# *A new type of rock-cut works: the apiaries*

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***Abstract***

*Since many decades, the Centro Studi Sotterranei (Genoa, Italy) is conducting wide range investigations on artificial cavities. The objective is to identify and document the ancient underground structures that have historical or architectural significance built or excavated by man, studying their origin, evolution and purpose of utilization. Over the years, a large number of rock settlements has been explored, widely distributed on the Mediterranean Basin, from Italy to the Far East, and chronologically diversified as regards types: passage, hydric, military, mining, worship works and, of course, residential works and relating infrastructures. Among the latter, researches are in progress about a particular type, the rupestrian apiaries, currently identified in three Mediterranean countries: central Turkey (Cappadocia), the island of Malta, and central-southern Italy. Waiting to extend in the near future investigations also to other areas, we propose here some considerations and comparisons between the structures so far documented.*

*Key words: apiaries, classification, Malta, Turkey, Italy.*

***Riassunto***

***Un nuovo tipo di struttura rupestre: gli apiari***

*Da molti decenni il Centro Studi Sotterranei di Genova sta conducendo indagini ad ampio raggio sulle cavità artificiali. L'obiettivo è quello di individuare e documentare le antiche strutture scavate o costruite dall'uomo nel sottosuolo che abbiano valenza storica o architettonica, studiandone origine, evoluzione e destinazione d'uso. Nel corso degli anni è stato esplorato un numero rilevante di insediamenti rupestri, ampiamente distribuiti sul territorio (dall'Italia all'Estremo Oriente), differenziati cronologicamente e diversificati nella tipologia: opere di transito, idriche, belliche, minerarie, di culto e, ovviamente, opere residenziali e relative infrastrutture. Tra queste ultime sono in corso ricerche su una particolare tipologia, gli apiari rupestri, attualmente individuati in tre paesi del bacino mediterraneo: la Turchia centrale (Cappadocia), l'isola di Malta, e l'Italia centro-meridionale. In attesa di estendere le indagini anche ad altre aree, si espongono in questa sede alcune considerazioni e confronti tra le strutture sino ad ora documentate, avanzando una proposta di classificazione tipologica per queste particolari opere destinate alla raccolta del miele e al controllo della sua produzione.*

*La raccolta del miele da parte dell'uomo è nota e documentata a partire dalla preistoria tra diverse popolazioni e culture in tutto il mondo, sia a scopo alimentare, sia per le sue proprietà curative. Da allora l'apicoltura ha conosciuto una lunga, continua e diffusa evoluzione che da sistemi di allevamento individuali condotti in semplici tronchi cavi, peraltro, in qualche caso, ancora oggi utilizzati, si è organizzata in sistemi compositi denominati apiari.*

*Si definisce apiario un insieme di alveari organizzato per l'allevamento delle api al fine della produzione del miele e di altri derivati (cera, propoli, pappa reale, polline). L'alveare è, a sua volta, composto da un contenitore (arnia) nel quale una famiglia di api (colonia o sciame) costruisce con la cera il proprio nido (favo) e produce il miele per nutrire le larve che nascono dalle uova deposte dalla regina.*

*Nell'antichità, in alcune aree è attestata la collocazione degli alveari all'interno di alloggiamenti appositamente predisposti (housing apiaries, che gli apicoltori chