed it upon the spawn” (<http://www.janswammerdam.org/bees.html>).

the tribe of bees does” (GA 761a5-6, trans. A.L. Peck). That Aristotle did not consider the matter closed but expected his theory to be refuted or confirmed by further evidence is made clear in the much-quoted passage in GA760b30f.: “But the facts have not yet been sufficiently ascertained; and if at any future time they are ascertained, then credence must be given to the direct evidence of the senses rather than to theories—and to theories too provided that the results which they show agree with what is observed.” (trans. A.L. Peck).

Science and literature after Aristotle

It is no surprise that Aristotle’s counter-intuitive conclusion that queen-bees (and queen-wasps) were neither male nor female did not influence everyday knowledge. If beekeepers had observed (as Aristotle notes) that queen-bees gave birth, they would naturally have assumed that they were female, and this practical knowledge eventually affected common linguistic usage. This is attested in two passages from Arrian (c. AD 86/89 – after 146/160) and one from *Joseph and Aseneth*¹¹, a pseudepigraphical biblical story expanding a reference in the Book of Genesis and variously dated between the 1st century BC and the 5th century AD.

And Megasthenes says that this oyster is taken with nets; that it is a native of the sea, many oysters being together, like bees; and that the pearl oysters have a king or queen, as bees do. Should anyone by chance capture the king, he can easily surround the rest of the oysters;

Arrian *Historia Indica* 8.2 (trans. E. Iliff Robson)

For who are you? are you the bull of the herd, or the queen of the bees? Show me the tokens of your supremacy, such as they have from nature. But if you are a drone claiming the sovereignty over the bees, do you not suppose that your fellow citizens will put you down as the bees do the drones?

Arrian *Epicteti Dissertationes* 3.22.99 (trans. T.W. Higginson)

And all the bees flew in circles round Aseneth, from her feet right up to her head; and yet more bees as big as queens, settled

11 We are indebted to Harissis et al. (2012) for this reference.

on Aseneth's lips.

Joseph and Aseneth 16.14 (trans. D. Cook)

In approximately the same period, however, Dio Chrysostom (c. 40 – c. 115 AD) has the philosopher Diogenes advising Alexander that a true king need not display emblems of his office in order to be obeyed by his subjects; the example he uses to illustrate this is the king of the bees (βασιλεύς), who is obeyed by his subjects although he is the only bee that has no sting.

Thus spoke Diogenes, counting it as nothing that he might be chastised, yet quite convinced that nothing would happen. For he knew that Alexander was a slave of glory and would never make a bad move where it was at stake. So he went on to tell the king that he did not even possess the badge of royalty. And Alexander said in amazement, «Did you not just declare that the king needs no badges?» «No indeed,» he replied; «I grant that he has no need of outward badges such as tiaras and purple raiment — such things are of no use — but the badge which nature gives is absolutely indispensable.» «And what badge is that?» said Alexander. «It is the badge of the bees,» he replied, «that the king wears. Have you not heard that there is a king among the bees, made so by nature, who does not hold office by virtue of what you people who trace your descent from Heracles call inheritance?» «What is this badge?» inquired Alexander. «Have you not heard farmers say,» asked the other, «that this is the only bee that has no sting, since he requires no weapon against anyone? For no other bee will challenge his right to be king or fight him when he has this badge. I have an idea, however, that you not only go about fully armed but even sleep that way. Do you not know,» he continued, «that it is a sign of fear in a man for him to carry arms? And no man who is afraid would ever have a chance to become king any more than a slave would.» At these words Alexander came near hurling his spear. Dio Chrysostom *Oration* 4.60-64 (trans. J.W. Cohoon).

Writing a century after Arrian and Dio, Aelian (c. 172 – c. 235 AD), a Roman who wrote in Greek and cites Greek authors, again mentions the kings of the bees, in contexts similar to those of Arrian's and Dio's:

The Pearl-oysters of India [...] are obtained in

the following manner. [...] the Pearl-oysters swim in shoals and have leaders (ηγεμόνας) just as bees in their hives have "kings" as they are called (ὡς ἐν τοῖς σμήνεσιν αἱ μέλιτται τοὺς καλουμένους βασιλέας). And I have heard that the "leader" too is conspicuous by his colour and his size.

Aelian, *De natura animalium* 15.8 (trans. A.F. Schofield)

Here, Aelian is certainly relying, if not directly on Arrian or Megasthenes¹², on a source drawing on either or both of these authors; however, unlike Arrian, he makes no mention of a queen of the bees, but of a king.

In another passage Aelian, like Dio, speaks of the fact that king bees have no sting.

According to one story the King Bees are stingless; according to another they are born with stings of great strength and trenchant sharpness; and yet they never use them against a man nor against bees; the stings are a pretence, an empty scare, for it would be wrong for one who rules and directs such numbers to do an injury.

Aelian, *De natura animalium* 1.60 (trans. A.F. Schofield)

In a passage immediately preceding this one, Aelian had praised the bees as master builders, whose abilities surpass even those of the great Persian Kings:

Historians celebrate these constructions, but the dwellings of Bees, which are far cleverer and exhibit a greater skill, of these they take not the slightest notice. And yet, while those monarchs wrought what they wrought through the affliction of multitudes, there never was any creature more gracious than the Bee, just as there is none cleverer. The first thing that they construct are the chambers of their kings (τῶν βασιλέων), and they are spacious above all the rest.

Aelian, *De natura animalium* 1.59 (trans. A.F. Schofield)

The architectural abilities of the bees are also praised by the 4th century AD mathematician Pappus

12 Cf. Lesky (1966), p. 853: "[Aelian] hardly had recourse to the ancient authors but limited himself mainly to collections".

of Alexandria (c. 290 – c. 350). In the opening paragraph of the fifth book of his *Synagoge* (Collection), he introduces his discussion of the isoperimetric problem by praising the orderly manner in which bees store honey in the hexagonal cells that they construct. The passage is beautifully written and interesting for many reasons, not least because Pappus mentions a female queen of the bees (ἡ ἡγεμὼν).

Though God has given to men, most excellent Megethion, the best and most perfect understanding of wisdom and mathematics, He has allotted a partial share to some of the unreasoning creatures as well. To men, as being endowed with reason, He granted that they should do everything in the light of reason and demonstration, but to the other unreasoning creatures He gave only this gift, that each of them should, in accordance with a certain natural forethought, obtain so much as is needful for supporting life. This instinct may be observed to exist in many other species of creatures, but it is specially marked among bees. Their good order and their obedience to the queens who rule in their commonwealths are truly admirable, but much more admirable still is their emulation, their cleanliness in the gathering of honey, and the forethought and domestic care they give to its protection. Believing themselves, no doubt, to be entrusted with the task of bringing from the gods to the more cultured part of mankind a share of ambrosia in this form, they do not think it proper to pour it carelessly into earth or wood or any other unseemly and irregular material, but, collecting the fairest parts of the sweetest flowers growing on the earth, from them they prepare for the reception of the honey the vessels called honeycombs, [with cells] all equal, similar and adjacent, and hexagonal in form.

Pappus of Alexandria, *Synagoge* 304.1-308.8 (trans. Ivor Thomas)

We have, then, four writers of the first few centuries AD two of whom write of a queen of the bees and two of a king. Which of them reflect contemporary knowledge about bees? We believe that the answer lies in the difference in purpose and style of their works.

Arrian's work *Epicteti Dissertationes* claims to

be an exact transcription of Epictetus' teaching, setting down his everyday speech without literary embellishment¹³. In the passage from the *Historia Indica* Arrian recounts the facts of pearl-gathering as reported by the 4th century BC diplomat and ethnographer Megasthenes; his aim is to give information on an exotic practice, not to make a literary, philosophical or moral point.

Joseph and Aseneth is a simple narrative written in the biblical Koine, with no literary pretensions whatsoever. We may thus safely conclude that these three passages reflect current practical knowledge and that, at least from the 1st century AD, the queen-bee was commonly regarded as female.

On the other hand, Dio's oration is a speech on kingship delivered before the Roman emperor Trajan and describing the qualities of a monarch. It would hardly be fitting to present the leader of the bees as female in this context.

Aelian's work on the characteristics of animals is a moral work exhibiting "[t]he stoicizing trend towards demonstrating the wisdom of nature" (Lesky 1966 p. 853); the aim is not to impart factual knowledge about animals but to draw a moral relevant to humans. The author, therefore, is interested in drawing the closest possible parallels between human and animal societies, so his bees have kings rather than queens because this is the case among humans.

Pappus, finally, does not aim at giving his readers information about bees, but at proving a mathematical point; and, in order to make his mathematical text more appealing, he includes a passage on the wisdom of bees, characteristic of the same "stoicizing trend" that motivated Aelian. In his case however, possibly under the influence of Xenophon, he envisages the beehive like an orderly household, with the bees preparing a divine food presided over by a capable and respected mistress. Here, therefore, the reference to the queen of the bees should not be attributed to actual knowledge but to stylistic concerns.

To our realism-trained eyes, this may seem fanciful or at least inconsistent¹⁴. At the time when

13 Cf. Lesky (1966), p. 847: "In the surviving books Epictetus' colloquial style has been preserved. They represent a valuable tradition, but not a literary achievement of Arrian's".

14 An outstanding example of realist writing about bees is Tolstoy's passage in *War and Peace* where Moscow, abandoned by its inhabitants, is compared to a queenless hive.

these authors were writing, however, it seems that there was no demand that literature conform to the pronouncements of science. Science and literature were seen as two distinct realms with different concerns and purposes. And this differentiation became explicit precisely at the time when science began to flourish as a discipline separate from literature, philosophy and religion.

Aristotle's evidence-based method "started the development which leads to the science of Alexandria" (Lesky 1966, p. 547). Indeed, the Hellenistic age saw a flourishing of scientific research in fields such as geography, astronomy, mathematics, medicine, philology etc. Major cities hosted important libraries and research centres presided over by scholars who often doubled as poets. These scholar-poets often inserted scientific information in their poetical works. This, however, did not mean that their aim was to impart only accurate scientific information at the expense of notions that had been proven wrong or discredited by systematic observation and research. For instance, Apollonius Rhodius in *Argonautica* 4.1522-1525 describes the symptoms of a lethal snakebite in wording which "fits the medical account of Philumenus" (Overduin 2009, p. 79). This description, however, is preceded by an account of the generation of the snake that administered the bite: it was one of the brood of serpents produced by the blood dripping from the severed head of the Gorgon as Perseus was flying over Libya (*Argonautica* 4.1512-1517). Even if Apollonius had consulted a medical treatise in order to give an accurate description of the symptoms of a fatal snakebite, he certainly did not expect his readers to assume that the explanation of the snake's generation was anything but mythological. In his epic, scientific and mythological knowledge coexist because his objective is not to impart accurate scientific knowledge but to please his readers while displaying his erudition in a variety of fields.

Tolstoy, an avid beekeeper, goes on to describe such a hive in minute detail that any beekeeper will recognize from experience. On the other hand, even in film, a medium with much closer ties to realism, an *auteur's* poetic vision may develop without too much concern for reality. In his film *The Beekeeper*, for instance, Theo Angelopoulos uses beekeeping as a metaphor for his alienated hero's itinerant life. The metaphor, though, goes only skin-deep and Marcello Mastroianni, manifestly uneasy around bees, makes an implausible beekeeper. Compare this film to Victor Nunez's *Ulee's Gold*, where Peter Fonda depicts a beekeeper whose profession truly informs his character and his management of challenging situations. Perhaps one reason why Peter Fonda's performance is so convincing is that his father, Henry Fonda, actually kept bees and produced honey.

The idea that scientific and literary writing do not serve the same purpose was a Hellenistic notion put forward by Eratosthenes, whose view that the poet's aim is not to instruct but to entertain is preserved by Strabo (*Geography* 1.1.10). Strabo may quote Eratosthenes in order to refute him, but the idea emerges again in Galen (*De usu partium* 3.1): Galen, as a physician, explains that two different species cannot mate and produce offspring, but he concedes that Pindar, as a poet, whose "poetic Muse [...] would agitate and enchant and enrapture her hearers, but not teach them"¹⁵, can sing of Ixion who mated with horses and became the ancestor of the Centaurs. And Seneca (*Ep.* 86.15f.) says that Virgil wrote his *Georgics* not to teach farmers but to delight his readers and goes on to give an example of a simple observation of his own that proves Virgil wrong¹⁶.

That this notion on the entertaining function of poetry originated in Hellenistic times is interesting because this was also the era that saw the flowering of didactic poetry, a genre purporting to convey scientific or practical knowledge in hexameter form and tracing its origins back to Hesiod's *Theogony* and *Works and Days*. However, even these didactic epics do not necessarily live up to their proclaimed goal. Instead, many didactic poets seem to use scientific terminology in order to enhance their status as poets, without caring about the accuracy of the information they are imparting. A case in point is Nicander of Colophon, whose *Theriaca* and *Alexipharmaca* claim to offer antidotes to snake-bites and poisons respectively. Modern commentators have remarked that the medical value of Nicander's

15 Strabo and Galen quoted in Curtius (1990), p. 478, n. 2. Curtius also mentions Oppian (*Halieutica* 3.1-8 and Philostratus *Lives of the Sophists* 480, who write that they aim "to provide pleasure and relaxation to the emperor".

16 "Vergil sought, however, not what was nearest to the truth, but what was most appropriate, and aimed, not to teach the farmer, but to please the reader. For example, omitting all other errors of his, I will quote the passage in which it was incumbent upon me to-day to detect a fault:

*In spring sow beans then, too, O clover plant,
Thou'rt welcomed by the crumbling furrows; and
The millet calls for yearly care.*

You may judge by the following incident whether those plants should be set out at the same time, or whether both should be sowed in the spring. It is June at the present writing, and we are well on towards July; and I have seen on this very day farmers harvesting beans and sowing millet." (Trans. Richard Mott Gummere). This passage of Seneca's is mentioned by Dalzell (1996), p. 28 who remarks: "There is a general pattern to these stories: a didactic poet is not expected to be master of his discipline. The demands of the poem take precedence over the accuracy of the text".

poems is practically nonexistent, but he was imitated by Virgil and Lucan and appreciated by poets as late as Milton¹⁷.

Virgil and beyond

We already mentioned Virgil as a poet who, according to Seneca, gives priority to the pleasure of his readers rather than the accuracy of his information. This is also evident in the references he makes to bees in the *Aeneid* and especially in the *Georgics*.

In *Aeneid* 6.706-709 the influence from the Homeric passage cited above is obvious, although here the reference is not to an army but to the souls who bide their time in the Elysian fields, waiting for their regeneration:

Innumerable tribes and peoples hovered round it:

just as, in the meadows, on a cloudless summer's day,

the bees settle on the multifarious flowers, and stream

round the bright lilies, and all the fields hum with their buzzing¹⁸.

Virgil *Aeneid* 6.706-709, transl. A.S. Kline

In *Aeneid* 1.423-436 the Carthaginians building and organizing their city are

17 "And in case we should imagine that the poet makes up for the 'repulsiveness' of his style by the authority of his exposition, Gow writes, 'Whereas the uninitiated reader may learn a good deal of astronomy from Aratus, the victim of snake-bites or poison who turned to Nicander for first aid would be in a sorry plight'. Nicander's stock, however, was not always so low. Virgil and Lucan paid him the compliment of imitation, Plutarch wrote a commentary on him, and Milton thought him valuable reading for schoolboys. Nicander's success, such as it was, seems to have been principally as a writer" Dalzell (1996), p. 29. See also Overduin 2009, 2010a and 2010b, e.g. "Nicander's poem is no longer a scientific treatise. It has become a vehicle for the poet's interest in manipulating the material at hand; it has become his interpretation of contemporary didactic poetry. This does not mean that the poet deliberately makes false claims or intentionally alters scientific observations, as indeed much of the information presented is found elsewhere as well. It *does* mean, however, that ultimately Nicander has little interest in science itself." (Overduin 2010b, p. 5f).

18 Cf. "as bees | In spring-time when the sun with Taurus rides, | Pour forth their populous youth about the hive | In clusters; they among fresh dews and flowers | Fly to and fro ... So thick the airy crowd swarm'd." Milton *Par. Lost* i. 768 ff.

compared to toiling bees:

The eager Tyrians are busy, some building walls,

and raising the citadel, rolling up stones by hand,

some choosing the site for a house, and marking a furrow:

they make magistrates and laws, and a sacred senate:

here some are digging a harbour: others lay down

the deep foundations of a theatre, and carve huge columns

from the cliff, tall adornments for the future stage.

Just as bees in early summer carry out their tasks

among the flowery fields, in the sun, when they lead out

the adolescent young of their race, or cram the cells

with liquid honey, and swell them with sweet nectar,

or receive the incoming burdens, or forming lines

drive the lazy herd of drones from their hives:

the work glows, and the fragrant honey's sweet with thyme.

Verg. *Aeneid* 1.423-436 (trans. A.S. Kline)

This marvellous and influential example of the *topos* of the bees as an organized and well-run community is a reworking of a passage in *Georgics* 4.158-169 describing the division of labour among bees:

For some supervise the gathering of food, and work

in the fields to an agreed rule: some, walled in their homes,

lay the first foundations of the comb, with drops of gum

taken from narcissi, and sticky glue from tree-bark,
 then hang the clinging wax: others lead the mature young,
 their nation's hope, others pack purest honey together,
 and swell the cells with liquid nectar: there are those whose lot is to guard the gates,
 and in turn they watch out for rain and clouds in the sky,
 or accept the incoming loads, or, forming ranks,
 they keep the idle crowd of drones away from the hive.
 The work glows, and the fragrant honey is sweet with thyme.
 (trans. A.S. Kline)

Virgil's main source for the behaviour and habits of bees is Varro (116 – 27 BC)¹⁹. However, he diverges from him when he mentions the generation of the bees. Varro (*De re rustica* 3.16.4) says that "bees are born, some from bees, some from the rotten carcase of an ox". Virgil, on the other hand, claims that bees collect their young from plants, a view, as we have seen above, discussed and discarded by Aristotle.

And you'll wonder at this habit that pleases the bees,
 that they don't indulge in sexual union, or lazily relax
 their bodies in love, or produce young in labour,
 but collect their children in their mouths themselves from leaves,
 and sweet herbs, provide a new leader and tiny citizens themselves,
 and remake their palaces and waxen kingdoms.

Virgil, *Georgics* 4.197-202 (trans. A.S. Kline)

¹⁹ On Varro's *De Re Rustica* as "not so much a handbook of husbandry, as a treatise on morals and an exercise in rhetoric and logical argumentation—and, possibly, a pedantic display of Varro's encyclopaedic knowledge" see Lewis (2013) p. 636ff., with references.

Virgil, however, is not interested in the biology of the bees but in showing them as an ideal, divinely ordained community (cf. *Georgic* 4.149f: "Come now and I'll impart the qualities Jupiter himself gave bees"). Their freedom from love and sex allows them selflessly to engage in productive communal work. Modern commentators have noted that the theme of the poem is "the regeneration of a war-ridden Italy under the new leadership of Octavius Caesar" (Leach 1977, p. 3)²⁰.

The image of the beehive as an organised community with division of labour is found again in the Archbishop of Canterbury's description of the life of bees in Shakespeare's *Henry V*:

Therefore doth heaven divide
 The state of man in divers functions,
 Setting endeavour in continual motion;
 To which is fixed, as an aim or butt,
 Obedience: for so work the honey-bees,
 Creatures that by a rule in nature teach
 The act of order to a peopled kingdom.
 They have a king and officers of sorts;
 Where some, like magistrates, correct at home,
 Others, like merchants, venture trade abroad,

²⁰ This notion of regeneration, of life conquering death and destruction, is also served by the two instances of bugonia in the 4th *Georgic*. On the function of these two passages within the overall structure of the poem, cf. the detailed analysis by Brooks Otis (Otis 1995, pp. 187ff.). Bugonia, the generation of bees from the carcasses of bulls or oxen, is a prime example of a literary *topos* gone wild in the hands of Hellenistic and later writers (for an detailed discussion of bugonia see Harissis, 2009). It is not attested in Greek sources before that time, and Aristotle ignores it in his extensive discussion of the reproduction of bees. It is possible that the belief spread to the Greek world from the Orient in Hellenistic times (Crane 2000, p. 581) and from there to the Romans. Invested with Virgil's authority, it found its way into Medieval and early modern writings. However, Columella (4-c.70AD), who often cites Virgil as an authority, sensibly dismisses this method on practical grounds: "Now Democritus, Mago and likewise Virgil have recorded that bees can be generated [...] from a slain bullock. Mago indeed also asserts that the same thing may be done from the bellies of oxen, but I consider it superfluous to deal in more detail with this method, since I am in agreement with Celsus, who very wisely says that there is never such mortality among these creatures, that it is necessary to procure them by this means. (*De re rustica*, 9.14.6, trans. Harrison Boyd Ash; for "Democritus" we should read "pseudo-Democritus"). Indeed, no true farmer could entertain the notion of sacrificing an animal as precious as an ox in order to obtain some bees that he could easily get for free at swarming time.

Others, like soldiers, armed in their stings,
 Make boot upon the summer's velvet buds,
 Which pillage they with merry march bring home
 To the tent-royal of their emperor;
 Who, busied in his majesty, surveys
 The singing masons building roofs of gold,
 The civil citizens kneading up the honey,
 The poor mechanic porters crowding in
 Their heavy burdens at his narrow gate,
 The sad-eyed justice, with his surly hum,
 Delivering o'er to executors pale
 The lazy yawning drone.

Shakespeare *Henry V* 1.2 183-204

Betts (1968, 152ff.) persuasively argues that this passage is indebted to *Georgic* 4 but also comments on the use Shakespeare makes of it, adapting it to the dramatic context and the character of the Archbishop. Shakespeare uses the bee simile²¹ deploying all the characteristics familiar from classical Greek literature to Virgil, his most likely model: the bees have a king; they are male, or at least they perform masculine tasks and their society is characterised by division of labour; the bees harvesting from flowers are compared to pillaging soldiers; and, last but not least, drones are lazy and must be cast out of the hive.

Thus we see Shakespeare, like Virgil before him, following the lead of a time-honoured literary tradition and adapting its devices to his own artistic ends. Meanwhile, practical knowledge of bees was advancing unheeded by writers of poetry and drama. A few years after Shakespeare wrote *Henry V* (c. 1599), the beekeeper Charles Butler published his *Feminine Monarchie* (1609), where he claims that worker bees are female and have a female queen, "this being an Amazonian or feminine kingdome", where "the males [...] beare no sway at all". Butler is also aware of the usefulness of the drones, as was Pliny, to whom he constantly refers (as he does to Aristotle and Virgil).

Pliny, writing in the first century AD, says of the drones:

And not only in their labours do the drones give them their assistance, but in the propagation of their species as well, the very multitude of them contributing greatly to the warmth of the hive. At all events, it

²¹ Cf. Betts (1968, p. 153): "the bee-comparison had been a literary commonplace even by the Elizabethan age".

is a well-known fact, that the greater the multitude of the drones, the more numerous is sure to be the progeny of the swarm.

Pliny *Natural History* 11.11 (trans. John Bostock)

Butler, who has a reference to this passage of Pliny, is also aware of the fact that drones are male bees²² and that, apart from their procreative role, they had other uses in the hive:

These Cephens or Drones, when they are fledge, doe not only serve for generation [...] but also doe helpe the females much by reason of their great heat, in hatching their broods. And for these causes they are alwaies in breeding-time mingled with them throughout the hive.

Charles Butler *The Feminine Monarchie* chapter 4.21

Yet the idea of the useless drone who lives at the expense of others has persisted not only in Shakespeare but even in our own time; although we are now fully aware of the drones' role in the hive, we persist in using their name to designate lazy, parasitic individuals, as if our knowledge of bees still relied on Hesiod.

²² Although he believed that they mated with the worker-bees, not the queen.

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THE CONSTRUCTION OF TWO COPIES OF ANCIENT GREEK CLAY BEEHIVES AND THE CONTROL OF THEIR COLONIES' HOMEOSTASIS

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The Greek word for the bee (*Μέλισσα* honey-licker) has been used from poets to describe the beauties of nature and from philosophers to name everything that is pure and virgin. The image of the bee has been depicted from the prehistoric times. In Mesolithic Spain, we find a famous wall painting with the harvest of wild bee honey (**Fig. 1**). In Egypt, its images were standing for "Lower Egypt", and with proper use of the word bee and a royal name, meant "all upper and lower Egypt"¹. Archaeological evidence in Tel Rihov in the Jordan valey, illustrated the Biblical reference of the Land of Israel, as the "Land of milk and honey"².

In ancient Greece beside art, bees are present in everyday life, in matters of religion, in economy and nutrition, music and, occasionally, in astronomy. It has been worshiped since the Minoan Crete as a symbol of eternity, wisdom, and an embodiment of virtue. Bee was famous for its prophetic abilities, and it was the soul of the dead who would leave the body after his exhalation³.

1 Sheppard et al. 2001.

2 Mazar et al. 2008.

3 Cook 1895.

The first beekeeper was Aristaeus, son of Apollo and Cyrene (**Fig. 2**). He was raised by Horai with nectar and ambrosia, and the nymphs Brisai (*βριτώ-βλίττω* to take the honey from the comb, *βρίτο-* variant of *μέλισσα* "bee") taught him apiculture. Through the island of Ceos he spread the secret of beekeeping to the humans⁵, and thus the coins⁶ of the island have as a symbol the bee⁷.

Honey bee has been a part in several divinities adorations, from which we will selectively refer to some of them⁸. Perhaps the most famous link between bees and gods is the one with Zeus. As an infant, he was raised by nymphs called *Melissai*, or by *Melissa*, daughter of king *Melissos*. The title of Zeus *Melissaios* was probably so common in Crete because of that myth⁹. An interested fact in this myth, is the

4 Elderkin 1939.

5 Diodorus Bibl. IV 81.

6 Historia Numorum p. 411.

7 Cook 1895. Elderkin 1939. Thomaidis 1979.

8 Chrisostomidou composed a catalogue, summarizing the gods that bees were connected to (Chrisostomidou 2010 pp.43-44).

9 Cook 1895. Elderkin 1939. Chrisostomidou 2010.

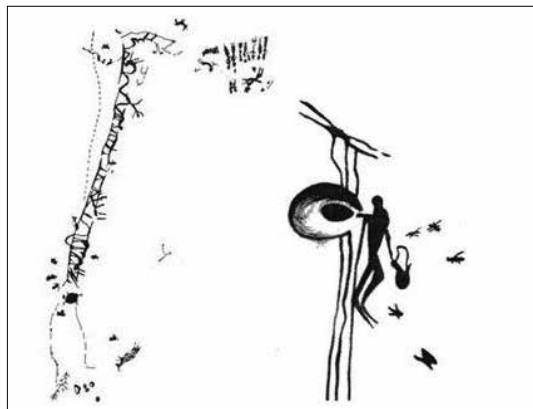


Fig. 1 Wallpainting in caves of Spain, in Valencia and Arana, around 6000 B.C. (photo from Eva Crane, The world history of Beekeeping and honey hunting).



Fig. 2 Aristeus between lions, in an oinochoe around 600-550 B.C., National Museum of Athens inv. No 16285 (photo from the Beazley Archive).

noise that Kourites made with their shields, in order to cover the cry of the infant. The noise (*μελιττοπηχεῖν*) near flying wild swarms was a common technique for capturing them¹⁰. Furthermore it was a common thought that the origin of the bee was from Crete, according to the 2nd c. B.C. poet Nikandros¹¹.

The importance of the insect in the circle of life was obvious in Eleusinian Mysteries, where the bee symbolized the circle of life and death. Just like bees, Demeter was responsible for the fertilization of plants and crops. The priestesses of the goddess and her daughter Persephone were called *Melissai* (bees). Furthermore, Persephone's nickname *Melitodes*, can be translated as "the honeyed one"¹².

10 Harisis and Harisis 2011.

11 Chrisostomidou 2010.

12 Sanchez – Parodi 2009.

The pure nature of the bee got associated with the virgin goddess Artemis, and the occasionally deadly sting with the arrow of Artemis. Bee was the symbol of the goddess in Ephesus, and her priestesses were also called *Melissai* or *Melissonomos* (*Μελισσονόμος* "beekeeper"). A common byname of Artemis, was Britomartis (*Βριτόμαρτις* the bee maiden)¹³.

The honey was first mentioned at the Homeric Epics, with the references to rituals for the dead¹⁴. Anaxagoras (510-428 B.C.), Democritus of Abdera (460-370 B.C.), Hippocrates (460-377 B.C.), and Aristotle (384-322 B.C.), are known for their studies on bees. The nutritional value of honey was promoted by the Pythagoroi, the followers of Pythagoras, who owned their prosperity on a diet based on honey and bread¹⁵.

Honey was used in ceremonial activities, such as libation for the dead, and offering to the gods¹⁶. An interesting fact is the use of wax for lighting, as remains of it on lamps and conical cups of Later Minoan I (1600-1450 B.C.) revealed¹⁷. Beeswax was widely used in art, in the construction of coper statues, as a motif for earrings and necklaces, as a theme for pottery painting and for tomb decoration.

The financial benefits of the beekeeping were extended from the beekeepers to the merchants and to the state. The state would enforce taxes both for beekeeping, also for the trading of the products. A great example for that system, was the Milisian state, that Tragaia was part of, and had an important apiary, as the archaeological findings proclaim¹⁸. The Zenon Archive informs us about the tax obligations. Also such details can be spotted at the sign of Teo, and in the treaty between Militus and Pisades¹⁹. During the 3rd century B.C. the cost for a quantity of 3.3 l. (*χούς*) was about 3 ½ drachmai and 9 oboloi, and for 39.4 l. (*μετρητής* = 12 *χόες*) varied from 16 to 37 drachmai²⁰.

Attic honey was by far the most famous, harvested on the sacred mount of Hemettus. It was a special gift for habitants outside of Athens basin. Great honey production took also place in Isthmia, Crete, Cea,

13 Elderkin 1939.

14 Odyssey K 519.

15 Chrisostomidou 2010.

16 Cook 1895. Elderkin 1939. Chrisostomidou 2010.

17 Eversed et al. 1997

18 Triantafillidis 2012.

19 Ibid.

20 Chouliara – Raiou 2000.

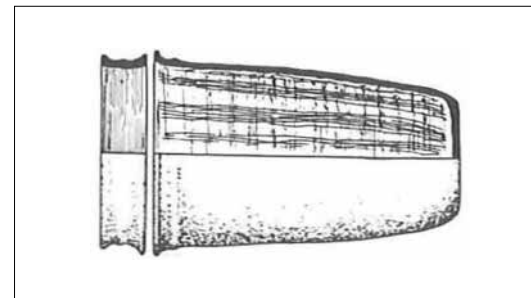


Fig. 3 Horizontal clay beehive (type 1) from Vari Attica, with the expansion ring (photo from Crane E., Graham A.J. 1985, "Bee hives of the ancient world. 2", Bee World 66 (3), 148-170).

Leros, Calymnos, Sicily and Hyblaia Megara²¹. The exportation of attic honey, spread throughout the Mediterranean Sea, was an indication for the significance to the economy. Considering the extent of this export, also the reputation of this honey, is obvious the existence of organized apiculture, already in time of Solon (640-553 B.C.)²². Probably, the Greeks had knowledge in the biology and behavior of a skep, and they had been practicing beekeeping using fitting expertise, like the construction and use of hives, as it is justified by the numerous findings all over the country.

As to the placement of the apiaries, the revetment walls were used in Agathonisi²³, and probably in other regions too. Also, in the interior of city walls, is proven to host beehives²⁴. Perhaps the court-yard was the perfect choice, but the flat rooftops should serve well²⁵. Solon foresaw the need the apiaries, to be placed with a distant of each other, of at least 100 m. (300 Greek feet), to prevent any confusion regarding to the ownership of the combs²⁶.

There was a range of materials used for hives, as it is mentioned by several Roman authors, such as Vir-

gil²⁷, Columella²⁸, Varro²⁹, Pliny³⁰ and Palladius³¹. Those materials were mostly used by the Romans, but it is possible that the Greeks were also familiar with some of them for the construction of hives.

The cork was highly recommended because of the ability to provide an even temperature. Barks of the tree should be removed in a way to form a cylinder. Perhaps the hives were sewn together. Another material was ferula, probably woven together, or shaping a rectangular box. Ferula was also high standing, because of its insulating attitude. Furthermore withy, willow and plans that could also be woven together, were in common use, and mud should be applied on the gaps. Wood was also used, in particular boards, from trees such as oak, fig, pine and beech, shaped like boxes, perhaps similar to the modern Langstroth beehives. A way to simulate the natural home of wild bees was the use of hollow logs. It is unknown whether the logs were found hollowed, or were carved to become hollow³².

Non botanical materials were also used. Dung was not in high recommendation, because of its flammability, however fireproof enclosures could prevent ignition. Brick hives were heavy to move, so they were not praised. Clay was a common fabric in ancient Greece, but it was in full absence at Rome, because the authors claimed that it assimilated the exterior temperature, thus it would not provide a viable environment for the bees³³.

There are two types of ceramic beehives, horizontal and vertical. The horizontal tupe (from now on the horizontal type will be referred as type 1 (**Fig. 3**) has been found in ancient Egypt dated back to the late Old Kingdom (2400-2133 B.C.) (**Fig. 4**)³⁴. The first findings in classical Greece are in Vari in Attica, dated at the 5th century B.C.³⁵. The main advantage is the fact that they can be stacked in several layers (**Fig. 5**). The shape is cylindrical and the mouth diameter is bigger than that of the base. Rims are usually flat on top, and have a projecting profile. Ceramic lids should cover the hives, and they appear to have holes which would host a handle and the entrance for bees (**Fig. 6**). A

21 Aktseli 2000.

22 Jones et al. 1973. Thomaides 1979. They were not harvesting honey from wild bees.

23 Triantafillidis 2012.

24 Lüdorf G. 1999, Leitformen der attischen Gebrauchskeramik: Ber Bienenkord. Boreas, 21/22, 41-169 cited in Mavrofridis G. 2006, "Μελίσσια «εντός των τειχών» στην αρχαία Ελλάδα", Μελισσοκομική Επιθεώρηση 20 (4), 227-230.

25 Rottrof 2002.

26 Thomaides 1979. Aktseli 1996.

27 Virgil Georgics IV. 33

28 Columella Res Rustica IX.6.1-4.

29 Varro De Re Rustica III.16.15-17.

30 Pliny Historia Naturalis XXI.47.80.

31 Palladius Opus Agriculturae I.38.

32 Francis 2012.

33 Ibid.

34 Crane and Graham 1985.

35 Jones et al. 1973.



Fig. 4 Horizontal hives on layers and bees, Egyptian tomb in Padasa, approx. 610 B.C. (photo from Sheppard W. S., Shoukry A., Kamel S., 2001 "The Nile honey bee – the bee of ancient Egypt in modern times", *American Bee Journal* 141 (2), 260-263.)

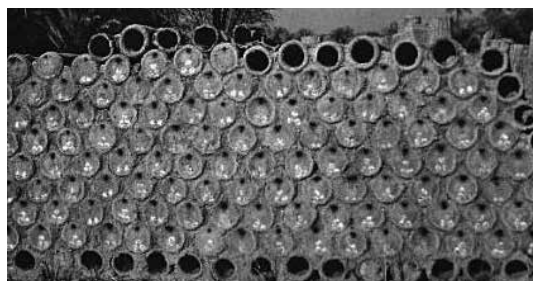


Fig. 5 Modern stack of 400 cylindrical hives, near Assiut Egypt (photo from Crane E., Graham A.J. 1985, "Bee hives of the ancient world. 2", *Bee World* 66 (3), 148-170).

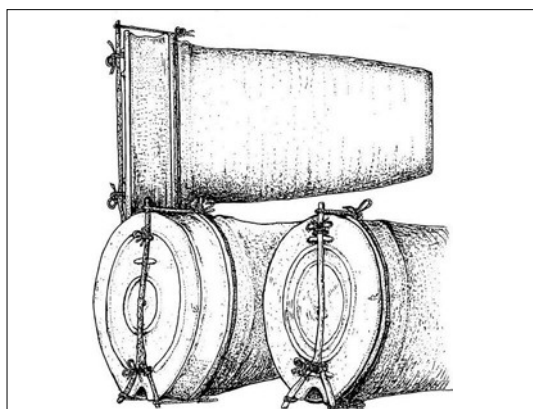


Fig. 6 Horizontal beehives from Trachones, Attica, Hellenistic period (photo from Anderson-Stojanovic V.R., Jones J.E. 2002, "Ancient beehives from Isthmia", *Hesperia* 71, 345-376).

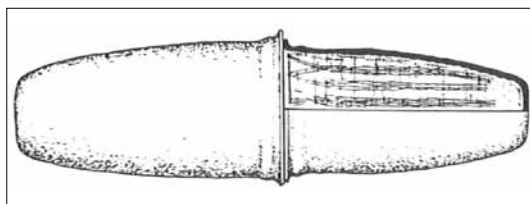


Fig. 7 Two horizontal beehives, as a coffin from Marathon (photo from Crane E., Graham A.J. 1985, "Bee hives of the ancient world. 2", *Bee World* 66 (3), 148-170).



Fig. 8 The engravings inside a horizontal beehive from Isthmia (photo from Anderson-Stojanovic V.R., Jones J.E. 2002, "Ancient beehives from Isthmia", *Hesperia* 71, 345-376).

rope would ensure the sealing of the hive, as it would be pulled and secured behind the rim³⁶. A remarkable usage for hives, have been found in Marathon and in West Necropolis of Eretria, as coffins (**Fig. 7**). Two horizontal hives, placed mouth to mouth, shaped a coffin to host, in the case of Marathon, a 7 years old boy³⁷.

Special feature, are the engravings along the whole length of the interior side of the wall, which would cover the one third of the vessels, and are probably made by a tool like a comb (**Fig. 8**). Sometimes are vertical and rarely skew. We are not sure about the use of those engravings, maybe they were made for guiding the bees to build honeycombs³⁸ or it was a kind of habitude, but at some point they stop being carved³⁹. Another suggestion is that they were part of the beekeepers effort to harvest more wax and honey⁴⁰. The fact that these scorings did not cover the whole vessel, seriously decrease the number of vessels recognised as beehives. Of course there would stamps on the outside surface to declare the owner

³⁶ Jones 1976.

³⁷ Jones 1976. Themelis 1978. Crane and Graham 1985.

³⁸ Anderson-Stojanovic and Jones 2002.

³⁹ Jones 1976.

⁴⁰ Jones et al. 1973.



Fig. 9 Honey thieves chased by bees, amphora (type b) with the manner of Princeton Painter, 550-530 B.C. British Museum inv. No B177. (photo from the Beazley Archive).



Fig. 10 Honey thieves chased by bees, amphora (type b) of Swing Painter, 550-530 B.C., Basel Antikenmuseum inv. No Z364. (photo from the Beazley Archive).

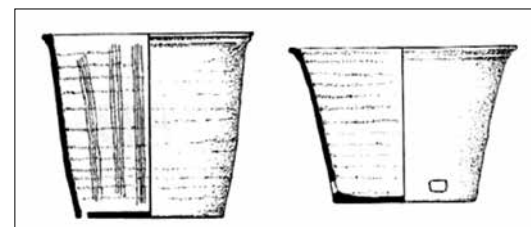


Fig. 11 Vertical beehives (type 2) from Isthmia 3rd-2nd c. B.C., (photo from Anderson-Stojanovic V.R., Jones J.E. 2002, "Ancient beehives from Isthmia", *Hesperia* 71, 345-376).

of the hives. Stealing honey was not uncommon, as a matter of fact, there are two attic amphoras showing this exact scene, both dated in 550-530 B.C. The first amphora from the British Museum⁴¹ (**Fig. 9**), could be relevant to a myth that Antoninus Liberalis⁴² tells us, about four Cretan thieves, that went to steal honey from the cave that Rhea gave birth to Zeus. The god punished the thieves by transforming them into birds. The second amphora from Basel⁴³ could be depicting the same incident, but there are no names like the other vase, and there are only three men on the frame (**Fig. 10**).

Important finds, are the expansion rings (**Fig. 3**), used to magnify the capacity of hives, and accommodate the honey harvest. As to their attachment with the main body, a rational hypothesis is the application of propolis or wax. It is possible that the rings were precursor of the movable combs. The unsmoked honey, a delicate honey quality, came from expansion rings⁴⁴. The benefit of them, apart from the capacity matter, was that the beekeeper did not have to disturb the entire swarm. The usual height was 0.08 m. and could reach 0.14m.

The height of the type 1 hive, was 0.40-0.70 m., the lip diameter 0.25-0.41 m. (Vari 5th century B.C. 0.32-0.40 m.⁴⁵, Tragaia 2nd century B.C. 0.24-0.41 m.⁴⁶, Isthmia 5th century A.D. 0.25-0.27 m.⁴⁷), rim diameter 0.29-0.35 m., base diameter 0.15-0.32 m.

Vertical hives (we will refer to them as type 2) seem to be post dated to type 1 (**Fig. 11**). A number of those have been found in Attica, Isthmia, Chios and Crete. Ancient kalathos is the vase that type 2 hive looks like. Most famous example is OPEΣΤΑΔΑ hive (late 3rd century B.C.), found in Isthmia by O. Brooner in 1955 (**Fig. 12-13**)⁴⁸. Initially it was identified as lenos (ληνός), a vessel for squeezing grapes but later research results proved that it was a beehive⁴⁹.

⁴¹ Inv. No B177. Para. 134. CVA Great Britain 4, London British Museum 3 pl. 32. Beazley recognizes the manner of the Painter of Princeton.

⁴² Antoninus Liberalis *Metamorphoses* 19.

⁴³ Inv. No Z364. Para 134.21. CVA Basel Antikenmuseum 1 pl. 30.2-4. Beazley attributes the amphora to the Swing Painter.

⁴⁴ Jones 1976. Triantafillidis 2012.

⁴⁵ Graham 1975.

⁴⁶ Triantafillidis 2012.

⁴⁷ Anderson-Stojanovic and Jones 2002.

⁴⁸ Brooner 1958.

⁴⁹ Kardara corrected the lenos explanation as a beehive (Kardara 1961), but a few years later Kardara and

Just like horizontal hives, type 2 hives had also a smaller base diameter than the mouth. Honey combs modulation, was again guided (if we accept this interpretation) by scorings along the vessel. Wood, stones, straw, brush smeared with mud, and clay lids, should be used for closing the hives. The square flight hole was situated just above the base. Benith the rim, or in the middle body, were the handles of round cut.

The height was 0.29-0.45 m. (Isthmia 0.29-0.33m., Vari 0.40-0.45 m.), mouth diameter was between 0.29-0.39 m. (Isthmia 0.31-0.38 m., Tragaia 0.29-0.33 m., Vari 0.33-0.39m.), and base diameter 0.18-0.27 m.

Several inscriptions have been found on hives of both types, scratched before the baking. The purpose was to announce either the potter, or the owner of the apiary. Perhaps the owner encarved his symbols (special rings could be used as stamps)⁵⁰ after the purchase of the vessels, so he could count his hives and got them registered on the public documents.

The inscription ΨΕΛΙ was found on a hive fragment at Tragaia (fig. 14). It could be restored as (KY) ΨΕΛΙ(ON) and therefore be the first identification by archaeological data, of the vessel hive (κυψέλιον). The fragment was a part of type 1 beehive, dated on 2nd century B.C. On another horizontal hive, is written ΨΑΛΙΑ ΔΑ, which can be read as ΚΥΨΑΛΙΑ ΔΑΜΟΣΙΑ (public beehive). The letter Δ, shaped either by dots or stamped on hives, was probably the owners sign. A beautiful stamped bee, found in the same apiary, must have been imprinted on the interior of a rim⁵¹.

Roman authors suggested against the use of ceramic beehives⁵², but they are very frequently found

Papadopoulou proposed a new identification of the vessel as a clepsydrae (Kardara and Papadopoulou 1984). Finally, in 2003 chemical analysis disclosed remnants of was to several beehives from Isthmia, where among them was also ΟΡΕΣΤΑΔΑ beehive (Evershed et al. 2003).

⁵⁰ Harisis and Harisis 2011.

⁵¹ Triantafillidis 2012

⁵² Columella Res Rustica IX.6.2 «*Deterrima est conditio fictilium, quae et accenduntur aestatis vaporibus, et gelantur hiemis frigoribus. Reliqua sunt alvorum genera duo, ut vel ex fimo fingantur, vel lateribus extruantur: quorum alterum iure damnavit Celsus, quoniam maxime est ignibus obnoxium; alterum probavit, quamvis incommodum eius praecipuum non dissimulaverit, quod, si res postulet, transferri non possit.*» Varro De Re Rustica III.16.17 «*Alvi optimaе fiunt corticeae,*



Fig. 12 ΟΡΕΣΤΑΔΑ beehive (photo from Anderson-Stojanovic V.R., Jones J.E. 2002, "Ancient beehives from Isthmia", Hesperia 71, 345-376).

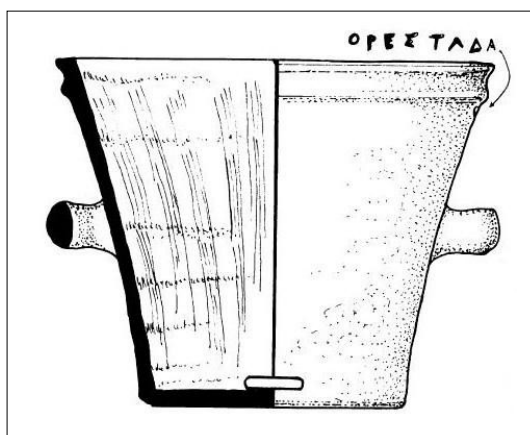


Fig. 13 ΟΡΕΣΤΑΔΑ beehive (photo from Anderson-Stojanovic V.R., Jones J.E. 2002, "Ancient beehives from Isthmia", Hesperia 71, 345-376).

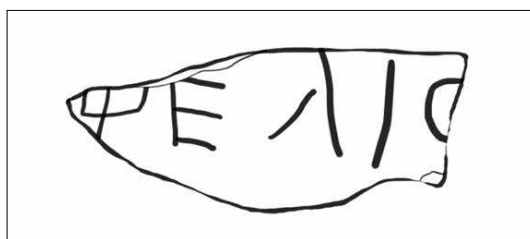


Fig. 14 Fragment of horizontal beehives with ΨΕΛΙ inscription, from Agathonisi, 2nd-1st c. B.C. (photo from Triantafillidis P. 2012, "Πήλινες κυψέλες από την Αρχαία Τραγαία (Αγαθονήσι)", Δωδεκανησιακά Χρονικά 25, 632-653).



Fig. 15 Horizontal clay hive before (A) and after (B) establishment of a honey bee colony

on archaeological sites in several regions in Greece. This contradiction led J. E. Francis to experiment on this matter. She used a cylindrical horizontal clay beehive of the 19th century A.D., similar to those of Minoan Crete. The installation took place in a village near Ierapetra, on a garden, at July 2003. For two days he recorded the internal and external temperature. It is of great importance to mention that the hive was empty and no colony was settled in it. The results favored the Roman authors opinion, as the rising temperature in the interior, was rapidly escalating during daytime, and even after the sunset when the exterior temperature was cooler, it was preserved high enough. However, as he also points out, the authors were not beekeepers, as they were not familiar with the ability of bees to control the temperature.

Based on this research, we decide to move a step forward, install swarms on both type 1 and 2 hives, and compare the temperature results between them, and also between modern Langstroth beehives. With the valuable help of the Hehe-Art Ceramics, Creativity and Human Developing, we created accurate imitations of clay hives (Fig. 15-16). Beyond of the reconstruction of the ancient hives, we intended to study the development of the installed colonies and compare different biological and behavioural factors with colonies in modern hives.

Two colonies with a population of about 10000 honey bees each were settled in the clay beehives. For the control, a colony of equal strength was used, settled in a wooden Langstroth beehive. All colonies were headed by sister queens.

During preliminary studies, we recorded brood and population area temperatures, by using the BARIONET recording system (accuracy $\pm 0,1C$). After the establishment of colonies in the beehives, sensors were adjusted at the middle of brood area and between the two external frames, covered by honey bees. Recordings were continuing for a period of 24 days.

The results showed that brood temperature was stable, presenting no difference between the three types of hives, while the peripheral temperature was slightly higher, thus no significant, in the clay hives. More specific, the average temperatures in brood areas were 35.14° C (SEM=0.055) for horizontal clay hive (HC), 35.2° C (SEM=0.058) for vertical clay hive (VC) and 35.08° C (SEM=0.051) for Langstroth hive *deterrimae fictiles, quod et frigore hieme et aestate calore vehementissime haec commoventur*».



Fig. 16 Vertical clay hive before (A) and after (B) establishment of a honey bee colony

(LH). One-Way Analysis of Variance (ANOVA) showed that temperature differences between the three hives were not greater than expected by chance ($p=0.3373$). A sample of brood temperature variation is presented in fig. 17.

The average temperatures in external frames were 27.63°C (SEM=0.612) for HC, 26.22°C (SEM=0.210) for VC and 26.08°C (SEM=0.837) for LH. Kruskal-Wallis Test (Nonparametric ANOVA) showed that temperature differences between the three hives were not greater than expected by chance ($p=0.338$). A sample of temperature variation is presented in fig. 18.

The results obtained by this study, clearly showed that the ancient Greek clay beehives offered ideal conditions for the development of honey bee colonies. Homeostasis, in terms of temperature variation, was normal and optimum for the rearing of brood and the functioning of adult population. Colonies established in clay colonies presented no adverse behavioural or biological effects. Strength of colonies (in terms of adult population and brood area) as well as wintering procedures was normal and colonies survived for two continuous years before re-established in Langstroth beehives for commercial manipulation.

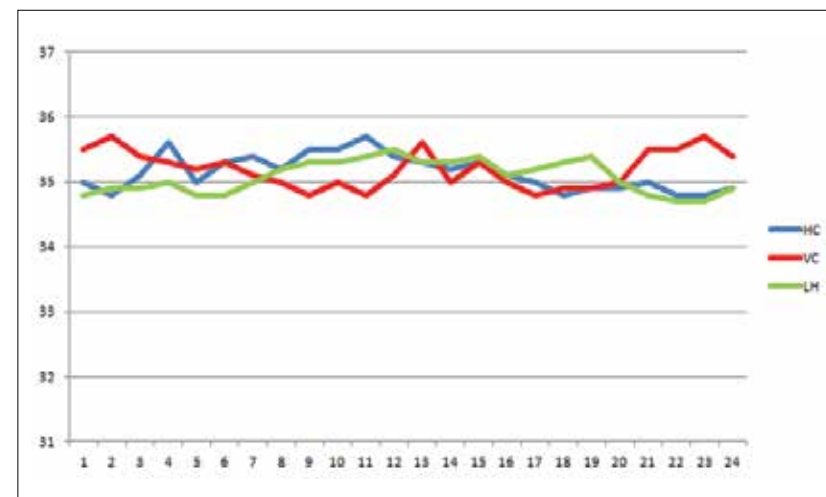


Fig. 17 Temperature variation within 24 hours in brood area. HC: Horizontal clay hive, VC: Vertical clay hive, LH: Langstroth wooden hive.

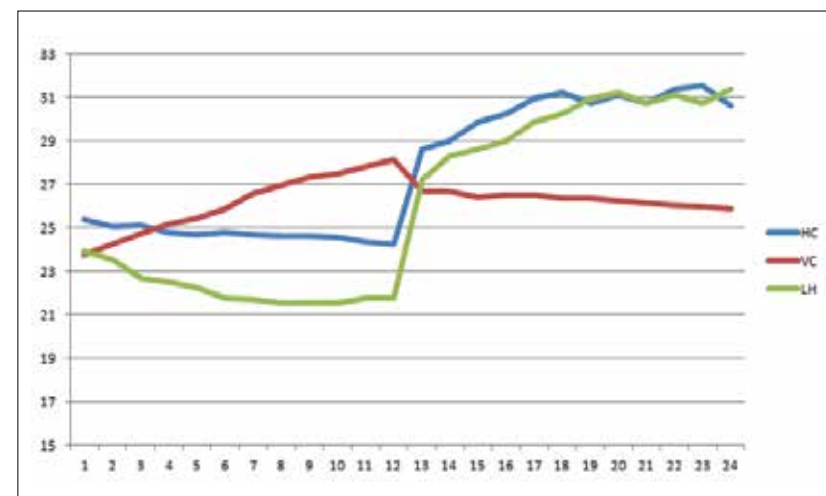


Fig. 18 Temperature variation within 24 hours at external colony frames. HC: Horizontal clay hive, VC: Vertical clay hive, LH: Langstroth wooden hive.

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BEEKEEPING PRACTICES IN AGATHONISI DURING ANTIQUITY

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Agathonisi being the northernmost island of the Dodecanese complex is located to the NE of Patmos and S of Samos. The morphology of Agathonisi is characterized as hilly with little arable land, a fact that lead to extensive animal husbandry and fishery development. The vegetation consists mainly of chasmofytes, illustrating interesting endemic plant taxa, salvia brushwoods and Mediterranean lentisk shrublands. Arid meadows typical of the Mediterranean landscape occur in the east of the island, while Aegean brushwoods, carob and oak trees in arboraceous formations, sages (salviae), thistles, asphodels, calicotomes, sarcopoteriums and bushy wild, olive trees complete the vegetal image of the island.

Strabo refers to the island as Tragia or Tragaia¹ in antiquity due to the vast goat population on it: «τα περί τας Τραγαίας νησία, υφόρμους έχοντας λησταίς»² (in the Tragaia surrounding islands, pirates lurked). Agathonisi was enlisted among the Milesian islands, along with Patmos, Arkioi, Leipsoi, Leros, Korseoi and Farmakonisi³ (**Fig. 1**). The Milesian islands seem to have supported garrison forts in the 4th century BC, in

Special thanks are due to Dr. Pavlos Triantafyllidis, Director of the Ephorate of Antiquities of Lesbos and of the Agathonisi excavations respectively, for the permission to publish the clay beehives and for his valuable guidance. This study based on previous publications of Dr. P. Triantafyllidis, is enhanced by new excavation data. The present English translation of the text was undertaken by the colleague and friend Konstantinos Sarantidis to whom I am thankful.

1 Στέφ. Βυζ., entry: *Τραγαίαι*, Τριανταφυλλίδης 2006, 178, note, 16.

2 Στράβ. XIV 1.7, 635c. Τριανταφυλλίδης 2006, 177, note, 10.

3 Haussoullier 1902, 125-143· Rehm 1929, 19-25· Ehrhardt 1988, 15-17.

order to safeguard the mercantile maritime networks of the Ionian Metropolis of Miletus⁴.

On the north side of the island, at the site of Kastraki, archaeological excavations have brought to light the fortified establishment of the late 4th - early 3rd century BC, which was inhabited until its abandonment in the second half of the 2nd century AD. The fort is divided into three terraces and is surrounded by strong defensive walls. The first and higher terrace is occupied by a square tower with a rainwater collection cistern in its basement and a cookhouse in front of it. In the middle terrace a sanctuary of Aphrodite and Eastern deities is situated, whilst at the third terrace storage rooms and workshops are on display, the most important being that of murex-processing for purple color production.

Among the important finds, which came to light from the excavation, a great number of clay beehives has been accumulated, a fact that testifies to a systematic and quite profitable occupation of the inhabitants. The apiary is located at the south, protected from the strong winds, slope of the hill. The site is appropriately formed in narrow terraces stretching from the North to the South through a series of retaining walls, in which the clay beehives were either enwalled or piled up. The most typical arrangement that has been discovered consists of parallel long walls each of 0.88m. width, at an interval of 0.88m. respectively, suitable for horizontal beehive type installation. The northern wall is of 2,85m. length and the south of 1,85m (**Fig. 2**). From this area a large number of beehive fragments has been accumulated, whilst from the next higher terrace an almost intact beehive of the horizontal type has been discovered (see below).

4 Δρελιώση-Ηρακλείδου, Μιχαηλίδου 2006, 38.



Fig. 1 Map with the Milesian islands.

The clay hives discovered in Agathonisi belong to the two known, ancient, wheelmade types; the horizontal tubular and the rarer, vertical, basket formed type. The horizontal hives are in fact a tube, open from both sides, with outcurved –almost horizontal-rims at their endings. Their interior surfaces bear closely stretched systems of horizontal, vertical and transverse grooves which often blend together. The rim diameter varies from 0.24m. to 0.41m. The tubular bodies of the hives, slightly narrower than the rims, have a varying diameter from 0.23 to 0.32m., resulting in an average of 0.28-0.30m. An intact hive of the horizontal tubular type derives also from Kastraki (Fig. 3); that hive has a length of 0.40m, rim diameter 0.31m. Its rims are outcurved horizontal with an irregular outline. The interior surface is covered in full by closely stretched horizontal grooves.

Except from the intact hive discovery, to the predilection of vertical tubular type hives advocates the fact that from the total sum of the hive fragments, no bases have been so far identified. Instead of bases, in the openings, there were, commonly, fitted clay perforated lids, or lids constructed by perishable materials such as wood, raw clay or even flat stones. The horizontal type of hives, enabling the beekeeper to work on both sides, offers a thorough inspection of the bee-flock and a safe honeycomb removal without jeopardizing the remainder. What is more, the adjustment of extension rings on both sides of the hive can increase production. Parallels for the horizontal tubular hive type, which is widespread in the Aegean region, in clay or wood have also been



Fig. 2 Parallel walls for installation of horizontal beehives south of the fortified area.

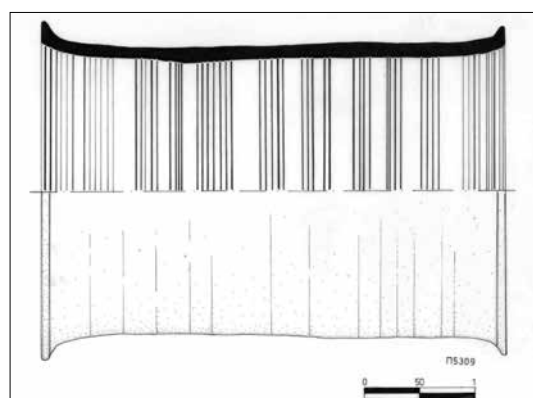


Fig. 3 Type of horizontal beehive open from both sides.



Fig. 4 Type of horizontal beehive of a ceramic deposit from an underground, deep cooling cave. Late 4th – second half of the 3rd century B.C.

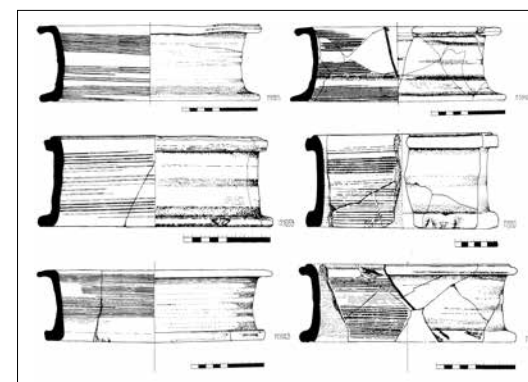


Fig. 5 Clay extension rings with two outcurved horizontal rims.

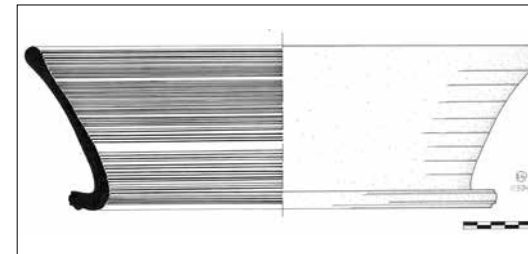


Fig. 6 Clay extension ring in the form of a truncated cone. This type is very rare in Agathonisi.

found in Spain, dated to the 3rd-2nd century B.C.

As for the dating of the beehives from Agathonisi, another important discovery at Kastraki attests to it. Among the finds of a ceramic deposit of the late 4th – second half of the 3rd century BC, from an underground, deep, cooling cave, many beehive fragments were accumulated. These fragments, which are associated with the early phase of activity in the fort, belong to the horizontal type. Their clay is clean and denser, their grooves are spaced more widely and their bodies are thicker (Fig. 4). The rims are commonly horizontal, flat on the upper surface, displaying a sharp angle, at the inner surface of the transition to the body. Five types have been pointed out, regarding the horizontal hive type, dating from the late 3rd century BC to the 1st century AD, without illustrating any remarkable evolution in the vessel shape⁵. In an inner part of a horizontal hive, traces of propolis, the so called «κηρός άπυρος»⁶ are still visible, while pine pollen grains are preserved.

Extension rings also belong to the equipment of horizontal type hives. These rings, which are used to increase production, share many common features with the horizontal hives, thus identifying them in fragmentary form, proves to be a very difficult task. Two types of honey chambers are known from Agathonisi. The first and most common, is the open ring with outcurved rims on both edges (Fig. 5), while the second and rarer, preserved only in an almost intact example – helpful, indeed, for the further identification of other fragments- has a shape in the form of a truncated cone forming an outcurved horizontal rim on only one edge (Fig. 6)⁷.

Vertical type beehives, all fragmentarily preserved, are scarce in Agathonisi, as elsewhere. These vessels feature banded or rounded horizontal rims, a downward steep body and have diameters that range from 0.29m. to 0.33m. (Fig. 7). Some of them have horizontal handles. The cause for their rare occurrence may possibly be the perishable material of their construction⁸.

⁵ Τριανταφυλλίδης 2014, 470, tables 153, 154.

⁶ Chouliara - Raïos 1989, 166-167, note, 10, 17- Χουλιάρá-Ράιου 2000, 89- Harissis et al, 2009, 4.

⁷ This type is extremely scarce in Agathonisi; not a single parallel is illustrated in the relevant bibliography that I am aware of.

⁸ Ακτσελή 2000, 32-40, mainly 35- Agora XXXIII, 127-128- Lüdorf 1998-1999, 51-52- Crane 1999, 203-204, table 24. 1A- Harissis et al. 2009, 60-61, fig. 52.

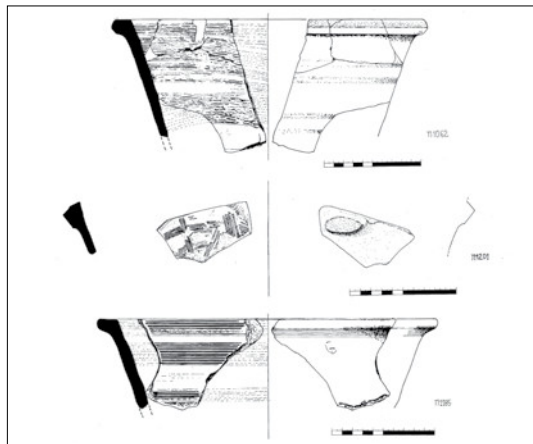


Fig. 7 Vertical clay beehives.

Both hive types were commonly covered by perforated clay lids⁹. The holes served the bee movement in and out of the hive and possibly the attachment of the lid to the hive. However, such examples from Kastraki are extremely scarce (Fig. 8). Therefore, the use of lids from perishable materials or flat stones cannot be excluded¹⁰.

In Agathonisi, also, came to light two very interesting, inscribed fragments of horizontal hives. One of them bears the incised, fragmentary inscription ΨΕΛΙ and possibly an O after that, yielding probably the word ΚΥΨΕΛΙΟΝ (hive). The second fragment dated to the late 2nd to 1st century BC, bears in a single line, the inscription ΨΑΛΙΑ ΔΗ which we reconstitute as ΚΥΨΑΛΙΑ ΔΗΜΟΣΙΑ (public hive). As it becomes evident, this important information probably indicates the public ownership of the apiary¹¹.

Laboratory analysis of the hives' clay, compared with the analysis of clay masses (kiln byproducts) from the site, associates the production of the hives with a local workshop. With the activity of this local workshop can possibly be associated a seal imprint, depicting a rather stylized bee head in the inside part

9 For flat, clay hive lids, see. Lüdorf 1998-1999, 66-67, 121, Typus A, nos BD 1-3 Jones, Graham, Sackett 1973, 393, nos 151-153, Taf. 75: Ακτσελή, as above (note, 18), 37, fig. 7.

10 Crane 1999, 195, fig. 22,3e, Μαυροφρύδης 2007, 135-145. Μαυροφρύδης (in print).

11 Τριανταφυλλίδης 2014, 472-473, tables 155, 156.



Fig. 8 Perforated clay beehive lid.

of a hive, dated in the late Hellenistic period. In the inside part of this hive, the typical horizontal grooves are present¹².

As it becomes clear, the large amount of hives discovered in Kastraki testifies to the systematic and constant occupation of the inhabitants with beekeeping, dating back to the fort's erection in the late 4th century BC until its abandonment. Before that period or after that and during the Byzantine command of the island there is a lack of evidence regarding beekeeping. In modern Agathonisi beekeeping has been abandoned, and the inhabitants are mainly engaged with farming or fishing activities.

In conclusion, it can be articulated that in ancient times, along with purple color production and textile trade, beekeeping also constituted a lucrative practice of the Ionian Metropolis, Miletus, which could have traded honey and other bee products in various centers of the Mediterranean. With the exception of Attica, the island honey was regarded as the best, the most outstanding being that of Kalymnos, as Strabo mentions (X.5,19) in *Geographica*: «ἅπαν μὲν οὖν τὸ νησιωτικὸν μέλι ὡς ἐπὶ τὸ πολὺ ἀστεῖον ἐστὶ καὶ ἐνάμυλλον τῷ Ἀττικῷ τὸ δ' ἐνταῖσδε ταῖς νήσοις διαφερόντως». Future research mainly outside the fort, at the site of the ancient apiary, may yield more and crucial information about its installation and function.

12 Τριανταφυλλίδης 2014, table 156.

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BEEKEEPING IN TURKEY: PAST TO PRESENT

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Abstract

Turkey is on the intersection of three continents and also located on two important trade routes of the past, namely the Spice and Silk Roads. Thus it played a very important role bridging Asia, Europe and Africa. Indeed Turkey was also the place where very important civilizations such as the Roman, Hittite, Byzantine, Ottoman and finally the modern Turkish Republic became established. Covering all of these civilizations, beekeeping can be divided into three main periods, supported by archaeological findings, the written laws of Ottomans and the present period of the new Republic.

Although the findings in archeology and in the Ottoman period are scarce, the present period has lots of information regarding beekeeping in Turkey.

Archeological evidence of the Hittite Period comes from excavations in two sites in Turkey. Comb, figures on the walls and the buzzing bees on the carpets are the signs of beekeeping in that area.

In the Ottoman period, although there is not much direct evidence of beekeeping, there are several laws attributable to beekeeping. All of these laws refer to managing taxation and the prevention of theft related to bees. The third, new period, is after the establishment of Turkish Republic. However, this latter section can be divided into two parts before the influence of Frederick Simon Bodenheimer and after. It was then that modernization took place and scientific beekeeping started, leading to Turkey becoming one of the main beekeeping countries in the Middle East and the business is still growing.

Introduction

The Republic of Turkey consists of two geographical parts divided by the Marmara Sea. The



Fig. 1 Two tablets found in Boğazköy (Hattuşaş) related to beekeeping laws (Sarıöz, 2006; Akkaya and Alkan, 2007).

main part, called Anatolian, is in Asia and the much smaller part is Thrace, the European part of Turkey. The whole country covers a total of approximately 800,000 km². In this vast geographical area different topographical and climatological features, shaped by evolution, make for a wide variety of flora and fauna. Over 10,000 plant species create huge biodiversity and this is well reflected honey bee biodiversity. A total of five honey bee subspecies and also many ecotypes are now found in this region suitable for modern beekeeping. Indeed, since the antiquity, beekeeping has been a major part of the agriculture of these areas. The history of beekeeping in Turkey is well documented in many books and articles (Crane, 1983; Crane and Graham, 1985; Kandemir 2003; Akkaya and Alkan, 2007).

Beekeeping before The Ottoman Empire

Ancient beekeeping in Turkey was reported by Crane and Graham (1985). Beekeeping history goes



Fig. 2 Buzzing bees motif on the rug (Çatalhöyük) (<http://marlamallett.com/ch.htm>).

back to the Hittite Kingdom before other civilizations like Roman and Byzantine. From archeological excavations many beekeeping remains such as hives, bees, comb and bees wax have been found in Central Anatolia, Bogazkoy (Corum) and Hattusa (BC 1300) along with some tablets having laws related to bees (Hoffner 1974, 1997). These laws (**Fig. 1**) are all related to honeybee theft and how to punish the thief. One punishment was to sting the thieves with honeybees.

Later, the theft punishment was changed and thieves got a fine for their actions. Akkaya and Alkan (2007) in their articles explained the writings on the tablets and translated the Hittites' laws into modern language. They also explain the details of Hittite beekeeping terminology (some words). From these terms and laws, we can understand how beekeeping was important 3000 to 4000 years ago.

In the other excavations from Çatalhöyük, between 1961 and 1965 by Mellaart, a much older civilization was unearthed dating back to BC 8000-7000. The first city was found which shows evidence of first domestication of many animals. Also honey and beeswax have been found (Flores, 2000). Mellaart (2005) explained the daily life in Çatalhöyük as it is pictured in paintings on the walls and motifs and in objects like buzzing bee figures on the rugs (**Fig. 2**). Some wall paintings seem to depict a bee life cycle (Mellaart, 1967).

Later beekeeping related remains (mostly depicting of bee figures on different objects such as coins and sculptures) came from the Hellenistic and Roman periods and were found in excavations in Ephesus and Torbalı (Meriç 2003) (**Fig. 3 & 4**, taken from Sariöz, 2006). Artemis (Goddess of the Hunt, Forests and Hills, the Moon and Archery) in Ephesus is called "queen bee" and during the peak years, the bee figure is minted on coins and also used on jewelry. Except for these remains, there is not much



Fig. 3 Bee figures on the jewelry and candle found in Metropolis excavations in Ephesus (BC 3-2. century) (Sariöz, 2006) (Ephesus museum collection).



Fig. 4 Bee figures on coins found in Metropolis excavations in Ephesus (BC 3-2. century) (Sariöz, 2006) (Ephesus museum collection).

documentation about beekeeping during Hellenistic and Roman periods.

One other historical beekeeping information came from mad honey intoxication almost 2500 years ago. Xenophon stated in The Anabasis that during the year 401 B.C. soldiers came to Trabzon (a city on the coast of the Black Sea) and visited villages. There they all consumed honey from the hives and showed symptoms of intoxication due to "mad honey". Still "mad honey" intoxication incidences are seen in these areas. On the Black Sea coast there are a species of



Fig. 5 *Rhododendron ponticum*, the source of mad honey on the coast of Black Sea.

Rhododendron containing gyanotoxins which cause honey to be poisonous. The species with purple colours, *Rhododendron ponticum* (**Fig. 5**) is still widely distributed in those areas and beekeepers pay attention to those nectars and harvest separately so that the honey can be used for medicinal purposes.

Beekeeping in the Ottoman Empire

Beekeeping was one of the irrevocable occupations during Ottoman Empire. Many Ottoman Sultans used honey as a sweetener and encouraged beekeeping. In Seljuk, even before the Ottomans, presenting honeysyrup to the visitors was a tradition. During the period of Ottoman Sultan -Fatih Sultan Mehmet, more than 3 tons of honey was consumed in Topkapı Palace according to the records. In the Ottoman Empire period, beekeepers had to pay tax for their hives (Öşr-ü kovan meaning hive tax) and honey (Öşr-ü asel meaning honey tax). However, hives were divided into two according to strength. If the hive was good then the beekeeper should have to pay 2 otherwise 1 akçe (currency at that time). Due to these taxations very good beekeeping records were taken in Ottoman Empire. However, during the period of Magnificent Sultan Suleiman, the hive and honey taxations were lifted if they were for the beekeeper's own usage.

In the Ottoman period, until the end of 18th century, all sweets were made from grape molasses and honey. During this period the honey produced was stored and marketed in a place called "Balkapanı". Not only honey but also olive oil, hazelnuts, salt, cotton etc. were sold in this place.

Beeswax was also used in Ottoman Empire for document seals and also candles as light sources. Modernization in beekeeping in Ottoman Empire was started far too late. At the end of the Ottoman period (the beginning of 1900's) beekeeping books



Fig. 6 First beekeeping leaflet published during Ottoman Empire Period (<http://aricilikmuzesi.blogspot.com.tr/>).

and leaflets were published (**Fig. 6 & 7**) and the first modern beekeeping book was translated but not published for a long time. This book would be the first book published on beekeeping during the first years of Turkish Republic.

Modernization Period

After the establishment of the Turkish Republic beekeeping stayed constant for some time. After 1923, changes began to be made within the agricultural infrastructure. Beekeeping was taught in schools as an applied profession but this did not continue long. The schools closed unexpectedly and primitive beekeeping continued until F. S. Bodenheimer's arrival before World War II. In those years the number of primitive hives (skep, cylindrical mud, trunk, clay, etc **Fig. 8**) were predominant (Crane, 1975; Crane, 1983) and the honey yield was very low compared to current beekeeping (around 5kg per hive). This period is characterized by the transition from primitive beekeeping to modern beekeeping equipment and practices. The first detailed scientific apicultural study was completed by F. S. Bodenheimer between 1933 and 1937 (Bodenheimer, 1942). This survey was to get a picture of Turkish beekeeping in those years. He prepared a questionnaire and sent it to all cities at that time. The questionnaire obtained basic statistics on Turkish beekeeping - the number of



Fig. 10 Ali Nihat Gökyiğit (ANG) Foundation conservation apiaries in Turkey (upper) *Apis mellifera anatoliaca*, Gündül-Ankara and (below) *Apis mellifera caucasica*, Posof-Ardahan.

One institute in north east of Turkey, Ardahan, aims to produce Caucasus honeybee breeding stocks and is working on their conservation. Another institute in Ordu (Ordu Arıcılık Enstitüsü) has a grant from the EU with their project namely "My Bee, My Honey and My Comb" to develop a better beekeeping model.

Besides these institutes, non-governmental organizations are also working on beekeeping. Especially ANG Foundation (Ali Nihat Gökyiğit Foundation) which has carried out a long lasting project since the late 1990s for the selection, breeding and conservation of Caucasus honeybees in two

regions (Macahel and Posof). After their success, the same NGO continued a similar project with a partial support from the ministry to conduct research on central Anatolian honeybees.

These two studies are good examples of honeybee conservation efforts in Turkey (**Fig. 10**).

In the last few years universities have been involved in such research and development projects related to bees and beekeeping. The number of projects granted by Ministry of Food, Agriculture and Livestock and also by Turkish Scientific and Research Council (TUBITAK) has increased remarkably. Besides

ministry institutes, universities and NGO's, private sector companies are involved in beekeeping research and development. Beekeeping related companies like Balpamak, Balarısı and Aksu Vital spend their budget for R & D projects on beekeeping so as to produce new products, or make improvements to existing ones, and get financial grants mainly from TUBITAK.

Indisputable developments in Turkish beekeeping have been achieved recently and the statistics are much better compared to current figures (FAO 2015). Almost one million primitive hives converted to seven million modern hives in 80 years. Similarly the honey production increased from around 5 kg to 16 kg/hive (Kandemir, 2003). Turkish beekeeping is still on the move and needs further improvement to be more competitive worldwide: with the cooperation of all the parties (Ministry, Universities, Institutes, NGO's and Private Sector) without losing its bio diversity. In all parts of Turkey there are developments in all aspects of beekeeping. But still some beekeepers keep to tradition and manage colonies in an old fashioned ways using primitive equipment. Thus by bridging the past to present Turkey promises to be one of the major beekeeping centres in the world - as it was in the past.

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HONEY CULTURE IN BYZANTIUM

AN OUTLINE OF TEXTUAL, ICONOGRAPHIC AND ARCHAEOLOGICAL EVIDENCE

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Apiculture is a stockbreeding activity of diachronic and intercultural importance, as it covers a basic human need, the consumption of sweet food, a need as old as human existence itself. Nevertheless, the process followed for the production, the use of beekeeping products and primarily, the multifaceted expressions of these activities in the art, archaeology, intellectual and material culture of the Byzantine era, have not been closely documented. The present paper attempts to fill this gap, focusing on information pertaining to three main fields, namely the various textual, artistic and archaeological sources.

A limited interest in this realm of study was already demonstrated in the time of Aristotle and, later on, by the Roman agricultural authorship (Varro, Virgil, Columella, Pliny the Elder, Pappus of Alexandria, Palladius¹). However, it was not pursued in the Byzantine era, with certain exceptions. The modern scholarship on this last subject-matter, such as the books of Phaidon Koukoules, *Life and Culture of the Byzantines*, in 1952, and the dissertation of Eleni Chouliara-Raiou, *L'abeille et le miel en Égypte d'après les papyrus grecs*, in 1989, coupled with the conference *The bee and its products*, held at Nikiti, in Chalikidiki, and the recent article of Angeliki Liveri, *Die Biene und ihre Produkte in der Kunst und im Alltagsleben (Frühchristliche und Byzantinische Zeit)*, in the journal *Zbornik radova Vizantološkog instituta* in 2011, expanded considerably the relevant bibliography. Joanita Vroom and Platon Petridis included ceramic beehives, finds from their own excavation research from Boeotia and Delphi, in their handbooks *Byzantine to modern pottery in the Aegean: 7th to 20th century. An introduction and field guide*, Utrecht 2005

and *Early Byzantine pottery in Greece*, Athens 2013. As a result, beehives met attention and currently are increasingly exhibited in their capacity as cultural objects, especially in Athens (i.e. Syntagma metro station, Airport museum).

The insect and its products met extensive literary uses. They appear frequently as paradigms in the theological works of saint Basil the Great, bishop of Caesarea, whose text of the *Hexaemeron (The Six Days of Creation)* created an extensive tradition². Commonly used schemes by Fathers of the Orthodox Church include the contrast between physical weakness and mental strength, the comparison of the divine dicta to *sweeter than honey*, the attribution of the insect as industrious and diligent. Moreover, references in the Lives of Saints not only provide useful information concerning apiculture in a theoretical basis but could also be used to shed light on practical activities during the Byzantine era. In a symbolic context bees sometimes express and depict evil nature and demonic moral (*Life of Nikon the Repenter*, 1000-1042 or 1042 or 1149³) whereas in other occasions they became part of a heavenly vision (*Life of Andrew the Fool*, 5th or 6th century⁴).

Furthermore, references related to the honey production and the possession of beehives as personal property prove valuable. A typical example is the account of the wealthy saint Philaretos (821/822) who is reported to own an impressive total of 250 hives in Paphlagonia, Pontos⁵. Inscriptions and lyric tributes

² Giet 1968(1950), 446-448. Grant 1999, 91-92.

³ Lampsidis 1987, 72, lines 34-39, 252, lines 49-51. Sullivan 1987, 124-125, chapter 36, par. 10-15.

⁴ Rydén 1995, II, 48, line 524.

⁵ Rydén 2002, 74-74, line 249, 82, lines 352-375.

¹ Crane 1994, 118-135. Crane 1999, 204-211, 558. Mavrofridis 2011, 266-271.

(Georgios Tornikios' praise to the deceased Anna Komnene, 1153⁶) add to the importance of honey and bees within Byzantine popular culture. The citation of honey on the funerary marble slab of Isaakios Komnenos (second half of the 12th century), in the katholicon of the monastery of Panagia Kosmosoteira in Vira (Pherae), is of great interest⁷. The same applies to the dedicatory inscription of the All Saints church in Apano (Upper) Floria Selinou in Crete (1470), which mentions ten beehives, a sole known example of that kind of donorship⁸.

The sufficiency in honey and wax was a priority for the monastic communities in order for them to address both nutritional and other practical needs⁹. It was achieved either through inheritance endowments, such as those made by Ioannis Xenos (Crete, 1031¹⁰) and Theodoros Skaranos (Chalkidiki, 1270-1274¹¹), or through the establishment of apiaries, as mentioned in Athonian monastic archives. According to the law, bees fell in the category of animate, movable assets and were considered as wild flying animals only if they remained free in nature. A tax on beekeeping and bee exploitation appeared for the first time in 1152 under the term *melissoennomion*¹² or *dosis melisson* or *kouveliatikon*.

The only Byzantine treatise exclusively focused on farm life, including chapters dedicated to apiculture (2 and 9 of the book XV), was the *Geoponica*, a compilation by an unknown writer of older works, composed at around the 10th century. The attribution of the name *chytridion* (pyre vessel) to the fumigator (*kapnistirion*) stands out among the various practical details related to the production process, since it does not appear in other sources¹³. Apicultural products are mentioned in a variety of literature works, ranging from medical prescriptions and pharmaceutical treatises to popular narrations,

6 Darrouzès 1970, 297-299, n. 14.

7 Rhoby 2014, 136-139 (GR2), fig. 6, 991, where past bibliography.

8 Kalopissi-Verti 2003, 85, where past bibliography.

9 Andoudis 2000(1996), 211-220.

10 Thomadakis 1948, 59, 60, line 137. Thomas, Constantinides-Hero 2002, 143-147 (Fiaccadori).

11 Bompairé 1964, n. 9A, line 22. On Skaranos: Loos 1978, 11-12. Lefort 1986, 362-372.

12 Lemerle et al. 1982, n. 25, 132. Lefort et al. 1994, n. 56, 70, 77, 79 dated in 1220-1328. Oikonomidès 1992, 74-76.

13 Beckh 1994(1895), 447, chapt. 6, par. 1-3. Dalby 2011, 296-307.



Fig. 1 Postcard, apiary in Chaladri, Athens, first half of 20th century.

such as the *Oneirocritica*¹⁴, the novel of *Barlaam and Josaphat*¹⁵ and the *Acts of Joseph and his wife Aseneth*. The latter includes the first mention of the female queen as the leader of the swarm, indicating probably a high educational level on apicultural biology and practices¹⁶.

The professional specialisation and the institutional organization of the people involved in apiculture, the equipment of apiarists, the manufacture centers and the various uses and trade of apiculture products consist another field of investigation. The time of collection or the origin of the nectar influenced the quality of the honey, as well as the flavor, the color and the aroma, which also affected wax quality in a lesser grade. The establishment of the monastic foundations and their gradual economic growth played a significant role in the development of apiculture, especially after the end of Iconoclasm (843). Scattered evidence for honey production indicates the presence of beekeeping centers in the areas of western and central Asia Minor, Mount Athos and in particular Chalkidiki, Thebes, Cyprus, Monemvasia. Non-fumigated honey was a distinct category which was probably collected from beehive extension rings, without using smoke¹⁷. Thyme honey, collected at the feet of Mount Hymettus, was valued at all times, while the honey production of Athens, especially that coming from the Kaisariani monastery, was widely reputed, even in the recent years¹⁸ (Fig. 1).

14 Oberhelman 2008, 98-99, 159, 180, 216.

15 Volk 2006, 127-130.

16 Philonenko 1968, 186-190, chapter 16, par. 1-17. West 1974, 70-81.

17 Mavrofridis 2009, 200-204.

18 Kolovou 1999, 99. Mpouras 2010, 111. Pallis 2013, 164.

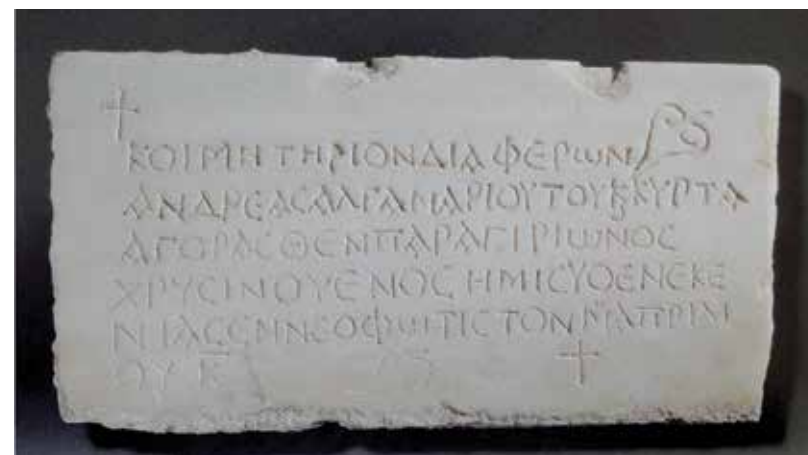


Fig. 2 A funerary marble inscription of a saldamarios, from Lerna, 5th - 6th century.



Fig. 3 Miniature of Aristaeos inventing beekeeping, *Cynegetics* by Pseudo-Oppian (cod. gr. 479), mid-second half 11th century.

In the *Book of the Eparch* by the emperor Leo VI the Wise, apiarists were not regarded as independent professionals. The specialists associated with the most relevant to honey and wax were *saldamarioi* (expert grocers) and the profitable *keropoioi* (wax merchants), who run the trade of the respective commodities, without, however, being their producers (Fig. 2)¹⁹.

The collection of honey was the hard task, regarded as a peasant activity that demanded skill and physical power. It was performed with the use of few, basic, yet necessary, tools. The fumigator was, without question, the most useful device from Antiquity up to present day. Even though its form was attested from prehistoric finds, its Byzantine counterpart is known solely through the descriptive term *chytridion* in *Geoponica*. Previous research considered the apiarists' protective clothing as first introduced in the medieval West. Nevertheless, a type of perforated "face mask" was depicted in a Byzantine miniature, included in the manuscript cod. Gr. 479 of the *Cynegetics* (*On Hunting*) by Pseudo-Oppian (second half of 11th century), relating the invention of apiculture to Aristaeos (Fig. 3)²⁰. This may be considered as an indication for technical progress in the field of honey collection in Byzantium.

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Beehives consisting an apiary on a stable basis were placed in rows, facing south, in order to be protected from winds. Their position should ensure protection from hostile animals and harsh weather conditions. Most busy period of year was from the end of spring to the beginning of autumn, when three main processes took place; swarm capture and transport to a hive, bees' reproduction, honey harvest. Tools used in the processes of extracting, transport and storing of beekeeping products, were limited to the very basic –mainly knives.

The uses of honey and wax were numerous and diverse. For many centuries honey remained a unique delicacy, the only available sweetener before the introduction of sugar following the Crusades. Furthermore, it was a popular additive, its use ranging from cooking, pastry and refreshing herbal tea recipes to food preserving, due to its antioxidant properties²¹. In monasteries, honey was

20 Spatharakis 2004, fig. 51.

21 Dalby 2003, 151, 152, 157. Anagnostakis 2013, 82, 88-92. Anagnostakis 2013(a), 175, 176, 180, 181. Liveri 2010, 24-29.

a vital dietary substance, served on specific days and season periods²². On the other hand, wax, next to its self-evident use for candles, was a basic ingredient for the so-called encaustic technique²³ and was mixed with Chios mastic in order to produce a dye applied on sculptures²⁴. Both wax and honey were widely applied in medical and pharmaceutical treatments, especially those related to cosmetics and gynecology. The use of bees as guided “biological” weapons, following a century-long tradition, was described in Byzantine written sources, such as the *Taktika* (895-907) of Emperor Leo VI the Wise, in the chapter *On Naval Warfare*²⁵. Bees were also related to torture in some *Lives* of saints, as in the cases of Maurikios and Asteios, bishop of Dyrrachion. The latter was put to death while covered with honey and stung by bees under the hot sun in the year²⁶.

Bees, beehives and apicultural scenes are present in a limited number of Byzantine pictorial sources. These are usually details depicted in mosaics, miniature artifacts, illuminated manuscripts and sculptures. They represent various forms of beehives;

(a) woven wicker, as in the cases of the mosaic pavement of the Hippolytos Mansion in the basilica of Madaba in Jordan²⁷ (**Fig. 4**), probably the ivory caskets attributed to Constantinopolitan workshops of the so-called “Macedonian Renaissance”²⁸, the 12th century reliquary from the Treasury of San Marco, Venice²⁹,

(b) horizontal wooden and plank (*Sacra Parallela* cod. 923³⁰ **Fig. 5**), *Homilies* of Gregory of Nazianzos cod. Par. gr. 533³¹,

(c) clay, cylindrical shaped, open only in front end (monostomes, *Cynegetics-On Haunting* by Pseudo-Oppian cod. Gr. 479,³² (**Fig. 3**),

22 Talbot 2007, 115.

23 Doxiadi 1996, 93-98.

24 Coden 2004, 304-311. Coden 2006, 33-68.

25 Dennis 2005, 526.

26 Lockwood 2008, 9-25. Mavrofridis 2008, 233-238. Germanidou 2013, 91-104.

27 Piccirillo 1993, 66, 51, fig. 3, 55, fig. 6. Buchhausen 1986, 147-148, fig. 124, 125, pl. IX.

28 Beckwith 1962, 12, pl. 16.

29 *Architecture as icon...* 2010, 160-161, where past bibliography.

30 Weitzmann 1979, 120, fig. 237, pl. LX.

31 Galavaris 1969, 236. *Byzance. L'art byzantin...* 1992, 356, n. 267.

32 Spatharakis 2004, fig. 128.



Fig. 4 Mosaic pavement of Theotokos basilica, depicting cupid stung by bees in Madaba, Jordan, 6th century.

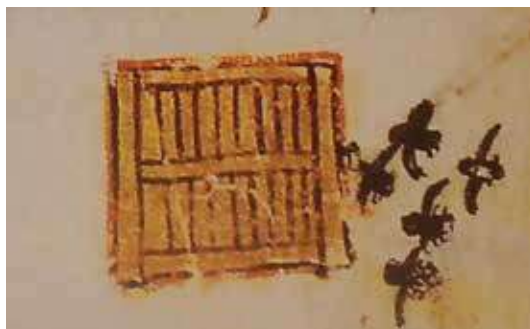


Fig. 5 Miniature of a wooden plank beehive, *Sacra Parallela*, cod. Par. gr. 923, first or second half of 9th century.

(d) horizontal tree trunks or clay, open at both ends (distomes), *Homilies* of Gregory of Nazianzos cod. Taphou 14³³ (**Fig. 6**), and finally

(e) vertical tree trunks (*Job*, Par. Gr. 135³⁴ **Fig. 7**).

The different types of beehives not only bear witness to the apicultural practices and methods used in various regions at specific time-period; they can also serve as potential evidence for a number of factors, such as the local materials available for manufacturing daily objects, the regional eco-system and the related economic sources exploited. From the artistic point of view, the beehive types can be used in the study of pictorial sources, principally in illuminated manuscripts. A key-example is the plank 33 Vocotopoulos 2002, 137, fig. 64.
34 Velmans 1967, 227, 228, pl. 23. Liveri 2010, fig. 7. Linardou 2011, fig. 11.4. See Andrews 2008, 111-119 for past bibliography.



Fig. 6 Horizontal tree trunks or clay beehives, open at both ends (distomes), *Homilies* of Gregory of Nazianzos, cod. Taphou 14, 1075-1085.



Fig. 7 Miniature of a tree-trunk beehive, *Job* cod. Par. gr. 135, 1362.

hive depicted in *Sacra Parallela*, which may probably be attributed to a South Italian workshop rather than a Palestinian one, based on the fact that in the latter region wood was scarce and hardly used for utilitarian objects. Another case is the trunk-hive illustrated at *Job*, presenting the notch opened at a high point, a structural detail that may allude to western medieval patterns.

In the mid Byzantine era, the most prominent pictorial source on apiculture, though exhibiting strong western influences, is the group of the *Exultet* rolls, created in monasteries south of Rome. They owe their name to the initial word of the hymn *Exultet iam angelica turba coelorum...* chanted on Holy Saturday, according to the Latin ritual³⁵. The hymn included the “Praise of the Bees”, where the bee is exalted as creator of the holy wax, the honey, and above all, as a direct symbol of the Virgin Mary due to the insect’s reputed physical chastity. The graphic details of the description allowed for bold illustrations of apicultural scenes. Three categories may be distinguished according to the main theme depicted: in the first group, the character of the scenes was narrative and the tasks of apiculture were presented realistically. Beekeepers were depicted, in various and vivid poses, performing honey harvest and production transport, swarm gathering and capture. They were using all the necessary equipment and were clad in the appropriate clothing, which covers the whole body, hands and feet in full like a primary “working-uniform” (Bari 1, Mirabella 1, Brit. Mus. Add. Ms. 30337, Vat. Lat. Barberini, Pisa 2, probably Bari 2, **Fig. 8**).

The main theme of the second group is the depiction of beehives and bees, without portraying any people or bearing connection to a religious scene. In the majority of images, beehives made mainly of wood and planks are piled in rows, forming a roofed apiary (Vat. Lat. 9820, Capua 2, Troia 1, Gaeta 2, Gaeta 3, Montecassino 2, Paris 710 (Fondi), Troia 2, Troia 3, Casanatesne, Salerno, **Fig. 9**). In the third group, bees entering and flying around their beehives are exceptionally pictured flanking the scene of the Nativity of Christ, as symbols of the Immaculate Conception and the birth of Christ by Virgin Mary. This iconographic unicum in medieval art of the period stands out for its bold character, remarkable synthesis and striking compelling dogmatic allusions
35 The bibliography of the *Exultet* rolls is extensive. See in general: Avery 1936. Belting 1968, 167-183. Cavallo 1973. Belting 1974, 5-6, 15-16. Cavallo, Orofino, Pecere 1994, 129-141. Pace 1994, 15-33. Forrest-Kelly 1996. Speciale 2000, 191-224. Tsuji 2000, 103-140.

(Montecassino1, Gaeta 1, J. Rylands Libr.)³⁶.

There are few examples of individual representation of bees. In most cases bees either form decorative part of a wider pictorial composition imitating nature or they assume a symbolic function. In this latter group one can include the intriguing and rare representation of bees among other Christological motifs found in the mosaic pavement of the baptistery at Kelibia in Tunisia³⁷; also, the early Christian (6th century) relief images portrayed on capitals from Constantinople and on a marble door frame from the Acheiropiitos church in Thessaloniki (Fig. 10)³⁸. Honey, on the other hand, is singularly depicted in the Parable of the Unicorn, in the novel of *Barlaam and Josaphat*, symbolizing human vanity³⁹. The decorative design of the hexagonal honeycomb is occasionally, though not often, depicted as an accessory pattern on wall paintings, drafted for example on mantles and secondary architectural spaces, while also used for the outline of liturgical ware. In a few notable cases the motif acquired a symbolic meaning, probably emanating from funerary allusions of ancient times, for example on the garment covering the death bed in the scene of the Dormition of the Virgin in the church of Panagia Mavriotissa, Kastoria⁴⁰.

Archaeological evidence for beehives is a valuable source of information, although rarely identified and recorded. It was only in the late '70s that pottery sherds with incisions on their inner surface were unearthed from the Hellenistic Vari House at Athens and were chemically tested with the method of gas chromatography by the American excavators⁴¹. Wax residues were found on the walls of the sherds, confirming the hypothesis of their apicultural use. Interior grooving in random lining became the main identification lead for the horizontal, clay beehives, although it was never connected to any real practical need or met functional requirements.

The excavated beehive finds of Byzantine date are brought together and studied, based on their form and typology, but also on their geographic distribution and chronological range. Right from the

36 Germanidou 2012, 257-264.

37 Février, Poinssot 1959, 151-156. Palazzo 1992, 102-120. Liveri 2010, 11-12, fig. 3.

38 Firatli 1974, 45, fig. 7. Maguire 2012, 55-57, εικ. 2.2.

39 Der Nersessian 1970, 63-67. Dufrenne 1978, 91, 143-144.

40 Pelekanidis, Chatzidakis 1992, 66-83.

41 Jones, Graham, Sackett 1973, 354-452.



Fig. 8 Miniature of Exultet roll Vat. Lat. Barberini 592, 1070-1100.

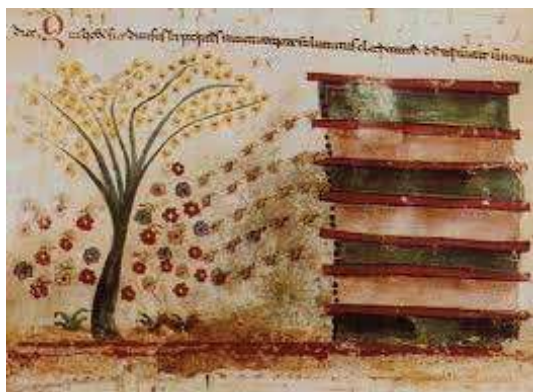


Fig. 9 Miniature of Exultet roll Troia 3, 1150-1200.



Fig. 10 Bees on a marble door frame, from Acheiropiitos church, Thessaloniki, 6th century.



Fig. 11 A clay beehive from Isthmia, Corinth, 6th century. Details of the inner grooves and the domed back.

start, one has to acknowledge the limited amount of published material. Furthermore, errors used while describing beekeeping vessels and sherds impeded archaeological documentation and forestalled conclusions. From a geographical perspective, finds were recorded in Attica (Ancient Agora of Athens, feet of Hymettus, Mesogeia outskirts)⁴², Boeotia (both from the capital Thebes, as the centre of production, and from other rural sites)⁴³, Delphi⁴⁴, Crete (especially Eleftherna⁴⁵ and Gortyna⁴⁶), Skyros⁴⁷ and the Hexamilion fortress in Isthmia, Corinth⁴⁸ Fig. 11). From a chronological point of view, samples were

42 *Everyday Life*...2002, 135, n. 147. *Alimos*...2006, 139, 143, 146.

43 Vroom 2003, 140, 144-145. Vroom 2005, 50-51

44 Pétridis 2003(1999), 445, fig. 5. Pétridis 2010, 120-121, pl. 39, fig. 209, 210. Pétridis 2010(2006), 95, fig. 8. Pétridis 2013, 197, fig. 40.

45 Anderson-Stojanović, Jones 2002, 345-376.

46 Yangaki 2005, 162, 464, pl. VI, fig. 5,6,7.

47 Karambinis 2015, sporadically.

48 Di Vita 1993(1988-1989), 446-448, figs. 33a-b, 34a-b. Crane 1999, 191-192, fig. 22.2d.

mainly dated to the 6th century, with the absence of late Byzantine finds being noteworthy.

In all these cases, beehives were made of clay, were meant to be positioned horizontally in groups and form cylindrical walls. Despite the limited number of known examples, some interesting aspects of material technology can still be investigated: these may relate to the various arrangements of the inner grooves or to the presence of decorative elements, such as painted bands and signs on the exterior (Fig. 12), and characteristic letters. Furthermore, the construction of notches on the rear closed end of the vessel improved ventilation and facilitated both, the bees' circulation and honey collection by the beekeepers. Found in the same contexts with beehive sherds and also related to apicultural practices were such items as clay circular extension rings, which were adjusted on the opening to increase the capacity of the beehive, as well as the lids equipped with a bee passage hole, which blocked the entrance to the vessel. No architectural remains have been identified as an apiary, at least from the Byzantine era. A single



Fig. 12 A clay beehive from Delphi, with painted bands on the exterior, 6th century.

exception is recorded in the blocks of beehives hewn in the tuff rocks of the Cappadocian plains. This, however, is a singular form of apiculture adjusted to a unique and distinctive landscape⁴⁹.

Concluding this short presentation, questions are raised on the matters that were briefly presented above; the documentation of the almost unknown beekeeping culture within the frame of the Byzantine society; the re-creation of a particular aspect of the daily life and the working routine of the common Byzantine people, merely obscured or partly exiled by current bibliography and scholarship; finally, the highlighting of the “aesthetic” value of a humble yet functional object of everyday life, such as a beehive, and its contribution to the clarification of collateral issues related to written sources, works of art, topography and ceramics.

⁴⁹ Demenge 1995, 48. Bixio, De Pascale 2013(2012), 61-68.

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WILD AND DOMESTIC HONEY IN MIDDLE BYZANTINE HAGIOGRAPHY: SOME ISSUES RELATING TO ITS PRODUCTION, COLLECTION, AND CONSUMPTION

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Information provided to us by Byzantine Hagiography relating to the production, collection and consumption of honey is not particularly copious but very specific and possibly unique. In this paper which focuses on information mainly from the 8th-12th century, we chose those Hagiographies best representing the subject and in fact those concerning Byzantine Southern Italy, Calabria, the Southern Peloponnese, Crete and south-west Asia Minor, specifically the mountainous area of Antalya. The imaginary arc formed by these regions corresponds to the maximum area covered by the Middle Byzantine state and characterized largely as dry arid and semiarid climates, with temperate coastal or island honey-producing regions, as well as large mountain ranges, forests, gorges and plateaus with a continental climate (**Fig. 1**). Ever since ancient and of course Byzantine times up to the present day these regions have been famous for their honey. In the hagiographies we chose to study we shall focus mainly on views on the production and consumption of honey by monks and which to a certain extent reflect the opinions of the Middle Byzantine man. Indeed in some cases details are given about wild and domestic honey, their co-existence in production and consumption, as well as the gradual replacement of the former by the latter. We must point out from the start that we shall only deal briefly with the abundant information provided by the monasteries' Typika on the amounts and kinds of honey in the monastic diet.

We start from Calabria. A host of Middle Byzantine hagiographical texts provide us with information

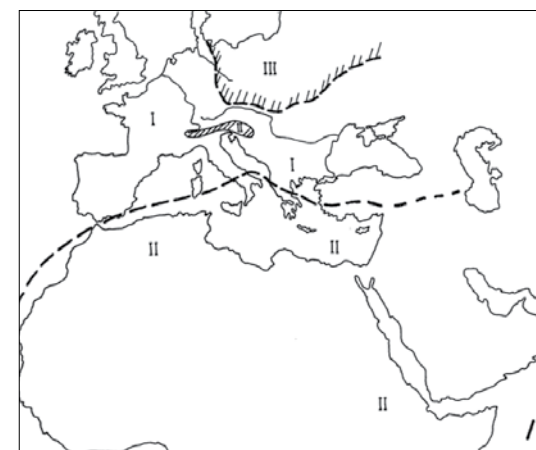


Fig. 1 Map of arid regions indicated by II according to an older diagram by F. Ruttner (1979) regarding the distribution of various types of hives in Europe (From Naso 1989, 216).

about bee-keeping in Southern Italy. Despite the climate changes over time, Byzantine bee-keeping in the region developed, as today, in a stable Mediterranean environment, with long, dry summers from mid-May to mid-September, when temperatures could exceed 40°C, and with mild winters with rainfall in the coastal regions and on the plains, but cold and snow on the mountains. And so as not to repeat ourselves later on, the other regions in the arc to which we shall refer (Crete, the Peloponnese, and Southern Asia Minor) have roughly the same climate (**Fig.1, 2**). As regards the area of Calabria, Greek sources make

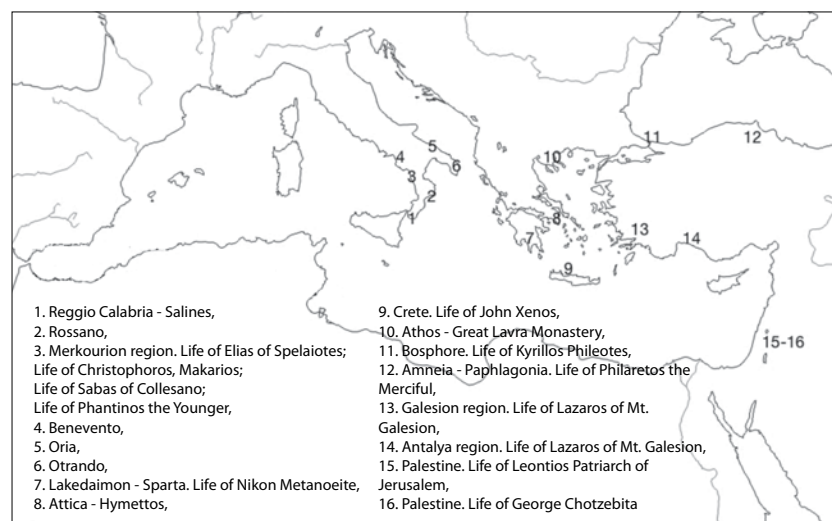


Fig. 2 Places and Lives of Saints concerning bee-keeping referred to in this study (I. Anagnostakis).

no mention of wild bees and wild honey, without this meaning that there weren't any. On the other hand we have accounts of domestic honey from the coastal area, eg. from Rossano, as well as from the mountains where Byzantine monasteries were located in which the monks were engaged in bee-keeping. This could include two to three kinds of honey, thyme and flower honeys from the coastal region and honey from the coniferous trees on the verdant mountain slopes¹. In fact according to information from physicians in the region, excellent honey was produced in the 10th century in Otrando and Oria, and above all the honey from Rossano was considered on a par with that from dry Attica, namely the thyme honey from Hymettus, with which constantly throughout the years since Antiquity all honeys have been compared² (**Fig. 2**). Mention should also be made of the widespread dissemination in Southern Italy and the Longobard Benevento of beekeeping depictions, rich in detail and expression, on parchment rolls with

clear Byzantine reference, known as *exultet* (with the Christian hymn to the bee), and which reveal the important role played by beekeeping in monasteries and generally in the economy of the region from the 9th century onwards³.

So *Saints' Lives* mention then that the Byzantine monasteries of Calabria had bee-hives and took particular care of protecting the bees from attack by wild animals. In complete contrast to modern times, we have evidence during the Middle Byzantine years of the existence of bears, wild boars and deer in the region. *Lives of Byzantine Saints of Southern Italy* note the destructive nature of wild boars and bears, animals that trample gardens and destroy legumes, fruit and bee-hives. They even describe the sheltered places in the hewn-out rocks and the threshing fields where cereals and wine were stored, and hives protected, providing in other words valuable information about crops and agricultural practices in the region⁴.

The *Life of Elias of Spelaiotes* (864-960) mentions that Elias, a saint who roamed from Sicily to the Peloponnese but founded a monastery in Calabria, comes face to face with a bear that has come down from the mountain opposite the monastery and eats the honey from the hives. The bear is described as a savage beast that often stole from the clay hives (συλοῦσα ἀπὸ τῶν ἀγγείων τῶν μελισσῶν), namely

3 Avery 1936; for the *exultet* with bibliography Germanidou 2012, 257-264 and Germanidou 2017, 66 ff.

4 Luzzi 2006; Ditchfield 2007, 155-158; Anagnostakis 2011, 219-223; Anagnostakis 2014, 189 and note 40.



Fig. 3 Dilapidated, circular bee-garden (melissokepos) built with walls of loose stones and holes. Unpublished bee-garden (circa 17th - 18th c.) in the place named Melissokepos from Gouves Pediados, Irakleion Crete (Photo Ilias Anagnostakis).

breaking them, eating the honey and leaving undisturbed⁵. It should be noted that to protect them from thieves and destructive animals the hives were usually surrounded by a fence or a stone-built circular wall and this enclosed area in modern times was called “μελισσομάντρι” or “μελισσόκηπος”, in other words “bee-garden”. The *Geoponica* in fact reveal how to construct a θριγκίον, an enclosure with loosely laid stones (ἐξ ἀραιῶν λίθων), in other words with many openings for bees to go in and out: “the beekeeper (ἐσμοφύλαξ) should build a wall (θριγγίον) with loose stones around them so that bees can fly into the holes and escape the dew and any predatory birds”⁶ (**Fig. 3**). In a later 13th-century Saint's *Life* the honey is called κηπευτόν, meaning produced in a “bee-garden”, a domestic honey, as this adjective is widely used by physicians in Late Antiquity, and not only then, to describe domesticated, cultivated plants and other products and as the opposite of the corresponding wild ones⁷.

5 *Life of Elias of Spelaiotes*, 867A; Naso 1989, 214; Anagnostakis 2011, 219-221.

6 *Geoponica*, Book 15, 2, 9 and English translation Dalby, 300. See also Koukoules 1952, 297-302; Crane 1999, 188.

7 *Life of Leontios Patriarch of Jerusalem*, 58 § 23 12 and commentary 175 where the editor understands that “κηπευτόν means something grown in a home garden, so maybe this was honey from bee-hives which were placed in or around a home orchard... it can also mean honey made from various plants such as carob or sesame”! However, on the use of κηπευτόν meaning cultivated and as the opposite of wild, see Dioskorides,

Regardless of the miraculous or ecological way in which the saints dealt with the bear, what can be deduced from the *Life of Spelaiotes* is the ongoing concern about guarding and protecting the bee-hives and the crops. Besides, in the *Life* the very monastery the saint was to found is described as a hive and the monks as bees (this is of course a common hagiographical topos) in accordance with the dream vision seen by the saint. He saw a swarm of bees (ἐσμὸς μελισσῶν) flying around his head, not intent on stinging him, but on the contrary their buzzing was melodious. And the saint took a large empty vessel (μέγα σκεῦος κενόν), put his head in with the bees flying around it and thus the bees remained in the vessel and a hive was created which he put in the garden with the plants and the flowers. When he took his head out of the vessel, some bees that had got tangled in his beard flew away. And the saint interpreted his dream to mean that on that spot he was to build a monastery with many monks⁸. The various elements of this dream reveal a) the way to create a domestic apiary from a free or wild swarm (by placing the swarm in a clay vessel/hive and putting it in a garden with different plants and flowers) and b) it reminds us of the images of Eros stealing honeycomb, showing him putting his head inside a hive⁹ (**fig. 4**). Probably a similar wild swarm or some swarm (συστροφὴ μελισσῶν) that had escaped from its hives had settled in a vessel at the monastery of Chotzeba in Palestine, according to the *Life of Saint George Chotzebita*, a 6th-7th century saint. The swarm had begun producing honey in the old clay vessel (παλαιὸς κέραμος) that lay in the courtyard of the monastery¹⁰.

What interests us here is the taming of wild nature, the transition from the escaped, or wild bee swarm to domestic honey keeping and Elias' creation of an apiary (be it as a vision) in the cave where he lived as a hermit. Indeed according to the *Life*, the new monastery would acquire an apiary which though would always be coveted by wild animals and

Book 2, 119, 1; *Geoponica*, Book 12, 30, 7.

8 *Life of Elias of Spelaiotes*, 864. Gerstel 2007, 151. See something similar in the very early apocryphal story (2th c.) when dozens of white bees leave honeycombs and hives and envelop Aseneth's entire body and head, Joseph and Aseneth, § 8-17x: And bees came up from the cells of the comb, and they were white as snow ... And all the bees flew in circles round Aseneth, from her feet right up to her head; and yet more bees, settled on Aseneth's lips. See also on Aseneth's gastronomic vision and mystical theophagy, Putthoff 2014, 96-117.

9 On the subject of the putei, see illustrations and presentation with all the relevant bibliography, Germanidou 2017, 54-59.

10 *Life of George of Chotzeba*, § 13.

particularly bears. So one day when Spelaiotes saw a bear coming to steal honey from the monastery's bee-gardens, he yelled to drive it away, without harming the animal in any way. He severely scolded it, rebuking it for shamelessly stealing the product of the monks' labours, and ordered it to leave and never return. And the beast lowered its head and went away in shame¹¹. Human feelings and logical behaviour are projected onto the bear that tries to steal the honey. This is made easier by the fact that the bear is considered a wise animal that resembles in every way a man; it walks upright and has the same limbs as he does¹². Spelaiotes' treatment of the bear is characterized by precisely the same anthropocentrism that we see in its extreme form in 6th-century Italy in Gregory the Dialogist's tale of the bear-shepherd in a flock in Norcia in Umbria¹³.

A similar story to that of Spelaiotes and the bear appears again in Middle Byzantine Calabria, according to the *Life of St. Christopher* and his sons, Makarios and Sabas of Sicily (10th c.), most likely written by an Italo-Greek, the Patriarch of Jerusalem, Orestes (- 1005/6). The saints, already renowned ascetics, escaped to Calabria after the Saracen invasion of Sicily and lived as monks initially in Reggio and Salines, ending up in the Merkourion region, in the valley of the Lao river, an area famed for its forests, waters, caves, hermitages and monasteries and, according to the *Lives* of the saints, also for bees and bears. Although the monastery's crops were guarded even at night, a bear managed to destroy the gardens that the monks had grown in specially deforested, cleared areas¹⁴. Southern Italian *Lives of Saints* frequently refer to the extensive clearing and crop-planting of entire areas during the 10th and 11th centuries. Tree-felling means the disappearance of wild flora and fauna and obviously of wild bees¹⁵. So when

Christopher's turn comes to guard the monastery's legume crops, he gets chatting with the bear. In fact the question he puts to the bear expresses his doubt as to how he should treat it, either as a beast or as something different, closer to man. It is an ecological approach that is only possible to a bear and almost never or very rarely to any other destructive animal. It is as though the saint is addressing a person with reason, feelings and morality when he asks it if it was sent by God to punish them or if the injustice committing to the monks by stealing their crops is its own choice. The bear is supposedly aware of the injustice like a sinful man, feels ashamed of his actions and is persuaded to move, to go to other places, as the story says¹⁶. The bear's removal that is repeatedly mentioned in the *Lives* simply refers to the expulsion of wild animals, the deforestation and cultivation of untamed wildernesses and their turning over to domestic apiculture. Moreover, widespread domestic bee-keeping and honey consumption emerges in the Merkourion region when someone from a village in the area wishing to receive the blessing of St. Sabas, came up with the idea of keeping honey as a gift, but as his own hives (σίμβλον) had no honey, he stole some from the hives belonging to his fellow villagers. As usual the saint becomes aware of the incident and reprimands him (also a common hagiographical topos) and we learn of the existence of more than one apiary in the region¹⁷.

Another story (similar to the previous ones) about dealing with a bear that eats honey from the hives of the monks in Byzantine Calabria (region of Merkourion) appears in the *Life of Phantinos the Younger* from the 10th century (late 9th – late 10th c.). The monks take up arms to kill it, but again Saint Phantinos, like Adam in Paradise before his disobedience who lived and talked with the animals (ἄλλος Ἀδὰμ πρὸ τῆς παρακοῆς γεγονώς), warned the bear of the fate that awaited it and persuaded it not to appear in the region again¹⁸. The bear moves on and is not seen there again. Phantinos in another incident calmed and drove away hungry wild boars that surrounded him menacingly after he came across them in the forest during the harsh winter eating wild pears¹⁹.

takis 2014, 189 and note 40.

16 *Life of Christophoros and Makarios*, § 15.

17 *Life of Sabas of Collesano*, §28. See also in 1007 the donation of 2 hives by a monk to the Greek monastery of saint Elias and Anastasios of Carbone in Lucania, Robinson 1929, 136. 38; Germanidou 2012, 264.

18 *Life of Phantinos the Younger*, § 24. Anagnostakis 2000, 172-173.

19 *Life of Phantinos the Younger*, § 12.



Fig. 4 Eros the honey thief, detail from a basilica's 6th-century mosaic floor, Madaba Jordany.



Fig. 5 Driving away the bear that has stolen honeycomb, cod. par. gr. 550, f. 94v (11th /12th c.), Bibliothèque Nationale Paris (Photo A. Grabar, Byzance. L'Art Byzantin du Moyen Âge du VIII e au XV e siècle, Paris 1963, 145).

In all the aforementioned cases the animal is simply pursued and driven away, as both its integrity and the protection of the hives are taken seriously into account. In addition, all these stories use in their narration as a commonplace the concept of the bear's well-known partiality for honey. In fact the Byzantines considered and called the bear μελισσοφάγα – honey eater²⁰ (Fig. 5).

Completely different though is the treatment of a bear in another *Life* that is not related to the geographical arc we are studying but which is worth mentioning. According to the *Life of Kyrillos Phileotes* (ca. 1015-1110/20), on the Bosphorus, not fifty kilometres from Constantinople (Fig. 2), in the late 11th century a wild bear tormented Kyrillos' spiritual father: it used to steal honey from the few μελισσοφάγια, as he calls the hives²¹. Here though the monk kills the bear with one blow, wishing, according to the *Life*, to flaunt his bravery. The interesting reasoning behind the killing of the bear can be summarized as a simple dilemma between possession and ownership and thus survival: you or me. According to the *Life*, before the monk killed the bear, he put the following dilemma before it: either you will collect the honey or I will²². Here we find ourselves facing another type of monastic ideal and an entirely opposite view from that of Italo-Greek saints who clash ethically and ecologically with the bears stealing honey in Byzantine Calabria²³. In all probability there would also have been similar stories of honey-eating bears in Byzantine Asia Minor. Byzantine sources inform us about bear activity in mountainous areas and about the production and collection of wild and domestic honey. Indeed the destruction of hives by fierce animals is verified by the tradition in Asia Minor of constructing tower-like apiaries aimed at protecting the hives by placing them many metres above the ground (Fig. 6).

20 Paidiofrastos diegesis, verse 844; Anagnostakis 2011, 228-230.

21 *Life of Kyrillos Phileotes*, 99, §19, 1. See also, Hesyhios, Lexicon, letter kappa entry 4759 : (4758) κυψέλη· πλεκτόν ἀγγεῖον μελισσῶν, (4759) κυψελίδες· μελισσοφάτναι.

22 *Life of Kyrillos Phileotes*, 99, §19, 1.

23 *Life of Kyrillos Phileotes*, 99, §19, 1; Anagnostakis 2000, 172-173. In Anagnostakis 2011, 224-226 a comparison is attempted between two diametrically opposite types of behaviour to the bear, that of the 10th-century Italian monks and those monks originating from the military aristocracy of Komnenian years.



Fig. 6 Tower-like apiaries aimed at protecting the wooden, cylindrical hives from wild animals, Beydağları Antalya Turkey (Photo "Çamkuyusu, Turkey," Bryn Mawr Collections, Bryn Mawr College Visual Resources Center)

Before however moving on to Asia Minor and then ending up in Crete, another hot, dry region is worth mentioning, this time in the Southern Peloponnese, in the Byzantine province of Lacedaemon, where Saint Nikon the Metanoite (ca. 930-1000) was active, and his *Testament* (after 997) mentions wild bees (ἀγριομέλισσες) in a rocky, deserted area, full of ancient ruins, on a hill in Sparta²⁴. The wild bees fly out from the ruins of monuments and the rocks that are being excavated to build the foundations of a Christian church or even as a swarm they prevent the celebration of the Divine Liturgy. However, the translator in the English version of the *Testament* translates them as wasps, influenced by the reference in the *Life* that says wasps (σφήκες), a *Life* written somewhere in the middle of the 11th century²⁵. Demons and heretics are often equated and correlated with wasps or wild bees by the Byzantine authors of the *Lives* of saints. Probably in this case it is a commonplace, when in fact the wild bees or wasps emerge from ruins, wastelands and rocks in an area that still has many unbaptized persons. These wild bees could be the type of bees known as mason bees (*Chalicodoma murairia* F.) that are also called ἀγριομέλισσες by Greek people and they often make nests in various buildings and churches, defacing

²⁴ Testament of Nikon the Metanoite (ed. Lampisdis), 252. 48- 56. For this equation and correlation, see Anagnostakis 2000, 173-174.

²⁵ Life of Saint Nikon Metanoite, 72.36 (ed. Lampisdis), 124 §36 (ed. Sullivan) and Testament of Nikon the Metanoite English translation, 318.

Byzantine monuments in Greece²⁶. Anyway a swarm of bees flying over Byzantine Sparta, known as Lacedaemon, and which according to the *Testament* leaves, flies away and is lost at the edge of the river Eurotas, beyond the symbolism or the demonic relevance lent to it, must have been and is always a familiar picture in the Southern Peloponnese. This region with its pines, firs, chestnut trees, thyme and flowers, has always been a honey-producing area, located between Mounts Parnonas and Taygetos, Monemvasia and Mani.

Moving on now to Byzantine Asia Minor, the information we have on beekeeping from narrative sources and the *Lives of Saints* is sparse. An exception is the *Life of Philaretos* on beekeeping in 8th-century Paphlagonia where the saint lived (701-792), although the information provided by the *Life* written in the 9th century (821/822) is probably loaned, as is the entire story of the saint's life and tribulations, from the life of Job in the Old Testament. It says therefore that the rich and charitable lord Philaretos from Amneia, who squandered all his riches by giving to the poor, had many estates, many slaves, many beehives and many herds of animals: 250 hives, six hundred head of cattle, one hundred yoke of oxen, eight hundred mares in the pastures, eighty saddle horses and mules, twelve thousand sheep, forty- eight estates and many slaves. Apart from possible exaggeration, it was a very large fortune for a provincial lord, which though when compared with the other items, the 250 hives does not seem excessive. The terminology used for beehives (μελίσσια βουτιά), apiary (μελισσιών), harvesting the honey from the beehive (τρυνᾶν τὸ βουτίον τοῦ μέλιτος) is of particular interest.²⁷

However the most detailed information is provided by the *Life of Lazaros of Mt. Galesion* (ca. 966/7-1053), from all aspects both unique as regards the subject we are studying (wild and domestic honey) and Byzantine beekeeping in Asia Minor in general²⁸. Born in Western Asia Minor, near the Aegean coast in Magnesia on the Meander valley, during the second quarter of the 11th century and the third decade

²⁶ Mourikis et alii 1978, 229-236. I thank Sophia Germanidou for this information.

²⁷ Life of St. Philaretos the Merciful, 60.5-15, 74.249, 82.352-365 and translation 75 and 83. Nesbitt 1969, 150-158; Koukoules 1952, 297-300. On bees and grapes and τρυνᾶν μέλι, see Anagnostakis 2000, 179-182; Harissis - Harissis 2009, 45 and note 201.

²⁸ Life of Lazaros of Mt. Galesion, 508-588, and particularly about honey 513§13, 530 § 65, 534 §81-82 and English translation by Greenfield, 91-92, 153-154, 169-173.

of his life he roamed Asia Minor, through Phrygia, Pamphylia, Cilicia, travelled to Jerusalem, returning through Cappadocia and Pontus, settling for the remainder of his life in Galesion in Magnesia (Fig. 2). His *Life* offers us a great deal of information on the production and consumption of wild and domestic honey in rural and monastic communities where the saint lived, referring repeatedly to the production and consumption of honey as well as to the existence of bears on Mount Argaios (present-day Erciyes) in Cappadocia and in the mountainous region of Ephesus on Mount Galesion, where he finally settled down. Previously, though, during his approximately seven-year stay in the area of Antalya (984/6-991/2) he would lead the life of a hermit in a cave on a mountain near to the city and was on good terms with an abbot from a monastery in this mountainous region, which to this day has not been identified²⁹. The *Life* provides us with unique descriptions of the saint's activities during this period of his life in the area of Antalya and the wild hinterland, inhabited by honey collectors, heretics (probably Paulicians) and uncouth, uncivilized people, according to dominant Byzantine views³⁰. One of the inhabitants' main occupations was to collect wild honey on the steep mountain peaks in the region. It is worth mentioning by the way that ever since antiquity and up to the present day, honey has been produced in the area of Antalya, where as previously mentioned, traditional tower-like apiaries can be found (Fig. 6). These tower-like constructions are apparently used to keep the hives high up away from cunning wild animals like the bear. Nowadays in the mountainous hinterland of the Antalya the Taurus mountain honey, *Toros balı*, and a pine honey, *çam balı*, are produced and one of the most important honey festivals in Turkey is also held there (Antalya Honey Festival: Gündogmus in August)³¹.

²⁹ A reference in the *Life* indicates that ecclesiastically the monastery and the area belonged to the bishopric of Philetos who came under the metropolitanate of Lycian Myra, Life of Lazaros of Mt. Galesion, 512§10 and English translation 88, note 61. For this reason the monastery and honey-collecting incident are probably placed erroneously by some somewhere in Lycian Myra, Kaplan 1992, 38, Hellenkemper - Hild 2004, vol. 1, 153. Contrary to this, see Lambropoulou 1986, 78 note 67 and 149-150 note 52; Anagnostakis 2000, 186 note 71.

³⁰ Life of Lazaros of Mt. Galesion, English translation 88, note 60. Also Lambropoulou 1986, 149-156; Anagnostakis 2000, 186 notes 173-174.

³¹ On these constructions, see Germanidou 2017. On timeless honey production in the area,

So Lazaros in an effort to tame this wild place, again according to the *Life*, advised the inhabitants to give up the dangerous task of collecting wild honey from steep cliffs. Some, though, asked for his blessing to go to the precipitous part of the mountain to collect honeycombs (ὅπως ἀπέλθωσιν ἐπὶ τὸ κρημνώδες τοῦ ὄρους πρὸς τὸ τρυγῆσαι μελίσσεια). The saint underlines the danger of such work and by sharing with them the honey from the monastery, he demonstrates the safety of domestic honey and implicitly encourages them to set up apiaries. There were obviously reactions to the attitude of the saint, his opposition to a traditional occupation and practice. The *Life* describes precisely such a reaction. One honey collector claims he knows this job very well and is an expert (τεχνίτην εἶναι), that he has been doing it for many years and in defiance of the saint he goes to collect wild honey. At this point the *Life* describes how his helpers tied a rope to him and lowered him down the steep mountainside to the cave in which were the wild honeycombs, and that just as he was about to collect the wild honey the rope broke and the unfortunate craftsman fell to his death. This is in actual fact a unique description of wild honey collecting (it is considered the first such record and account in the Western world)³². I believe that this description could in a unique way annotate modern photographic material showing wild honey collection in the Himalayas, where honey collectors hang on rope ladders over precipices (Fig. 7)³³. I quote the whole excerpt:

"Some people went out to Lazaros from the village that lay near the mountain and asked for his blessing to go to the precipitous part of the mountain to collect honeycombs. The father, however, told the brothers to bring some honey and, when they had brought it, said to these people, "If it's honey that you want, look, here's honey! Eat as much as you want and then go back to your homes; but don't go onto the cliff there lest you return with a harvest of bitterness instead of the sweetness of the honey." One of them replied brashly to the father, "I've collected many such honeycombs and nothing bad has ever happened to me, so I'm not worried about going onto the cliff now." But the father answered him, "Believe me, brother, this time it won't do you any good to go there." However, when Lazaros was unable to dissuade them, despite

see Hellenkemper - Hild 2004, vol. 1, 153.

³² Crane 1983, 28-31; Kaplan M. 1992, 38 ; Anagnostakis Ilias 2000, 175-177.

³³ Crane 1983, 28-31, and 82 fig. 86; Crane 1999. See also the commentary and bibliography of the honey hunting of Nepal in English translation by R. P. H. Greenfield, *The Life of Lazaros of Mt. Galesion*, 91-92 note 70. And read more <http://www.dailymail.co.uk/news/article-2584541>.



Fig. 7 Honey hunters who risk their lives in the foothills of the Himalayas to collect honey
(Read more: <http://www.dailymail.co.uk/news/article-2584541>)

saying many things, he let them go and do what they wanted. So they went off and, after attaching a rope to the man who had told the father he was expert at this, began lowering him toward the cave. Before he reached it, however, the rope was cut through as if by a human hand, causing the wretched man to be flung down the cliff; he was smashed on the rocks and expired at once. So the others went down and picked him up, and then, amidst much weeping and wailing, went off to the village to bury him. But they told everyone about the father's prediction and the words that he had spoken to them in trying to prevent them from going there."³⁴

The important thing here is that once again the *Life* of a Middle Byzantine saint records the transition process from collecting wild honey to collecting domestic honey, as Lazaros "was trying to prevent them from going there". The monks showed

³⁴ Life of Lazaros of Mt. Galesion, 513§13 and English translation, 91-92.

themselves willing to provide the inhabitants with honey from the monastery's hives. This offers two possibilities a) either that we are dealing with a transition period, namely that domestic honey from the monastery is temporarily provided to the villagers until they can set up new hives and give up their wild life, or b) that the monastery produced such plentiful amounts of honey that it had a surplus to distribute and this constituted a means of approaching, proselytizing and subduing the heretics³⁵. Certainly both cases could apply. However the distribution of domestic honey leads us to yet another conclusion, that most likely not a lot of honey was consumed in monastic communities due to specific regulations in the monasteries' *Typika*. We have many accounts stating that honey was treated ambiguously by monks and was regarded as a delight and a temptation; it was either partly excluded from the diet or the clay hives were considered demonic and smashed³⁶. We are not sure that this kind of treatment applied everywhere, judging from the recorded amounts of honeycombs (κηρία μέλιτος) consumed, but this term may conceal mainly wax which the monasteries needed. Probably an exceptional case is that of the annual rations of a simple monk Damianos, based on a document from the Monastery of Great Lavra on Mount Athos, dated 1101/ 1102. What is strange for a single monk is the excessive amount of 102 litres of honey (μέλι) but only 3.4 litres of oil: this amount of honey corresponds to 306,000 calories. One explanation that could be put forward for the large amount of honey, usually given as honeycomb, is the need for making candles (but here the wax is mentioned separately), or even that the said honey makes up for the lack of calories and other basic nutrients caused by the absence of meat and dairy products in the monastic diet³⁷. Getting back now to the case of Lazaros, at the monastery of the saint on Mt. Galesion, inhabitants of the area sent honeycombs (κηρία μέλιτος) to the saint who lived the life of an ascetic on a pillar (a similar gift to that in the *Life* of Spelaiotes previously mentioned), a fact that can be interpreted to mean that the monastery sought honey and also that there was beekeeping activity in the greater area of Galesion³⁸. It is also mentioned

³⁵ Life of Lazaros of Mt. Galesion, 512§10 and English translation 88, note 61.

³⁶ Historia monachorum in Aegypto, §12, §26.33-34; Life of George of Chotzeba, §13; Byzantine Monastic Foundation Documents, 1704-1705, 1708; Anagnostakis 2000, 173-175; Androudis 2000, 211-220.

³⁷ Acts of Lavra I, 280-282; Kaplan 1992, 26; Androudis 2000, 211; Papagelos 2000, 190.

³⁸ Life of Lazaros of Mt. Galesion, 530 § 65 and En-

that the saint consumed a drink of honey or a mixture of honey and water, and boiled concentrated must, a kind of grape syrup (μέλι ἢ ἔψημα ἢ γλυκύ) and that at New Year his fellow ascetics ate *lalangia* (λαλάγγια), something like pancakes with honey, at that time the only sweetener in existence, along with raisins, prunes and figs³⁹. We can mention yet another example from the *Life of Leontios Patriarch of Jerusalem*, given in a monastic and symbolic context, that of a sweet similar to *lalangia* called *chartopittouta* (χαρτοπιττούτα), "a paper-thin cake" composed of flour and sweetened with "garden honey" (κηχευτόν)⁴⁰.

We shall close with a deliberately naïve question that leads us to an obvious answer and to general conclusions from this review of wild and domestic honey mentioned in Middle Byzantine Hagiography. Really, what purpose did apiaries in monasteries serve, if ultimately the monks did not eat much honey, at least openly and officially, and when the impression is given that, except in cases of illness, honey, just as oil, was a luxury, constantly in short supply and sought after⁴¹? The answer, although naively obvious, is based on yet another example from the *Life* of a saint in the ever driest, hottest, biggest honey-producing area in the arc we are exploring, Crete. Indeed what we shall present below is essentially a reproduction of what we maintained in a former article of ours, but updated with new data and bibliography⁴². The *Life and Testament* (1031) of John Xenos (fl. ca. 970 - after 1027 or 1035), who came from southern-central Crete, states that the saint toured many places and villages in Central and Western Crete (present-day prefectures of Heraklion, Rethymnon and Chania). Working alongside the locals, he built churches, constructed water tanks and bee-gardens (μελισσοργεῖον), planted vineyards, orchards with numerous kinds of trees, and founded monasteries which he endowed with many animals, sheep, goats, beasts of burden and with all the technical tools required by monastic

glish translation, 153-154. On honey hunting in more modern times in the same area and in Asia Minor in general, see Crane 1999, 46-47, 387.

³⁹ Life of Lazaros of Mt. Galesion, 534 §81-82 and English translation, 169-173. On sweets with honey in Byzantium, see Anagnostakis 2013, 87-92; Leontsini 2014, 123-131.

⁴⁰ Life of Leontios Patriarch of Jerusalem, 58 § 23. 10-13 and commentary 175.

⁴¹ Life of Sabas of Collesano, § 28; Life of Lazaros of Mt. Galesion, 530 § 65 and English translation, 153-154; Byzantine Monastic Foundation Documents, 1704-1705, 1708; Montanari et alii 2002; Ditchfield 2007, 157 note.

⁴² Anagnostakis 2000, 177-178.

and agricultural life⁴³. This creative work to redevelop a province, sometimes described as abandoned, desolate, dry, without wood and vegetation, occurred some decades after the island's liberation from Arab occupation (963). This is clearly a missionary and civilizing project aimed at boosting agriculture and production with the help of Byzantine ecclesiastical and imperial power, continuing the corresponding short mission of Nikon the Metanoite.

As regards the saint's intervention in apiculture, he founded the *metochion* (a dependency) of Saint Patapios in the village of Mousela (probably to the west of Rethymnon, where today there is only a river of the same name), and created an apiary (κηριανός) with 150 hives (μελίσσια). This *metochion* was a dependency of the monastery founded by the same saint in honour of the Mother of God Antiphonetria "on the mountain of Myriokephala" in Rethymnon and therefore the apiary belonged to the monastery which had 12 monks⁴⁴. While active in southern Crete the saint also created a bee-garden (μελισσοργεῖον, very lush according to the late codex K) at the monastery of St. George at Azogyre, which it was recently suggested should be placed in the thyme, savory and herb-filled area of Sfakia, on the Libyan sea coast, at the western end of Crete near the present village of Azogyres⁴⁵.

Of these two cases of creating a bee-garden, the first is of particular interest that will allow us to answer the question we posed. The *Life* states the following: "from the godly Christians in the area the saint collected 150 hives (μελίσσια) which he placed in the monastery's bee-garden, *kerianon* (κηριανόν), *kerianon* from *kerion* (κηρίον), wax and candle⁴⁶". Thus the place where the monastery's hives are kept takes its name from the product that is of greatest interest to the monks, wax. The monasteries were always interested primarily in wax and created the

⁴³ Life of John Xenos, 4-8; Testament of John Xenos, 11-12 and English translation of the testament with commentary by Fiaccadori, 143-147.

⁴⁴ Life of John Xenos, 6. 80-85 (12 monks, codex C), 9. 46-51 (6 monks, codex K). For all references to place names, suggested identifications and the activity of the saint, we hereinafter refer, without noting it, to the edition Tomadakes, Life of John Xenos, 13-22. See also Psilakes 2014, 217-235.

⁴⁵ Life of John Xenos, 7.109-117 (codex C), 11. 107-119 (codex K); Testament of John Xenos, English translation, see commentary, 144; Psilakes 2014, 223.

⁴⁶ Life of John Xenos, 6. 81(codex C), codex K does not mention anything.

infrastructure to give them trouble-free access to this raw material. Therefore, the number of 150 hives is in no way excessive, as is the opinion of some who focus their attention only on honey production and its consumption by 6 or 12 monks, and do not take into account the production of wax⁴⁷. Besides, even in the case of a disproportionately large honey production in relation to the number of monks, the honey could be distributed to the country people, as we have already seen in the *Life of Lazaros of Mt. Galesion*, and we cannot even rule out the possibility of the monastery exchanging it for other products or trading it.

But of even greater interest is the way in which the *kerianon* is created. While no details are given about the creation of the bee-garden of Azogyres, it is clarified that the creation of the bee-garden of Mousela was made possible by the contribution of the faithful⁴⁸. If in other cases that we saw previously the faithful gave honey to the monasteries (*Life of Sabas of Colessano*, *Life of Lazaros of Mt. Galesion*), here the faithful offer entire hives and help the monastery acquire its own bee-garden, its own honey and wax. Besides, even during the Arab occupation, Crete was renowned for its rich honey⁴⁹, and the bee-garden of Azogyres is described as very wealthy, opulent, consequently the superabundance of bees and hives could not be ruled out which could be generously given away. This fact of the superabundance of bees and the offer of hives is attested and emphasized even more by the creative activity of John Xenos, who along with vineyard and orchard crops, promoted bee-keeping.

Based on the *Lives* of the saints we have studied, I believe that we have been able to see how from wild nature or abandoned countryside we are led to the creation of areas clear-felled for crops, to the not so ecological onslaught by medieval man on the environment, and the development of bee-keeping through monasteries. Domestic production, as opposed to the hazardous and unpredictable or chance element of wild production, was one of the monasteries' priorities which ultimately contributed to the spread of beekeeping in Byzantium⁵⁰. *Lazaros of Mt. Galesion's* exhortation to the boorish collectors

47 Kaplan 1992, 38; a different view by Anagnostakis 2000, 177.

48 See also in 1007 the 2 hives given by a monk to the Greek monastery of saint Elias and Anastasios of Carbone in Lucania, Robinson 1929, 136. 38.

49 Christides 1984, 98, 117; Anagnostakis 2000, 177.

50 Papaggelos 2000, 190-210. For much of that previously mentioned, see Anagnostakis 2000, 177-178.

of wild honey reveals in a unique way this change and the monasteries' offer: "Look, here's honey! Eat as much as you want!"

From the 11th century onwards the production of honey became widespread in Byzantium and this brought about the introduction of special taxes. In the mid-12th century (1152) evidence can be found for the first time of the *melissoennomion* (μελισσοεννόμιον), a tax or charge levied on bee-hives⁵¹. In the same century a Jewish writer, Samuel ben Meir (Troyes, c. 1085 – c. 1158), affirmed "that beekeeping in the Greek kingdom stood on a higher level than in his own land, northern France"⁵², although we are not sure if this was ultimately an impression formed from ancient Greek and Roman medical authors.

In conclusion, monks, like the Italo-Greek saints and Lazaros of Mt. Galesion and John Xenos from Crete, who civilized wild, desolate or abandoned places, all these hermits (from ἐρημίτης, a person living in solitude, in the desert or wilderness), all these solitary bees⁵³, as they are described by their biographers, offer us the unique experience and account of the transition from wild honey collecting to domestic, well protected and organized beekeeping.

51 Bartusis 1991, 701; Oikonomides 1996, 74-76.

52 Kraus S. 1914, 113; Kazhdan et alii 1991, 130; Kazhdan 1997, 56; Anagnostakis 2000, 178.

53 Geoponika, Book 15, 2, 9 and English translation Dalby 330; Anagnostakis 2000, 171-173.

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BEEKEEPING IN ATTICA DURING THE OTTOMAN PERIOD (1456-1821): A MONASTIC AFFAIR

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Honey was by far the most famous and best-selling product of Attica during the Ottoman Period. Its production and distribution is significant, not only because of the special conditions formulated both by the period and the region itself, but also because bee-farming was practiced to a rather vast area in Attica. The most prominent source for the study of beekeeping is the accounts of the travelers, who would swarm about Athens from the 17th century and on, looking for traces of its ancient past; in the course of their descriptions, they would never overlook references related to aspects of everyday life of that time. Lately, invaluable information, coming from the Ottoman archives and most precisely from the tax registers, which had detailed records of Attica’s product fiscal classifications, has seen the light of publication. However, there is no archaeological documentation for the above practices in Attica, since the rather debased material used in the production line would leave no actual traces, e.g. the barrel shaped basket beehives.

Attica belongs to those regions of the Greek territory that enjoyed a mild rule under the Ottoman domination¹. The peaceful surrender of Athens to the

I would like to thank my colleagues and friends Sophia Germanidou, Georgios Mavrofridis and Prodromos Papanikolaou for their help in preparing this paper.

1 On the history of Athens and Attica under the Ottoman rule two old studies remain valuable: Kambouroglou 1889, 1890 1896. Philadelphus 1902. For a recent account see Karidis 2014.

Turks in 1456 and the granting of local governing privileges and other kinds of freedoms to the Christian population created an advantageous frame of living, which could not be overturned by the pressure or the deviations the Ottomans exercised from time to time. The Athenians and the villagers had the right to elect their own lords and to manage their community’s issues. During the 16th century Athens and Attica was in a prosperity climate; it had a healthy economy, grew demographically and at the same time monasticism was thriving and many churches and monasteries were being rebuilt. This 16th century boom withdrew gradually in the 17th and mainly in the 18th century, due to at-large developments and events within the Ottoman Empire. Nevertheless the milestone two monastic establishments, the Asomaton Petraki and the Penteli monastery, had managed to turn to the most powerful economic agents of the region.

During the Ottoman times bee-farming production of Attica started or rather continued with the dynamics it already possessed; according to the published tax registers of the Ottoman authorities, Athens produced in 1506 15.000 kilos of honey, whose cost was of 75.000 akce². In 1570 production had risen to 21.600 kilos, and its cost to 151.200 akce³. Two monasteries, that of Kaisariani at mountain Hymettus and the aforementioned Penteli monastery were the actual centers of production. Their honey connected the area of Attica to the Sublime Porte and it is believed to have contributed to the special

2 Kiel 1992, 420, pl. 4a and b.

3 Kiel 1992, 420, pl. 4a and b.

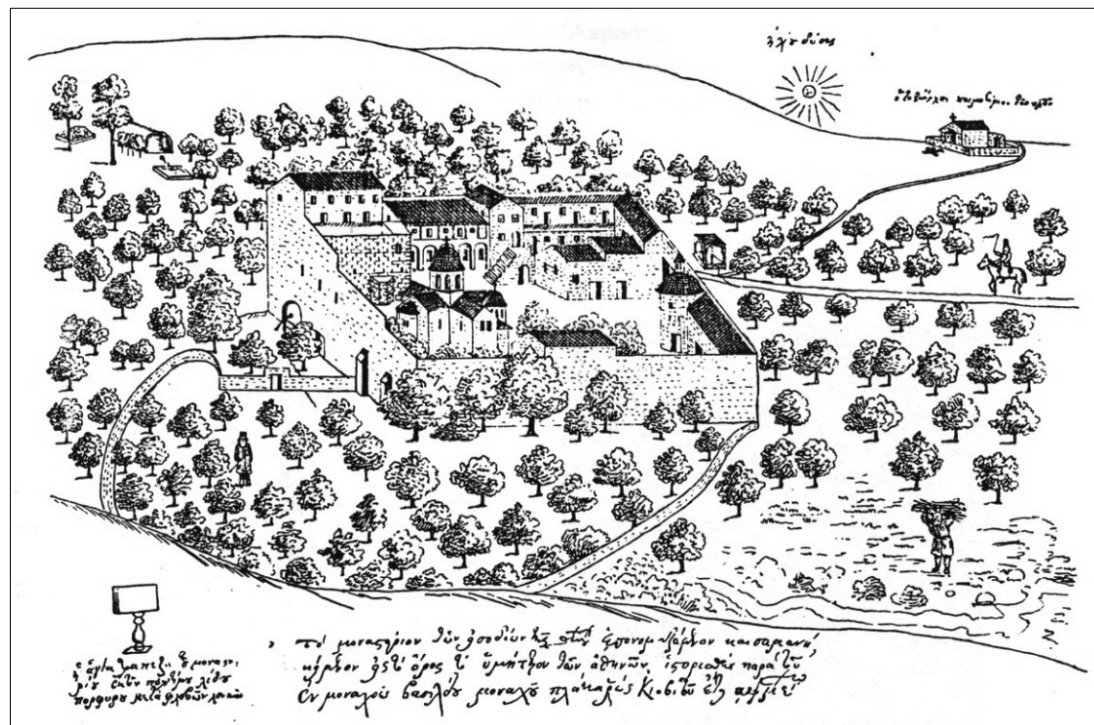


Fig. 1 The monastery of Kaisariani in a sketch of the Russian pilgrim Basil Barskij dated to 1745 (source: A. K. Orlandos, *Μεσαιωνικά μνημεία της πεδιάδος των Αθηνών και των κλιτύων Υμηττού-Πεντελικού-Πάρνηθος και Αιγάλεω*, Athens 1933, 160, fig. 213).

treatment the region benefited of by the Ottoman authorities. The honey's line production, described meticulously by George Wheler, Felix Beaujour and John Hawkins, has already been excessively treated in the studies of Georgios Mavrofridis⁴, leaving no place here for any lengthy commentary.

The monastery of Kaisariani (**Fig. 1**), founded close to a creek up in the mountain Hymettus at the beginning of the 11th century, lived uninterrupted up to beginning the 19th century⁵. Its monks practiced beekeeping systematically from the early 13th century, according to the exiled bishop of Athens Michael Choniatis's letters, which he addressed, a few of them, to the abbot of Kaisariani⁶. The mountain of Hymettus, whose vegetation has been the same since the ancient times, was covered up in aromatic herbs like thyme and produced a famed honey. Clay

beehives of the byzantine period have been tracked in different places all over the mountain⁷.

Beekeeping in Kaisariani must have continued swimmingly even when Attica was under the Ottoman domination, because, according to the legend, its abbot was among the leading personalities working towards the peaceful surrender of Athens. The earliest information about Kaisariani's apiaries can be dated two centuries later after the Ottoman held Athens, and comes from Western travelers' accounts. The French consul Jean Giraud wrote in 1674 that the most famous honey in whole Turkey was produced in Hymettus and that the best of it was made in Kaisariani⁸. Two years later Spon and Wheler would note that in Istanbul there was a high demand for honey produced in Kaisariani and they would go on describing –mainly the latter- its way of production⁹.

⁴ Mavrofridis 2010. Mavrofridis 2012.

⁵ On the history of the monastery and its building complex see Pallis 2009, 333–346, fig. 164–170, with earlier bibliography.

⁶ Lambros 1880, 311.11–18.

⁷ E.g. at the Pani hill, near Alimos (Kaza-Papageorgiou 2006, 143, fig. in page 146).

⁸ Collignon 1913, 415.

⁹ Spon – Wheler 1678, 223–225.

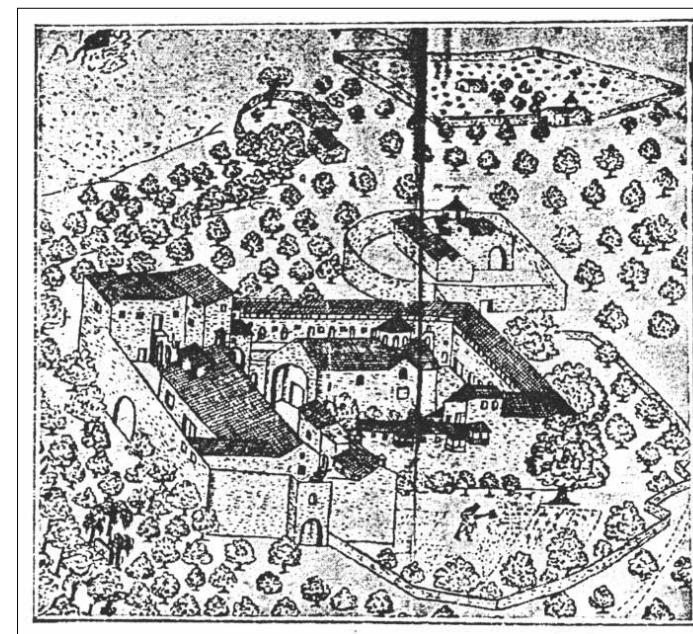


Fig. 2 The monastery of Penteli, in a sketch of the Russian pilgrim Basil Barskij dated to 1745 (source: A. K. Orlandos, *Μεσαιωνικά μνημεία της πεδιάδος των Αθηνών και των κλιτύων Υμηττού-Πεντελικού-Πάρνηθος και Αιγάλεω*, Athens 1933, 188, fig. 252).

However, things for the Kaisariani monastery took an unexpected turn. Albeit the tax exemptions or the affluence of its incomes the continuous maladministration during the 18th century led it on the verge of bankruptcy. The peril of losing its fortune and control over the Turkish authorities was averted, when the Athenian community succeeded to fixate Kaisariani to the local bishopric in 1792¹⁰ – until then the monastery enjoyed its own rule as a stauropegial one. By that year the few apiaries owned, about forty, are sheer evidence that its production had decreased a lot¹¹. The bishops of Athens used ever since the Kaisariani monastery as their own private property and were mainly interested in the gains made by the trade of honey. Already in 1794, Sibthorp wrote that Kaisariani's honey was the bishop's property and its pauper monks, being under austere surveillance, did not even allow him to taste it¹². Soon enough the monastery was turned from a monastic center to a beekeeping unit with its monks as staff. In 1802 Edward Clarke recorded that he had found in Kaisariani «a regular apiary»¹³. The destructions caused by the Greek Revolution of 1821 and the official dismemberment issued by the Greek state in

1833 did not manage to end the eight centuries of beekeeping tradition of Kaisariani, which continued during the reign of king Otto¹⁴.

The great honey production would have needed great storage spaces as well, for which there is only some indirect mention in the travelers' accounts¹⁵. From the surviving till today auxiliary buildings, the northeast wing could have been used as a storage place, because its ground floor is equipped with two great vaulted and shaded chambers¹⁶. Of course such an assumption cannot be proven as a systematic analysis and study of the building is still lacking.

The other important bee-farming center of Attica, the monastery of Penteli on the homonym mountain (**Fig. 2**), was founded in 1578 by the former bishop of Euripus, Timotheos¹⁷. It did not take too long before it turned to one of the wealthiest monasteries of Greece, owed a vast estate property and had many privileges granted by the Ottoman authorities. The first mention ever for the monastery's apiaries was made by the Ottoman traveler Evliya Çelebi, who passed from

¹⁴ Mavrofridis 2012, 403.

¹⁵ In 1805 Edward Dodwell found the monastery's storage spaces clear and filled up (Dodwell 1819, 485).

¹⁶ Charkiolakis 1997, 312, fig. 4-5.

¹⁷ Pallis 2009, 256–272, fig. 115–124 (with earlier bibliography).

¹⁰ Kambouroglou 1891², 134–137. Kambouroglou 1892, 119–122.

¹¹ Kambouroglou 1892, 123.

¹² Walpole 1818, 149–150.

¹³ Clarke 1814, 576.

Penteli in 1667¹⁸. A few years later, in 1676, Spon and Wheler visited the monastery; according to them the tax that the monastery had to pay was 6.000 pounds of honey, which was designated for the Valide Sultan's Mosque¹⁹. An extra quantity of pounds in honey was also sent for the same taxation for 5 piaster every quintal. The beehives of the Penteli monastery at an earlier date were believed to have numbered approximately 5.000 pieces, but as late as the late 17th century their number was much smaller. When Penteli annexed the nearby Pantokrator monastery (Daou) in 1692 the owed tax was raised up to an extra 1.000 oka of honey²⁰. Almost a century later in 1794 Beaujour estimated that the Penteli monastery preserved 1.200 beehives approximately, without counting in those of its dependencies²¹, which were scattered and expanded all over Attica. In 1805 the taxation in honey towards the Sublime Porte amounted to 9.000 pounds according to Dodwell, but its quality was slightly lower than that of the Hymettian honey²². Hobhouse on the other hand estimated a lower number for the same taxation, about 6.000 pounds in 1810²³. The abbot's Cyril the II excellent knowledge of every aspect of the bee-farming and honey production, as John Hawkins impressed it upon his text -which was recently noted by George Mavrofridis²⁴- reveal the primary importance beekeeping had for the Penteli monastery.

We do not know under which circumstances Penteli got the privilege of paying its taxes in honey instead of money²⁵. It is also unknown when this privilege was granted, but the fact that it is mentioned by Çelebi in 1667 poses a terminus ante quem, which allows us to place it at the early decades of the monastery's existence. The late granting of the same privilege to the Petraki monastery, which will be discussed next, must have been the result of backstairs actions of its abbots in the ruling courts of the Istanbul, either that of the Sublime Porte or the Patriarchate.

The building units of the Penteli monastery have no clear traces of its formerly great beekeeping activity, because it has been heavily modified during the 19th century and also lately during the 1950's and 1970's. Whatsoever its south wing, the today so-called "Secret school", is equipped with an extended series of vaulted chambers at a lower ground level²⁶, where they could have stored the harvested and valuable product of honey. Its transportation to Istanbul was probably made through the port of Porto-Rafti, the second most important port of Attica after that of Porto-Drako or Leone (the today port of Piraeus). The Porto-Rafti port gave an immediate access to the maritime routes to Istanbul, other than being the closer one to the Penteli monastery.

At the end of the 18th century a new important honey producer appeared in Attica, the immensely rich monastery of Asomaton Petraki²⁷. Between the years 1795 and 1796 the monastery succeeded in issuing a decree that would fixate it to the mausoleum of Valide Sultan, managing thus exemption of all taxes with the condition to provide 1.000 oka of honey²⁸. The expansion of its estates up in the mountain of Hymettus must have offered the monastery the ability to gather larger quantities of honey per year. In 1721 the monastery bought a large lot of an ottoman land in the area of Theologos, which included bee-farms as well²⁹. Also of decisive importance was the annexing of two smaller monasteries that practiced beekeeping and in the meantime had gone in decline, losing both their independence and their stauropelial status. The first one was the monastery of Saint John at Kareia, at the southwest slope of mountain Hymettus, founded probably by 1575 or slightly earlier, that turned into a dependency of Petraki in 1777³⁰, while the second one was the monastery of Saint John at Theologos, today at the suburb of Papagou, placed under the control of Petraki since 1702.³¹

Those important monasteries of Attica were the actual centers of honey production, with the contribution of some smaller ones too, for which unfortunately information is still lacking. Beaujour's record that four of the main monasteries of Hymettus

could maintain 3.000 beehives³², must probably be related to the monasteries of Kaisariani, Kynigou, Kareia and Theologou, still operating by the end of the 18th century, although the latter two were dependencies of Petraki. The majority of the monasteries were at first directly under the jurisdiction of the Patriarch of Constantinople as stauropelial ones and their primal obligation was to send honey to the Patriarchate, as is known from the example of the Penteli monastery, which had to pay «εις σημειον υποταγής μέλιτος οκάδας εικοσιπέντε, κατά την των σταυροπηγίων συνήθειαν» ("twenty five okas of honey, to show obedience, as the stavropegia are used to do")³³. It is also noteworthy to mention the record once made by a visitor of the Patriarchate in 1577; he marked that he was offered honey from Attica, almonds and pomegranates as a treat³⁴.

However, beekeeping developed as well and beyond the monastic context by the great landlords, the Athenian small farmers holders and the peasants of Attica. In fact Beaujour lists them as equals to the monasteries when he estimates that their beehives could number up to 6.000 approximately³⁵. Nevertheless, the image we have for the non-monastic production remains rather unclear as the existing information so far is insufficient compared to that of the monastic production. The second in scale land estate after the monastic property, the ottoman chifliks seem to merely have contributed in the honey production of Attica. From the published sources we learn that, before the eve of the Greek Revolution of 1821, the chiflik of Epáno Trachones (the today Glyfada) at the SW of Hymettus -located on the most prominent place for such a purpose- had only one bee-farm with no more than 20 to 30 apiaries³⁶. It has to be noted that a chiflik's arable land had been estimated at 10 acres³⁷, which compared to the small number of apiaries it hosted clearly suggests that the latter could be considered as an insignificant activity. In the neighboring chiflik of Kato Trachones a Greek Athenian Symeon Trimis³⁸ maintained two private bee-farms. Close to this area as well was the chiflik of Kara, the today Ilioupolis. Dodwell reported that honey of equal quality to that of Kaisariani was produced in Kara, without elucidating whether he was talking about the homonym chiflik or the nearby,

up in the mountain, monastery of Kareia.

But which was the actual place of the Athenian small farmer holders and mainly the peasants' of Attica in the honey production? The written sources seem frugal in any relevant information. In contracts of the Greek Revolution era, which should be taken to represent the practices during the Ottoman period, we rarely find any mention on bee-farms or apiaries as property's element that could be either dowered³⁹ or distributed⁴⁰. In other sources we meet again sparse testimonies for bee-farms in other places, like in Chaidari⁴¹. However, the case of an arvanites peasant named Buera, who knew all about beekeeping and who was the subject of a record made by John Hawkins at the beginning of the 19th century, along with the case of Cyril from Penteli⁴², are rather striking examples that the rural population of the countryside possessed the traditional practices of beekeeping by which it could complete both its poor nutrition and its low income. In any case, it seems that the production outside the monastic context was quite fragmented between the chifliks, the small farm holders or the landless farmers, fact which actually worked in favor of the organized thus of primary importance production of the monasteries gathering all the greatest amounts of honey.

The whole production of Attica, monastic or private was distributed according to Beaujour at the late 18th century as follows: besides the 1/10 that was consumed in the Athenian market, the rest of it was exported exclusively to Constantinople, to the sultan's palaces and the ruling class. Small quantities of honey from time to time would reach the European markets, most often Marseille and London, which the merchants used to give away to their friends as gift.

The worth of the exported honey from Athens, as Beaujour thinks, could be estimated approximately at 100.000 piaster. For the time being, we have no information about the importance of it as a dutiable good, although such evidence must probably exist in the Ottoman registers. As an indicative example we should mention that the taxation of honey in Andros of the year 1670 would produce one akce every four apiaries, a rather low amount of money⁴³, while the

18 Mpires 1959, 59.

19 Spon – Wheler 1678, 310–311.

20 According to the monastery's oral tradition, as it has been recorded by the abbot Kyrillos Dengleris (Kambouroglou 1891², 396).

21 Beaujour 1800, 167–168.

22 Dodwell 1819, 497.

23 Hobhouse 1833, 394. The monks offered to the travelers eggs, olives, honey and wine.

24 Mavrofridis 2012, 400–401.

25 On the role of Pentelic honey in taxation see Michalakis 2006–2007, 37–40.

26 Pallis 2009, 269–271.

27 Pallis 2009, 221–231, fig. 97–100.

28 Kambouroglou 1891², 369–371.

29 Kambouroglou 1891², 411. Kambouroglou 1892, 176–177, 203–204.

30 Pallis 2009, 380–387, fig. 193–194. Dodwell writes that the best honey of Attica was produced at Kaisariani and Kareas monasteries (Dodwell 1819, 480).

31 Pallis 2009, fig. 180–183.

32 Beaujour 1800, 167.

33 Patriarchal sigillion of 1692, (Lambros 1907, 95).

34 Zolotas 1926, 25.

35 Beaujour 1800, 168.

36 Drikos 1994, 61.

37 Drikos 1994, 64–67.

38 Drikos 1994, 64, 188.

39 Petropoulos 1957, 5 n. 1 (one bee farm), 125 n. 97 (five bee-hives), 177 n. 158 (ten bee-hives).

40 Petropoulos 1957, 544–545 ap. 724 (one bee farm at Γυψέλι and three more of unknown location).

41 Vlachogiannis 1901, 67.

42 Mavrofridis 2012, 401–402.

43 Polemis 1995, 100–101.

same tax in Trikala would produce one akce every one apiary⁴⁴, evidence that relates quality to price.

In conclusion we could say that beekeeping in Ottoman Attica was mainly a monastic affair. The important monasteries would assemble as many beehives and would commit to a well-organized and systematic production. Honey was the medium that would grant them a privileged treatment before the Ottoman authorities with tax exemptions and offer them the opportunity to resolve any domestic or private issues by addressing directly to the high ranking echelon of power –the ease with which

44 Michaelaris 2006-2007, 39, n. 15.

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the abbot of the Petraki monastery would travel to Constantinople to reasssure that he would issue patriarchal sigillia or firmans by the sultan for their causes is rather striking. This advantageous position had a broader positive impact in the everyday life of the Christian population of Attica, and we could postulate that honey was for Attica what was mastic for Chios. Of course there is still too much to learn about beekeeping in Attica, especially for the part that is connected to the peasants’ contribution to the production of honey, so that we can create a fuller image from the one we already have.

Kambouroglou 1890: D. Gr. Kambouroglou, *Ιστορία των Αθηναίων. Τουρκοκρατία, Περίοδος πρώτη*, 1458-1687, v. 2, Athens.

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STONE BEEHIVES ON THE ISLANDS OF THE EASTERN MEDITERRANEAN

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Stone is not a conventional material in the construction of beehives, and its use for this purpose creates several problems. First and foremost, constructing a stone beehive is usually a laborious task. Secondly, moving such a hive is extremely difficult, if not impossible, while its insulating properties, in most cases, are poor.

However, many beekeepers around the Mediterranean, especially in its eastern part, and mainly on the islands (**Fig. 1**), used various types of stone hives in traditional beekeeping. These hives were created in different ways: by chipping away and carving natural rock to create a cavity that could suitably function as a hive; by chipping away and carving a transportable piece of rock for the same purpose; by bonding stone slabs together in order to form a hive; by building the hive with or without the use of bonding material; and finally, by creating hives in dry wall terraces, in homes or even building specialised “bee houses”.

On several occasions, the choice of stone as material for creating hives seems that it had to do with the lack of abundant alternative raw materials for their construction, such as wood or the various branches used to weave baskets. Another reason was the cost, which the beekeeper often had to incur when selecting another material, such as hives made out of fired clay, for instance, which had to be ordered from a potter, or those made out of wooden boards, for which the necessary boards had to be purchased.

Nonetheless, stone hives did have advantages: they were long-lasting, they prevented theft to a great extent, and in some instances, such as in those

of wall hives, allowed beekeeping to be practiced more easily and often more rationally.

Ancient authors do not mention stone hives, and only Columella (*De Re Rustica*, IX, 6, 2-3), referring to Celsus, informs us about hives built out of brick, which he actually does not hold in high esteem due to their inability to be transported. For these hives, there is the view¹ that they were basically recesses in a brick wall.

The first written reference of a stone beehive was made by Abbot Alberto Fortis, who travelled throughout Dalmatia and published his travel impressions in 1774. On the island of Brač, he encountered many hives made out of stone slabs bonded together. The top slab was used as a lid and was definitely movable, while for the protection against strong winds, other stones were placed on it². Later, Valerijan Ritterman³ mentions that apiaries with similar stone hives existed on many parts of the island. They were exploited not only by individuals, but also by the monks of the Monastery of Blaca.

Here, I must once more express my deepest gratitude to the late agronomist and interminable researcher of traditional beekeeping, Thanassis Bikos, for his unreserved assistance on various issues relating to stone beehives. Thanks must also go to Lefteris Eleftheriou and Georgios Dimitriou from Cyprus for providing information and photographic material regarding the bee houses of the Alaminos village.

¹ Crane 1998, 11.

² Fortis 1774, 186-187.

³ Ritterman 1953, 178-179.

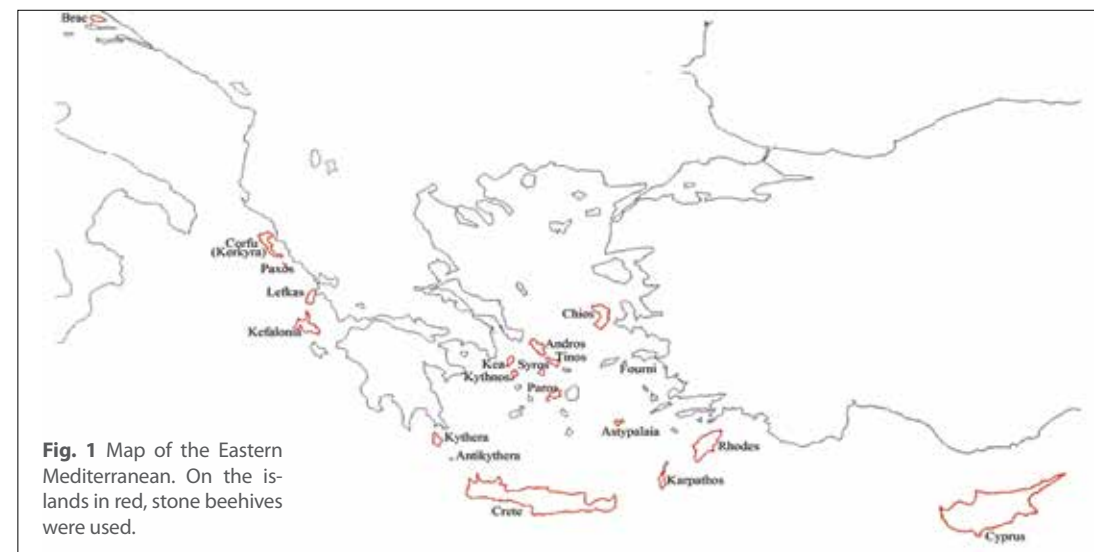


Fig. 1 Map of the Eastern Mediterranean. On the islands in red, stone beehives were used.

The aforementioned hives were in use until 1942-43, at which point they were abandoned. They were 60 cm in length, while their width and height was about 30-40 cm. In the upper part of these rectangular hives were placed a layer of twigs from olive or mulberry wood, to which the bees attached their honeycombs, without however resulting in movable-combs. Besides, the practice of beekeeping with movable-combs was unknown to local beekeepers. The reason for placing twigs in the top opening of these hives had to do with the high temperatures reached by the upper slab during the summer and the risk of the combs melting if they were attached to it⁴. The twigs, in other words, acted as insulation material, protecting the honeycombs from melting during the hot summer days.

Further south, on the island of Corfu, beekeepers in the northern part of the island used, among others, hives built out of stones and mud. On the top opening, they placed wooden bars, and above them a stone slab⁵. However, movable combs were not created. The bars used, as in the pottery vertical hive of the island (the “klembouri”), were too broad. Like their colleagues on the island of Brač, the beekeepers on Corfu did not know how to create movable-combs.

On Paxos, an island near Corfu, the local hives were built. They were rectangular in shape and consisted of three levels or floors (**Fig. 2**). According to a published photograph⁶, on the lower floor, they had an opening on the wider side, and on the middle floor, the opening

⁴ Ritterman 1953, 179; Crane 1999, 392.

⁵ Mavrofridis 2013, 34.

⁶ Rammou & Bikos 2000, 430.

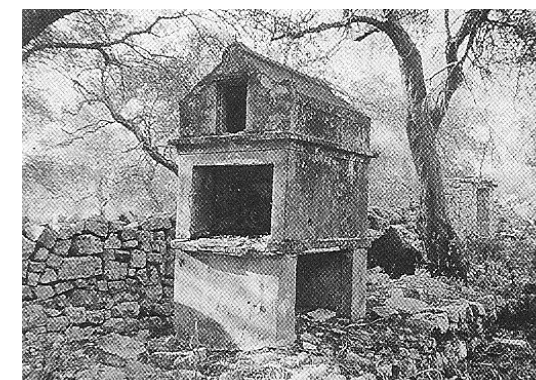


Fig. 2 Built hive of Paxos (photo: Th. Bikos).

was located on the narrower side. These openings occupied the entire corresponding side of each floor of the hive and were probably closed with a wooden lid. The third floor had a characteristic shape, with a pitched roof, which reminds one of a rectangular church or perhaps a home. Even the opening, which was small, resembles a church doorway.

On the island of Kefalonia, again in the Ionian, their traditional hives were also built (**Fig. 3 & 4**). They were horizontal and were built out of slate. They were usually stand-alone structures, but sometimes stood in groups of two, or one next to the other. The roof was usually made out of tiles, while in some cases, a horizontal stone slab served as a roof. Slate and tiles were bonded together using a bonding material (some type of lime-based mud) so as to create a



Fig. 3 Built hives of Kefalonia (photo: Th. Bikos).



Fig. 4 Built hive of Kefalonia with the date 1875 engraved on it (photo: Th. Bikos).



Fig. 5 Stone beehives of Lefkas (photo: Th. Bikos).

single entity. The length of the hive reached 30-40 cm, its internal width was approximately 30 cm, while its height exceeded 30 cm. The hive was closed from the front and back using two stone slabs. The front slab was permanently attached and had an opening at its base for the entrance of the bees. The rear slab was movable, so it could be removed during harvesting and when other work on the hive had to be carried out⁷.

On Poros, in the southeast of the island, a built wall with a series of hives has been detected and recorded⁸. These hives took their internal shape from three tiles, positioned longways, so that their edges touched each other. In this way, they created a single space, which had three cavities, though. This "bee wall" is very old and has been in use in the area for at least two centuries⁹.

On the island of Lefkas, beekeepers used, among others, hives which could be characterized as "hybrids". The primary hive was made out of local stones bonded together with lime and sand (Fig. 5). This resulted in a space with an opening only at the front, which was closed by a movable lid. However, this hive had a limited capacity, and when, as spring progressed, the bee population increased, a horizontal extension was adapted to the opening. This extension was made out of boards or even out of goat hides¹⁰. Only the combs that were attached to the extension were harvested, and the bees wintered in the primary hive, which, as witnessed, was made out of stone.

On Kythera, local beekeepers practised beekeeping exclusively with top-bar hives, which, in many cases, were made out of stone. In fact, several types of stone hives existed on the island. The most common one, called "gourna" (trough)¹¹, was constructed out of a piece of local porous rock, which was severed from the bedrock and then carved internally until it took on the desired form (Fig. 6). On the one long side, and near the base, an oblong hole was opened, which allowed for the entrance of the bees. At the opening of the hive, were placed wooden bars smeared with a layer of mud so that the hive

7 Nicolaidis 1955, 146; Komis 1987, 10; Bikos 2005, 94; Bikos 2015a, 213, fig. 12-13.

8 Bikos, 2005, 96-98.

9 Similar walls with the use of three tiles to create beehives have also been recorded in the Southern Peloponnese, in the region of Mani (Mavrofridis 2015, 53-55, fig. 10-17).

10 Bikos 2009, 18-19.

11 Nicolaidis 1955, 146; Bikos 1995, 14; Rammou & Bikos 2000, 425-426; Bikos & Rammou 2002, 9; Mavrofridis and Anagnostopoulos 2012, 483.

was tightly closed on its upper part¹². For protection against the elements, a stone slab was placed above the bars with the mud.

A similar hive was constructed on Kythera out of five stone slabs: one serving as a base, with the others placed vertically on it so as to form a rectangle¹³. At the opening of the hive, were placed bars smeared with mud, and above them, a stone slab for protection. Sometimes, between the bars and the protective slab, branches of different bushes were placed for additional protection from the high summer temperatures.

On the same island, beehives carved out of natural rock have been recorded. Their dimensions were generally similar to those of the "gourna" hives and to those made out of bonded stone slabs¹⁴. Naturally, these also included bars at the top openings in order to create movable-combs.

Some beekeepers on the island of Antikythera, where movable-comb hives were also known, practised beekeeping using fixed-comb hives built in recesses of stone walls. The upper side of the hives in question was semicircular, while the base and the sides were at right angles to each other¹⁵.

On Crete, stone hives were not customary, but there is a reference to hives that were carved into natural rock in the village Komitades, in the prefecture of Chania¹⁶.

In the late 18th century, Abbot Della Rocca¹⁷ refers to the use of horizontal hives made out of stone slabs on the island of Syros. Similar hives were recorded in the last century on the island of Tinos¹⁸ (Fig. 7 & 8), too. These hives were 80-90 cm in length, and usually 40-50 cm in height and width. They were constructed out of four elongated slabs and two smaller ones for the narrow sides. On the front slab was, of course, an opening (or openings) for the entrance of the bees.

Stone horizontal hives of the same style were known to other islands of the Cyclades, such as Paros (Fig. 9) and Antiparos¹⁹. Here, for these hives, lids made out of stone and wooden boards were used.

12 Protopsaltis 2000, 289-294.

13 Bikos 1995, 13; Rammou & Bikos 2000, 425-426.

14 Mavrofridis 2007a, 161; Mavrofridis 2007b, 136; Mavrofridis 2009, 289.

15 Mavrofridis 2007a, 161.

16 Crane 1998, 14.

17 Della Rocca 1790, 24-25.

18 Florakis 1971, 129; Rammou & Bikos 2000, 418-419; Bikos 2013, 178-180.

19 Rammou & Bikos 2000, 424; Bikos 2008, 310-311.



Fig. 6 Stone top-bar hive of Kythera (photo: G. Mavrofridis).



Fig. 7 Stone horizontal hive from Syros (photo: Th. Bikos).



Fig. 8 Stone horizontal hive from Tinos (photo: Th. Bikos).



Fig. 9 Stone horizontal hives from Paros (photo: Th. Bikos).



Fig. 10 Horizontal hives from Kythnos (photo: D. Varela & P. Harizanis).

These often bore many small holes - bee entrances.

Kythnos is another island where horizontal stone hives were used²⁰. However, these were mainly used by beekeepers who did not have a large number of hives, and who often practised subsistence beekeeping. On this island, though, in addition to hives constructed out of stone slabs, whether they were free-standing or bonded together, they also used horizontal hives with one open end, which were carved out of natural rock (Fig. 10) and called "melissospilies" (bee caves).

All these Cycladic horizontal stone hives were used just like the horizontal pottery hives with one open end, known in most cases as "ypselia", which prevailed on the islands in question. However, this was not the case on the islands of Kea and Andros, which belonged to the same chain of islands, as their beekeepers employed different beekeeping practices.

On Kea, local beekeepers made exclusive use of mobile-comb hives, mostly made out of fired clay and sometimes woven or made out of boards. However, reports dating to the last century mention the presence of top-bar stone hives made out of bonded slate²¹.

As for Andros, apiculture on the island is more complicated due to the many types of hives used by the beekeepers there. The simplest stone hive of the island was the "spilia" (cave), which consisted of a hollow piece of natural rock that was closed with a stone slab²² (Fig. 11). In several cases, the beekeeper was forced to carry out building work in order to adapt the hollow rock to his needs. In other cases, a wooden frame with a door was positioned over the



Fig. 11 "Spilia" (cave) hive of Andros (photo: Th. Bikos).

hollow rock and the interior took on the shape of a cupboard. This type of hive is called a "spiliodoulapo" (cave cupboard)²³. Similar hives, known as "doulapia" (cupboards - in the singular "doulapi"), were also created in dry wall terraces, some of which measured 51 X 48 X 51 cm in depth²⁴. The bee entrance consisted of an opening in the door of the "doulapi", from which the harvest was also carried out.

"Doulapia" hives that opened from the inside, though, while on their exterior was an entrance hole, were constructed on the walls (Fig. 12) of abandoned and other houses, too (wall hives). If the house was inhabited, the swarm would get caught in the "doulapi" and be relocated to some type of movable hive²⁵. Their dimensions were extremely varied. "Doulapia" hives measuring 40 X 42 X 43 cm

23 Speis 2003, 63; Bikos 2011a, 113-115; Speis 2016, 76-77.

24 Speis 2003, 60-61; Speis 2016, 74, fig. 35.

25 Bikos 1996a, 362-362; Bikos 1996b, 424-465; Speis 2003, 61-62; Speis 2016, 75-76, fig. 36; 53-55.



Fig. 12 "Doulapi" (cupboard) hive in the wall. Andros (photo: F. Hatjina).



Fig. 13 "Melissokipi" (bee house) of Andros (photo: G. Speis).

and others measuring 52 X 70 X 38 cm have been recorded. In addition, there were "doulapia" hives constructed (in the north of the island) in specially designed buildings (Fig. 13 & 14), usually made out of slate. They had beamed roves, which supported slabs on which soil was placed. These buildings were called "melissokipia" (bee gardens) or "melissotopia" (bee places)²⁶. In some cases, the bee entrance was located in the corner of the "doulapi"²⁷ in order for the bees to build their combs at a 45 degree angle. Also, when it was a good year and there was ample nectar, extensions were added to the "doulapia" hives²⁸ so that the bees could construct combs there, too.

Finally, there is the view, expressed for the first time by the late local beekeeper, Ioannis Rerras²⁹, that

26 Toufexis 1909, 89; Nicolaidis 1955, 147; Bikos 1996a, 360-362; Bikos 1996b, 462-462; Rammou & Bikos 2000, 421-422; Speis 2003, 64-70; Bikos 2011b, 190-191; Speis 2016, 76-83, fig. 42-52; 56-110.

27 Bikos 2011b, 191.

28 Speis 2003, 70; Speis 2016, 83.

29 See Speis 2003, 68; Bikos 2011a, 110; Speis 2016, 81.



Fig. 14 "Melissokipi". The "cupboards" clearly seen as the roof has collapsed (photo: G. Speis).

the "doulapi" hive of Andros is the evolutionary result of the simple "spilia" hive, which initially evolved into the "spiliodoulapo" hive, and later into the built-in "doulapi" hive and "melissokipia".

On Chios, especially in the village of Agios Georgios Sykousis, hives in a wall of a stone house, which opened from the inside, have been recorded (Fig. 15). There were more than 20 of these hives and they were arranged in four rows³⁰. Due to the lack of information, we assume that on the inside, there would have been some type of wooden construction - a type of door - in order to inspect the bees and carry out the harvest. The exterior would have closed securely with a stone slab, or perhaps again with some type of wooden construction. The practice of beekeeping with wall hives, such as those at Agios Georgios Sykousis, was not widespread on the island, and it seems to have been an exception.

Another type of Chian hive consisted of clay tablets which were connected to form a triangular hive³¹. In a number of cases, it appears that instead of clay tablets, similar stone slabs were used for their construction. On this island, there also existed horizontal stone hives, with openings at both ends, made out of four stone slabs³².

On the islands of Fourni, in addition to horizontal pottery hives, beekeepers also used horizontal stone ones made of slabs with one open end (Fig. 16), such as those on the Cyclades³³. These stone hives served as a cheaper alternative to local beekeepers, due to the fact that they constructed them themselves, while the pottery hives had to be purchased from other

30 Tselios 1998, 242; Bikos & Rammou 2002, 12; Bikos 2014; Bikos 2015b, 20, fig. 19-20.

31 Tselios 1998, 242; Anonymus 1998, 8.

32 Kourounis 2010, 29.

33 Bikos 2012, 102-103.

20 Varela and Harizanis 2011, 146.

21 Bikos 1999, 7; Rammou & Bikos 2000, 424.

22 Rammou & Bikos 2000, 422; Speis 2003, 16; Bikos 2011a, 110-113; Speis 2016, 33.



Fig. 15 Wall hives of Chios (photo: Th. Bikos).



Fig. 16 Horizontal stone hives from Fourni (photo: Th. Bikos).



Fig. 17 Astypalaia. Horizontal stone hive (photo: Th. Bikos).

islands. It is noteworthy to mention that, in the region of Bizani, there were about two hundred of these stone hives. These were known on these islands as "chtistes" (built hives).

Similar hives were known further south as well, on Astypalaia (Fig. 17). In their construction there however, smaller stones were often used³⁴. The hives were of different sizes, but they were all horizontal with one open end. Sometimes, on Astypalaia, these hives were built into the natural rock. Here, they were called "petrina" (made of stone) or "thyrides".

On the islands of Rhodes and Karpathos, the horizontal stone hives used by local beekeepers were open at both ends. This type of hive dominated not only on these islands, but in general on most of the Dodecanese. They also made traditional hives out of other materials: fired clay, boards, logs or bark. On Rhodes, the stone beehive was called "thyri", and was constructed out of stone slabs (Fig. 18), and the lids which existed on either side were made out of pine bark. Many such hives were arranged side by side, and in some cases, one on top of the other, and given the name "toura"³⁵.

On Karpathos the horizontal stone hives with two openings were made out of bonded stone slabs as on Rhodes, or carved out of porous stone, or out of a combination of both materials - the sides were made out of stone slabs and the semicircular roof carved out of porous stone. The caps in all instances were made out of wood. On Karpathos, besides the hives with two openings, they sometimes constructed makeshift stone constructions out of different types of stone, which also served as beehives³⁶. They had a single opening and were usually created at the base of rocks (Fig. 19).

For the island of Cyprus, we have the testimony of Denis Possot, who, in 1536, described the hives he had encountered in a village near Larnaka four years earlier³⁷. These were located on the walls of houses and their openings were on the inside. On their exterior were small holes for the entrance of bees.

Similar hives were recorded later on the island as well. Two "melissospita" (bee houses) with hives built on their walls have been recorded in the village of Alaminos, in the region of Larnaka (Fig. 20). According to our source, Georgios Dimitriou³⁸, a descendant of a beekeeper, these hives were made out of sun-dried bricks and covered with a drystone wall to protect

³⁴ Bikos 2007a, 285-287; Bikos 2007b, 345-346.

³⁵ Vrontis 1938, 195.

³⁶ Bikos 2003, 345.

³⁷ Gobham 1908, 65.

³⁸ Dimitriou 2013.

against corrosion. The "melissotrypes" (bee holes), as these hives were called, were created with stone slabs in the upper and lower side and measured approximately 30 X 30 X 50 cm. For harvesting and any other work that had to be carried out, they were opened from the inner side, which had a wooden lid. The outside was permanently closed with marble, at the bottom end of which was the bee entrance and a stone protruberance to assist the insects with their flight. The arrival of varroasis in the area led to the closure of the "melissotrypes", and since 1983, they stand empty.

Beyond the islands we examined, where stone hives have been recorded, there are lexicographic accounts regarding the existence of stone hives in the past on some other islands, too. These islands are Anafi in the Cyclades, Evia - specifically the village of Vrissi, and Lesbos³⁹.

To synthesise, stone hives, whether as stand-alone constructions or as constructions on walls were used on many islands of the Eastern Mediterranean. They were usually used along with hives built out of other materials; nevertheless, in some instances, stone hives were the only hives in use. Regarding their function, these hives were of various types. There were hives which had bars and created movable-combs on islands where beekeepers were aware of this method (Kythira, Kea); hives with bars and twigs, where beekeepers were unaware of how to create and use movable-combs (Brač, Corfu); permanent hives of relatively small dimensions without extensions (Paxos, Kefalonia, Andros Karpathos), or with extensions (Lefkas); large horizontal hives which mimicked corresponding pottery hives with one opening (Syros, Tinos, Paros, Antiparos, Kythnos, Fourni, Astypalea), or with two openings (Rhodes, Karpathos); and finally, built-in wall hives in one row (Kefalonia, Antikythera, Andros) or several rows (Andros, Chios, Cyprus), and in some cases specially constructed buildings (Andros, Cyprus).



Fig. 18 Horizontal, open at both ends, stone hives from Rhodes (photo: Th. Bikos).



Fig. 19 Stone hive of Karpathos (photo: Th. Bikos).



Fig. 20 Bee house (melissospita or melissonas) of Cyprus (photo: L. Eleftheriou).

³⁹ Katsouleas 2000, 354; 359.

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STEFANOS G. DELLA ROCCA, THE FATHER OF BEEKEEPING

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Stefano Della Rocca, was a Greek Catholic priest from the island of Syros. He is called 'father' of beekeeping as he invented the first wooden hive with **movable comb**, in Syros back in 1780 (Fig. 1, 2). He also published his "Traité complet sur les abeilles" (Study on beekeeping) in France and created the first State Beekeeping school in Versailles with the generous support of the Queen of France, in 1794. Della Rocca is also regarded as the first historian of Syros due to the fact that in his first book of his "Traité complet sur les abeilles" he shortly refers in the history of his home land, Syros dated from the ancient years till the last decade of the 18th century.

Short biography

S. Della Rocca was born in Istanbul in 1738. His parents were Greeks from Syros Island. He finished the Cappuccinos monks' school in Galata area, and then he left for Rome, where he studied Theology and Philosophy for eight years in the Greek College of Rome, Ag. Athanasios. In 1774 he returns to Syros as a priest and at the same time he is practicing beekeeping, "Traité complet sur les abeilles" (Fig. 3). In 1788, the local Municipality appointed him leader of a donating campaign in Europe, in order to collect money and to pay the heavy taxes imposed by the Turks to people from Syros. With this excuse he traveled to Italy and France and he collected much more evidences and facts for his study. Meantime he used the writing as a means to show to the rest of Europeans how much the people with the 'most glorious ancient civilization' were suffering under the Turkish occupation and that they had the 'right' to be free.

Finally, his "Traité complet sur les abeilles" was much greater than he thought, and it was published in a series of three books after been financed by the Queen of France. In the introduction of this book he says:

"When I arrived in France, I started studding all written works on beekeeping, as for example by Réaumur, Bonnet, Ducarne de Blancis, La Grenée, Pingeron, Duchet, Wildman with notes by Contardi. I also consulted the old and new encyclopedia and other French and Italian writers. I also read many parts of the 'Natural History' by Le Buffon, all in relations to bees. All this search and reading reinforce my idea that the people from Syros have a superior beekeeping practice! Every beekeeper I talked to agreed with me on this, and they suggested that I should write a book on this issue, that this book it would be well received in France, as beekeeping was not so well developed and the wax production was very low and important.

So I followed their advice mainly to show my appreciation to the State of France where I spent my youth years. My intention was to write a short book for the methods used by people from Syros to manage these insects. Therefore I studied everything that was written till then and I discovered many mistakes related to the natural and economical history of bees. My passion for beekeeping and truth, lead me further than I initially thought and finally I was confronted with a complete study on the subject without having the intentions to do so" (Fig. 4).

At the time Della Rocca was visiting France, the French revolution took place, and he was not then allowed to return to Greece. Therefore, he remained

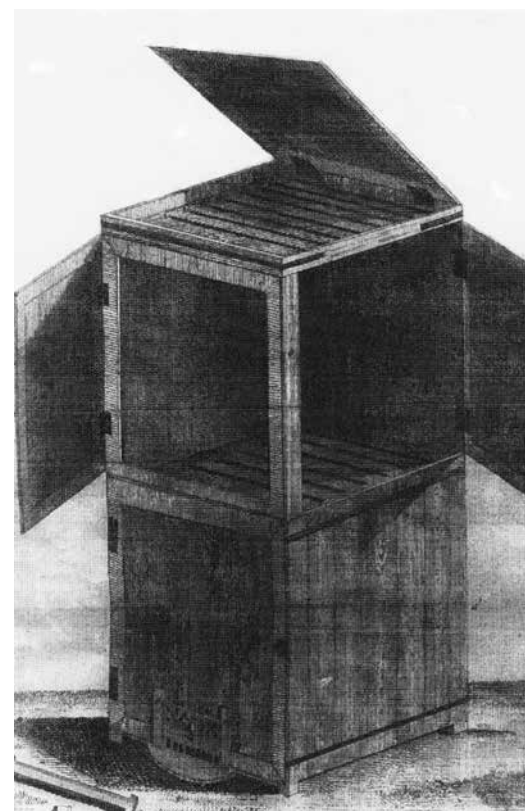


Fig. 1 The wooden hive build by Della Rocca in Syros island.

in France and managed to convince the Minister of Agriculture of France to create a state school for beekeeping. The school was established on the 21st of March 1794., at the small park of Versailles and it still exists. The aim of the school was not only the teaching of beekeeping but also the production of honey and wax, as the later was also very rare at that time. At the same time, wooden hives, beekeeping equipment and other tools were also were made and many bee beneficial trees were planned around the park. The arrangement with the Ministry of Agriculture was for Della Rocca and his assistance to have a salary, but this seldom happened, due to the financial and political problems of the time. The income from honey and wax was returned to the state in order to cover the expenses of the school. However, the costs were almost equal to the income.

The 1798 was a catastrophic year for Della Rocca was accused by some beekeepers, and the Minister of Agriculture found a good excuse to closed the school on the 12th of January. After that he could not received his wages and till 1810 he lived from the support of charities. In 1810 then writes a letter to the Minister of External Affairs:



Fig. 2 The apiary site of Della Rocca in Syros.

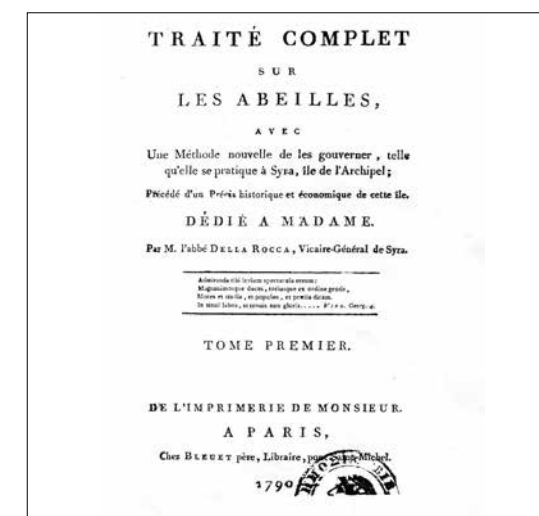


Fig. 3 The cover of the first tome of the "Traité complet sur les abeilles".

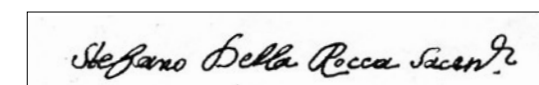


Fig. 4 Signature of Stefano Della Rocca.

"I am a Greek priest, forced to live in France because of the revolution. I am 72 years old and I had come to France with the task to collect money to help my fellow countrymen. I was working with the bees to support the French state, but I was not allowed to finish my work.

Stefano Della Rocca was given a pension of 300 francs, an amount determined by the Minister who had chosen for his sign the picture of a bee.

A BRIEF REVIEW ON THE DETECTION OF LOCAL HONEY BEE POPULATIONS IN GREECE BASED ON GENETIC STRUCTURE STUDIES

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Subspecies of *A. mellifera* in Greece

The honey bee *Apis mellifera* L. is one of the most studied invertebrates. The species has a wide range distribution in the Old World and has been introduced by humans to many other countries worldwide. Its ecological and economic importance and, moreover, its social organization, have stimulated research in a wide variety of fields.

Traditionally, the intraspecific taxonomy of *A. mellifera* has been based on morphology. At present, 29 subspecies of *A. mellifera* are recognized on the basis of morphometric characters^{1,2,3,4,5}. These subspecies are also described as "geographic races" because their distributions correspond to distinct geographic areas. Ruttner based on the application of numerical taxonomy using characters of "classical" morphometry concluded that the *A. m. adami*, *A. m. macedonica*, *A. m. cecropia* and *A. m. carnica* subspecies of *A. mellifera* exist in Greece⁶ (Fig. 1).

Specific studies on the genetic structure of honey bee populations in Greece

Classical morphometrics

There is only one comprehensive published study performed⁷, (Fig. 2), in Greece, on the Greek

1 Ruttner, 1988.

2 Ruttner, 1992.

3 Sheppard, Arias, Greech, Meixner, 1997.

4 M Engel, 1999.

5 Sheppard, Meixner, 2003.

6 Ruttner, 1988

7 Ifantidis, 1979.



Fig. 1 *A. mellifera* subspecies in Greece according Ruttner 1988.

subspecies of *A. mellifera*. According this study, that period there were no hybrid bees in Greece and different ecotypes existed in different geographical regions.

Geometric morphometrics

A new morphometry method, called geometric morphometrics, has been developed, based on the coordinates of landmarks located at vein intersections of the wings^{8,9}. In a recent research honey bees collected from 32 different localities in Greece were studied based on the geometric morphometrics

8 Bookstein, 1991.

9 Smith, Crespi, Bookstein, 1997.



Fig. 2 Map of sampling regions (Ifantidis, 1979).

approach using, the coordinates of 19 landmarks located at wing vein intersections¹⁰ (Fig. 3). The statistical analysis performed on the obtained data showed that honey bee populations from some Aegean islands (Chios, Astypalaia), from Kythira (an island close to Peloponnese) and from Crete island (Heraklion, Lasithi) can be discriminated based on this approach.

Alloenzymic approach

Alloenzymes (or also called allozymes) are variant forms of an enzyme that are coded by different alleles (number of alternative forms of the same gene) at the same locus. Many of the allozyme studies have contributed to understanding subspecies discrimination^{11,12,13} revealing the existence of hybrid zones between them¹⁴. In addition, they have been used to analyze the phylogeny of *A. mellifera* on the basis of genetic distance matrices¹⁵ and to detect significant genetic differences between commercial and feral honey bee populations¹⁶.

Allozyme analysis of some Greek populations

10 Charistos, Hatjina, Bouga, Mladenovic, Maistros, 2014.

11 Sylvester, 1982.

12 Sylvester, 1986.

13 Daly, 1991.

14 Sheppard, McPheron, 1986.

15 Sheppard, Huettel, 1988.

16 Schiff, Sheppard, 1995.

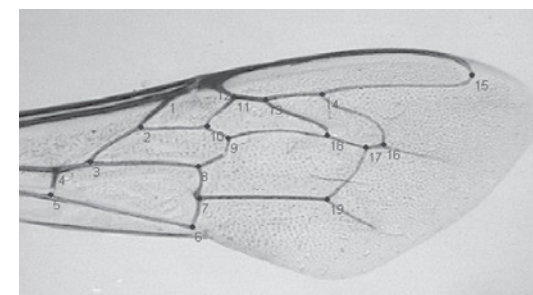


Fig. 3 19 landmarks located at wing vein intersection.

(Thrace, Macedonia, central Greece, Peloponnese) and populations on Crete showed the existence of a pure subspecies on Crete, as well as the possibility of distinguishing honey bee populations from northern and central Greece on the basis of allele frequencies¹⁷.

On 2005 honey bee populations from different areas of Greece, Ikaria, Kasos, (Aegean islands), Kythira, Phthiotida (central Greece), Macedonia, were studied, using starch gel electrophoresis on ten different gene-enzyme systems¹⁸ (Fig. 4).

Among the populations tested the highest percentage of polymorphic loci was found in the Phthiotida population. This observation could be due to gene flow, a hypothesis supported by the high frequency with which beekeepers in central Greece (including Phthiotida) are known to move their colonies because of changes in climate, flora, and other conditions¹⁹. The high level of polymorphism in central Greece contrasts with the situation in Kasos, which has the lowest percentage of polymorphic loci suggesting the maintenance of a rather pure honey bee population on that island.

Mitochondrial DNA (mtDNA) analyses

Mitochondrial DNA markers have been widely used to address population and evolutionary questions in *A. mellifera*, which was the first Hymenopteran for which the mitochondrial DNA sequence was published²⁰ (Fig. 5). The mitochondrial genome has been a very useful molecule for population genetic studies of *A. mellifera* and phylogenetic studies in the Genus *Apis*, as it contains regions with variable evolutionary rates.

17 Badino et al., 1988.

18 Bouga, et al, 2005.

19 Ifantidis, 1979.

20 Crozier, & Crozier, 1993.



Fig. 4 Sampling sites (Bouga et al., 2005).

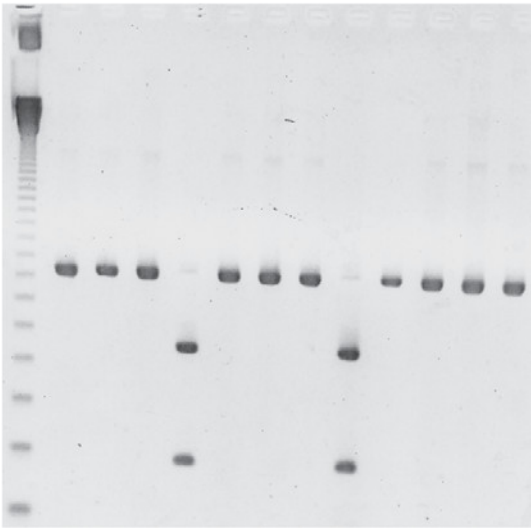


Fig. 6 *A. m. macedonica* diagnostic test.

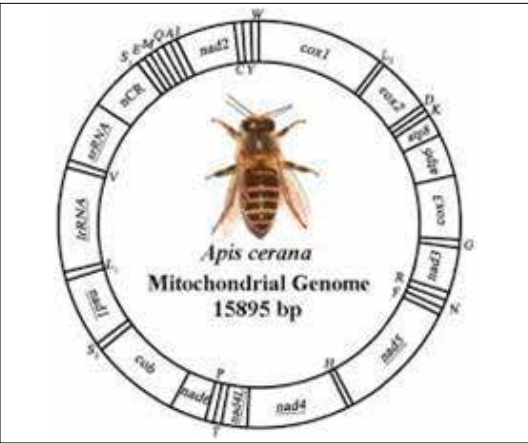


Fig. 5 Mitochondrial DNA.

The maternal inheritance of mtDNA, a property which has been demonstrated for honey bees denotes that all the workers and drones in a colony share the DNA of the queen²¹. Variation in the mtDNA of honey bees has been used to provide insight into their biogeography.

Diagnostic test for the discrimination of *A. m. macedonica*

Based on the results obtained using RFLP's molecular method (Restriction Fragment Length Polymorphisms) diagnostic patterns were revealed in the Macedonian honey bee population after the digestion of CO I (Cytochrome c oxidase subunit I, involving in the respiration) mtDNA gene segment, with the restriction enzymes (enzymes that cut DNA at or near specific recognition nucleotide sequences, known as restriction sites) NCO I and Sty I²² (Fig. 6).

Sequencing analysis

On 2011 a study presents the first comprehensive sequencing analysis of *A. mellifera* subspecies occurring in Greece, and it is the first time that sequencing data from the ND5 mtDNA gene segment have been obtained at the population level²³. Since honey bee mtDNA appears to be exclusively maternally inherited, the study of one worker per colony allows characterising the colony itself and the queen haplotype²⁴.

21 Meusel and Moritz, 1993.

22 Bouga, et al., 2005.

23 Martimianakis, et al., 2011.

24 Meusel and Moritz, 1993.

Haplotype 1	<i>A. m. cypria</i> (PYR, KOR, DAL1 and 2), Aegean race near to <i>A. m. adami</i> (LMN 1,2,3,4, NIS 1,2), <i>A. m. adami</i> (CRE 4), <i>A. m. macedonica</i> (MAC 3,4,5,6 and 7, THR 1,2,3 and 4, JII), commercial strain (genetically improved <i>A. m. cypria</i> (SB), <i>A. m. cecropia</i> (SAR3, MES 1,3,4), <i>A. m. anatoliaca</i> (BAR), <i>A. m. meda</i> (OSM), <i>A. m. carnica</i> (LUB1,2,
Haplotype 2	<i>A. m. ligustica</i> (PER1,2, RAV1 and 2)
Haplotype 3	<i>A. m. cecropia</i> (SAR1), <i>A. m. carnica</i> (KEF2)
Haplotype 4	<i>A. m. cecropia</i> (SAR2)
Haplotype 5	<i>A. m. macedonica</i> (MAC1 and 2)
Haplotype 6	Aegean race near to <i>A. m. adami</i> (CHI1,2 and RHD1)
Haplotype 7	<i>A. m. adami</i> (CRE 2 and 3)
Haplotype 8	<i>A. m. cecropia</i> (MES 2), Aegean race near to <i>A. m. adami</i> (RHD 2,3,4), <i>A. m. ligustica</i> (FOR)
Haplotype 9	<i>A. m. carnica</i> (LIT)
Haplotype 10	<i>A. m. adami</i> (CRE 1)
Haplotype 11	<i>A. m. carnica</i> (GOR)
Haplotype 12	<i>A. m. cecropia</i> (LAR1 and 2)

Fig. 7 Haplotypes of honey bees studied (Martimianakis et al., 2011)

Among the honey bees studied from Greece, one population from the island of Crete island was a unique haplotype (haplotype 10), as were populations from Larissa (Central Greece) (haplotype 12) (Fig. 7).

Conclusions

It is shown that based on the results of genetic studies on honey bees in Greece, using different genetic markers, there is a mixture of the populations due to the migratory beekeeping and the uncontrolled commercial practice.

Despite this, it also seems that there are still honey bee populations that there is the possibility to maintain local pure characteristics. There is the evidence that this happens especially to the bees from islands like Chios, Astypalaia, Kythira, Kasos and in a part of Crete island. It is also very interesting that something similar is for honey bee populations from Central Greece (Larissa).

The diagnostic test for *A.m.macedonica* is widely used for honey bees that it is supposed that belong to this subspecies that exists in this specific geographical area according Ruttner^{25,26}.

Perspectives

The research is ongoing using different approaches for the genetic study of honey bee populations in Greece.

The genetic markers can be applied in various honey bee populations of Greece, mainly on the bees from different islands, and there is the possibility to find out several local honey bees populations. It is well known that the local honey bee populations are better adapted to the local environmental conditions and they can survive more; so the detection of local bees can contribute to the sustainable development of apiculture.

25 Ruttner, 1988.

26 Stevanovic et al., 2010.

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IMPORTANCE OF ADAPTATION OF BEE POPULATIONS ON THEIR LOCAL ENVIRONMENT – THE EUROPEAN INITIATIVE AND ITS RESULTS IN THE GREEK TERRITORY – THE GREEK INITIATIVE FOR THE CONSERVATION AND BREEDING OF THE LOCAL POPULATIONS

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Beekeeping in Europe and in the world today

For millions of years honey bees have survived close to humans, in a way that not only the beekeeping practice but also the different populations surviving in each environment constitute a kind of an 'inheritance'. To successfully survive in the wide range of habitats where they naturally occur, as a result of the natural evolutionary process, the honey bees developed specific adaptations to different environmental conditions; they also developed into many different geographical subspecies and into a wide variation of ecotypes^{1,2}. Form Büchler et al³ we quote:

"The honey bee sub-species are also described as 'geographic sub-species' since their distributions correspond to distinct geographic areas. Even within Europe there is a wide range of climatic and vegetation zones which favoured differentiation, and at present about 10 subspecies of *A. mellifera* are recognized on the basis of morphometric and genetic markers⁴. Some of these subspecies were found to be more attractive than others for beekeeping, which as an economic

and social activity plays a crucial role in the sustainable development of rural areas by providing important ecosystem services via pollination, thus contributing to the improvement of biodiversity of plants and farming crops⁵. An understanding of the genetic variability of bee populations and their adaptation to regional environmental factors such as climate and vegetation, prevailing diseases and agricultural practices is an important prerequisite for understanding problems in the health of honey bee colonies.

Hatjina et al⁶ also noted:

Thus, long-term adaptations express suitable population dynamics of the bee colony, which enable the colony to make the most of the available resources and to successfully resist threats like unfavourable seasonal living conditions⁷, disease and parasite pressure^{8,9}. Adaptations can be recognised by genotype –

⁵ EU Parliament Report, 2011.

⁶ Hatjina et al, 2014.

⁷ Parker et al., 2010.

⁸ Fries et al., 2006.

⁹ Le Conte et al., 2007.

¹ Ruttner, 1988.

² Meixner et al., 2010.

³ Büchler et al, 2014.

⁴ De la Rúa et al., 2009.

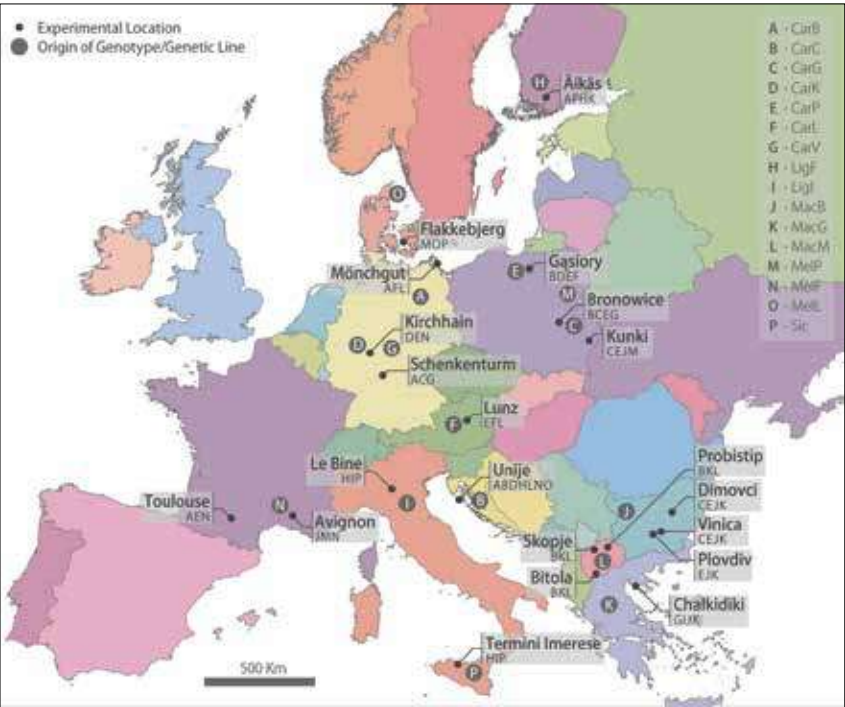


Fig. 1 Map of Europe showing the 21 locations covering the 11 countries participating in the European Genotype X Environment Interactions and the local populations used indicated by capital letters. Copyright International Bee Research Association. Reprinted from Francis et al¹¹.

environment interactions (GEI), in which distinct genotypes vary in the degree to which their phenotypes are affected by environmental conditions.

In light of the above, European -wide experimentation was conducted by several members of the COLOSS (Prevention of COLony LOSSes, Association, www.coloss.org) in order to study the complex interactions between honey bee colonies and their environment. We do know that distinct genotypes may vary in the degree to which their phenotypes are affected by specific environmental conditions - this phenomenon is known as "genotype-by-environment interactions" (GEI). Presence of the GEI indicates that the phenotypic expression of one genotype may be superior to another genotype in one environment but inferior in another environment. The different environmental conditions combine microclimate, vegetation, competition, enemies and the beekeeping practice. Different genotypes differ in how they react to the different environments and interaction explains the diversity in adaptability and superiority of some genotypes to specific environmental conditions. The same logic explains why there is no genotype the most suitable for all environments. The adaptability of a genotype It may also explain the possible suggested in some of the illnesses. Therefore we conducted a very large experiment involving 11 countries and

comparing comparing 16 different strains of honey bees (**Table I**) in 21 different environments for two and a half years, with respect to characters such as colony development, honey yield, overwintering, survivability, swarming and susceptibility to diseases.

The experimental apiaries were distributed across Europe, reaching from Finland in the North to Sicily and Greece in the South and from France in the west to Poland in the East (**Fig. 1**). Individual work with the results published in a special issue of the Journal of Apicultural Research 2014^{3,10,11,12,13,14,6}. A comprehensive report of the main findings of the above experiment can be found in American Bee Journal, issue of June 2015¹⁵. A significant difference it was observed in survival time between the local and foreign populations without therapeutic intervention. While in any given area, the foreign colonies survived an average of 470 days, the average survival time of the local bee colonies was 553 days.

10 Costa et al, 2012.
11 Francis et al, 2014a.
12 Meixner et al, 2014.
13 Francis et al, 2014b.
14 Usunov et al, 2014.
15 Meixner et al, 2015.

Table I. The 16 genotypes used in the GEI experiment and their origin

Genotype	Subspecies	Origin
CarB	Carnica	Bantín/ Germany
CarC	Carnica	Croatia
CarG	Carnica	GR1/Pulawy/ Poland
CarK	Carnica	Kirchhain/ Germany
CarP	Carnica	Kortowka/ Poland
CarL	Carnica	Lunz/ Αυστρία
CarV	Carnica	Veitshöchheim/ Germany
LigF	Ligustica	Finland
LigI	Ligustica	Italy
MacB	Macedonica	Bulgaria
MacG	Macedonica	Chalkidiki/ Greece
MacM	Macedonica	Skopje/ FYROM
MelP	Mellifera	Augustowska/ Poland
MelF	Mellifera	Avignon/ France
MelL	Mellifera	Laeso/ Denmark
Sic	Sicula	Sicily/Italy

The main conclusions of this great experiment were the following:

- no single strain showed superior performance at all locations., therefore there is no genetic superiority but good adaptability
- each genotype may respond differently to different environments
- locals bee populations have developed mechanisms which render the 'upper' of the 'foreign' populations in the survival, growth and sometimes productivity in the particular environment
- we need to improve and develop local populations in desired directions such as productivity and disease resistance, but we depend on imported genetic material

Adaptability result in Greece

In Greece the genotypes tested were CarV- *A. m. carnica* from Germany, LigI- *A. m. ligustica* from Italy, MacB- *A. m. macedonica* from Bulgaria and MacG- *A. m. macedonica* from Halkidiki-Greece (**Fig. 2**). We used 40 beehives, 10 for each genotype and kept them in an area away from other apiaries. No treatment for varroa mites was administered, other than the original treatment with oxalic acid before the introduction of the new queens. After 2 and half years, from the 40 beehives used in Greece, only 7

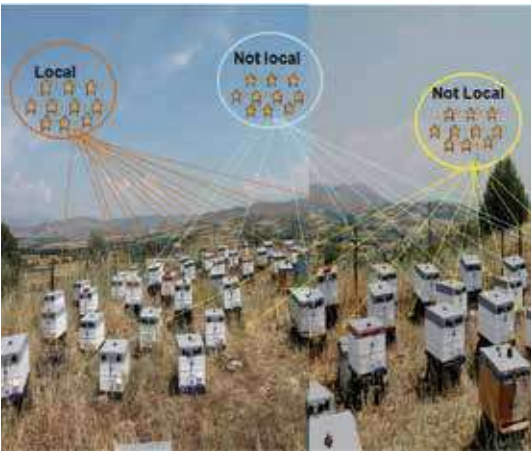


Fig. 2 Schematic presentation of the population origin in COLOSS- GEI experiment.

were alive in March 2012 (**Table II**). Of these only one was headed by Italian queens and the rest by Greek *macedonica* queens. Furthermore, it was also shown that the local colonies also produced more honey (**Table II**).

Table II. Average days of survival of different genotypes in Greece

Genotype	Average Days of survival	Kg of honey produced
CarV	384	15
LigI	428	27
MacB	503	25
MacG	580	29

Figure 3 shows the dynamics and the wintering ability of the survived colonies in terms of colony population, with the Greek colonies starting with higher population in spring. Interestingly, the population of colonies in spring was negatively correlated with varroa infestation in previous autumn, a expected result with what is known so far from the biology and development of the varroa mite.

It is believed that the adaptation of populations to abiotic environment may maintain the genetic diversity needed for the resilience to diseases and better exploitation of food sources. With the above experiment it became apparent that local bee populations have developed mechanisms to prove

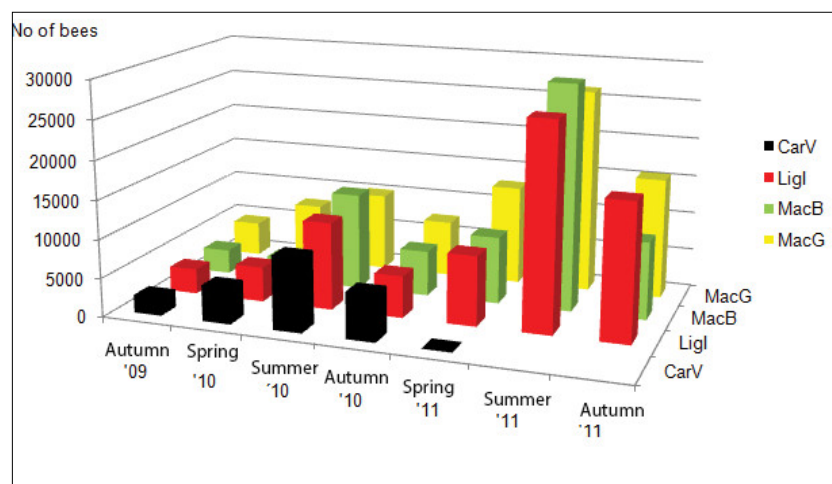


Fig. 3 Colony population (in honey bee numbers) of the survived colonies during the experiment.

that are far 'superior' of non local genotypes in the course of several years. It is no coincidence that the genotypes with high adaptation to environment of origin, characterize them as 'ecotypes'. It has also been written that different ecotypes have been established according to the availability and diversity of vegetation¹⁶. As so, the knowledge of the interaction between genotypes and the environment is very important in improvement and breeding patterns of various populations of bees. Is better to improve and develop local populations bees in desired directions such as productivity and resilience to disease, than to be dependent on imported genetic material. Certainly the genotypes which are reproduced and improved for many consecutive years in an environment different from the origin, at the end they will adapt to new living conditions. But the question is: what is the relationship between the final genotype with the original; One thing is certain: that trying to preserve the 'good' characteristics of a population or a genotype and breeding and conserving these characteristics in the natural environment could serve as the largest operation for the populations' evolution.

Preserving and breeding local Greek honey bee populations

According to Ruttner¹⁷, in Greece we had the following bee races: *A. m. carnica* (the Ionian islands), *A. m. macedonica* (Macedonia and Thrace), *A. m. cecropia* (in Central and Southern Greece), *A. m. adami* (in Crete and the Aegean islands). Today because of the many movements and trading, Greece is a country of great hybridization with dominant the Macedonian bee¹⁸ (Fig. 4).

16 Louveaux et al, 1966.

17 Ruttner, 1988.

18 Hatjina et al, 2002.



Fig. 4 Geographic locations for the four groups of samples distinguished by geometric morphometric analyses. Reprint from Hatjina et al¹⁸.

Recently, in very few areas (some Aegean islands and in Larisa-Central Greece) some populations different from the Macedonian bee have also been found^{19,20,21,22,23,24}. Detailed information on methods and results for the discrimination of the Greek populations, the reader can find in the previous contribution of this book written by Dr. Maria Bouga.

19 Bouga et al, 2004.

20 Bouga et al, 2005a.

21 Bouga et al, 2005b.

22 Martimianakis et al., 2011.

23 Charistos et al., 2014.

24 Hatjina et al., 2004.

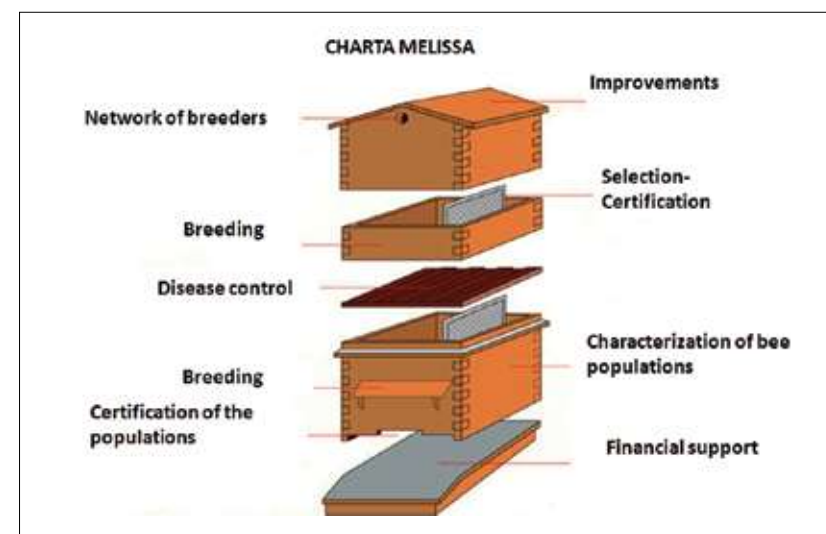


Fig. 5 Graphical description of the program "CHARTA MELISSA" undertaken by the Division of Apiculture -ELGO.

From ancient times until today beekeeping is for Greece a traditional rural profession. The 'return to Mother Earth' is a very popular message in our times with great success. Today in Greece there are approximately 20,000 registered beekeepers with about 1,400,000 colonies. The 39% of them are professional beekeepers with more than 200 beehives each, and 700,000 total colonies. It is also surprising that Greece holds again the highest density of colonies and apiaries (11.4 colonies per Km²) according to new research²⁵. The total annual honey production in the country is about 15,000 tons, of which 300 tons are exported, mainly in Europe. The average production per hive varies between 10 Kg and 20 Kg^{26,9}. The amount of such production is considered too small to cover the financial cost of maintaining the apiaries and to secure livelihoods, when Finland and Germany respectively have at least 30 - 40 Kg per beehive.

Beekeepers often believe that their bees are not productive or do not meet all the requirements and they introduce foreign genetic material with known bee 'excellence' with the main objective to increase production. However the imported foreign queens, even if they are known for their hybrid vigor, create additional hybrids and exhibit adverse effects (mainly aggressiveness and excessive swarming tendency) and the loss of productive benefits after the first generation. The result of the above phenomenon is that the native subspecies are replaced by foreign subspecies and therefore they could be driven to extinction and the Greek honey bee bio-diversity could be greatly reduced.

25 Chauzat et al., 2013.

26 Papanagioutou, 2010.

To solve the problem of productivity and to maintain the genetic diversity many governmental and non-governmental organizations started several improvement and conservation programs of their local honey bee subspecies since the 60s. Greece although it is a very important country in relation to beekeeping, does not yet have an organized system of selection and production of queen bees from the local populations.

A first attempt to maintain and breed the local bee subspecies is the research project undertaken partly by the Apiculture Division of the Institute of Animal Science (Hellenic Agricultural Organization 'DEMETER') (a program under the EC Directive 1234-1207) with the acronym "CHARTA MELISSA" and it is summarized in Figure 5.

The title of the project is "Preservation, improvement and conservation of genetic material of the Greek bee populations - CHARTA MELISSA: The characterization and identification of the Macedonian, Cecropian and Cretan bee through natural and artificial means of fertilization"

The aim of the project is

1. to find the local populations
2. to characterize them (monitor behaviour, development)
3. select and breed them
4. preserve them in their natural place or in a conservation area

No selection or conservation program can be achieved without the strict control of the couplings. Given the fact that the queen bees mate freely in the air, under certain conditions, the control of the couplings is a very important issue. In general, remote areas or small islands are ideal coupling areas but do not exist in countries with a high density of apiaries such as Greece. Possibly the very large crowds of colonies producing drones give a solution but does not ensure complete control. The artificial insemination on the other hand has solved this problem and is widely used not only by breeding centers but also some queens producers. But it is a technique that requires much time and specialized staff.

As part of this project the implementation of an innovative method would be the controlled mating of queen bees, called "The train of virgin queens". With this system we can achieve controlled, still free on the air, matings with precise handling of beehives used for the production of drones and virgin queens (Fig. 6). The 'Train of virgin queens' (TVQ) has been applied till now only in New Zealand and it is also known as the 'Joe Horner system'. The method requires a kind of a construction: a) a cabinet, or a cool box, which keeps the temperature at 14-15°C continuously; b) a number of hives bearing the virgin queens of the selected subspecies (each hive could be divided in 2 or 4 mating nuclei); c) a good number (more than 10) of drone producing colonies of the desired subspecies in a very close vicinity of the virgin queens d) a kind of rails, running out of the cool cabinet in the open surface, on which the hives with virgin queens are sliding. The hives bearing the mating nuclei are rolling on rails resembling a train (that is where the name came from), connected to each other with a chain of about 2 m long. Two days before the virgin queens are ready for mating, they are caged in their nuclei with a queen excluder and then they are placed inside the cool and dark cabinet. After the two days in the cool cabinet, in the afternoon, the queens are taken out of the cabinet. The nuclei are sliding on the rails in a way that in consecutive days they will always have exactly the same position, because the rails restrict their position and the chain between the nuclei restricts their distance. There are also some orientation cues around in permanent positions for the bees to facilitate their returning to home. The train of the virgin queens is going out of the cool cabinet for several afternoons and goes in again in the evenings just before dark.

At the same afternoons and only when all available free flying drones have returned to their colony, the drones from the selected colonies are allowed to fly, as they were kept restricted by queen excluder in their colonies. The pressure for mating is



Fig. 6 Views from "The Train of Virgin Queens" as established in the Division of Apiculture in New Moudania Halkidiki: a and b: the nuclei on their rails spread out; c: a close view of a nucleus; d: the drone colonies with the queen excluder to restrict the flying of the drones.

strong and the selected queens will eventually mate with the selected drones, as they are the only ones available at that time of day. The exact time of the day need to be defined in order to avoid undesired matings. The 'Train of the Virgin Queens' ensures the mating of several queens at the same time, without much labor. A video on 'The train of Virgin queens' can be found here: <https://www.youtube.com/watch?v=V8jXQeScgVg>.

At the first time, the above system was used in Greece, gave a mating efficiency >50%. The system will be tested again, with different subspecies in order to define the time of the day the queens are flying for mating naturally, the times they fly out, the duration of mating flights and the differences among

the populations due to the use of this mating system. The system will be tested for both macedonica and cecropia queens.

At the same time we are aware that no system or model is always effective. We need continuous efforts of specialized centers for several years to achieve the best of the results. But it is clear that without a National Selection and Improvement Program of our native bees we will never increase our economic benefit while maintaining our genetic material. In this effort it is absolutely necessary the close collaboration among scientists and beekeepers and State in order to reach the desired result, which is the economic development of industry of apiculture.

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Division of Apiculture

The Division of Apiculture is one of research units belonging to the new founded Hellenic Agricultural Organization ‘Demeter’, after the union of NAGREF with other governmental agencies. The whole responsibility is under the auspices of the Ministry of Rural Development and Food. It was founded by a decision of Presidential Decree 402/88.

The Division has been established in Chalkidiki region, as this is the area with the most professional beekeepers in Greece as well as the area with the greatest honey production (almost 60% of total production in the country).

Its mission is to produce and transfer knowledge on topics such as: Biology and Physiology of all species of bees; quality control of hive products and the queens produced; development of new technologies in beekeeping; bee flora conservation; enhancement of the role of bees in the environment; fight diseases with new environmental and biotechnological products; breeding and improvement of genetic material; evaluation of honey bee queen quality; the effects of pollutants on honey bee biology and physiology. <https://hellenic-beereseearch.gr/>



The Eva Crane Trust

Eva Crane Trust

The Trust was formed by Dr Eva Crane. It was enhanced by the residue of her estate bequeathed to the Trust on her death in 2007.

Its aim is to advance the understanding of bees and beekeeping by the collection, collation and dissemination of science and research worldwide as well as to record and propagate a further understanding of beekeeping practices through historical and contemporary discoveries.

The Trust is awarded grants to individuals and organizations that might otherwise find funding difficult in this specialized field. Recently the Trust has facilitated the English translation and revised edition of the book: ‘Beekeeping on the island of Andros’ written by George Speis and published by Kaireios Library in Greece.

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<https://hellenic-beereseearch.gr/>



Chamber of Cyclades

The Cyclades Chamber of Commerce was established in 1836 and is one of the oldest chambers in Greece. Headquartered in Syros and with 7 additional offices and conference rooms in Andros, Milos, Mykonos, Naxos, Paros, Santorini and Tinos islands, it represents and supports 17,500 companies on 24 islands of the prefecture through a variety of initiatives, actions and interventions.

The Chamber of Cyclades is mandated to uphold and safeguard the interests of local businesses as well as to promote regional business development covering sectors such as heavy industry, commerce, manufacturing, services, transport, tourism.

At the same time, it utilizes the latest technology and advanced digital communications between the islands, and has the most comprehensive business and tourist portal of the Cyclades. The website/ portal offers members innovative online services —adapted to the specificities and the needs of local businesses— and also provides visitors a complete Cyclades travel resource.

<https://www.e-kyklades.gr/intro.jsp>

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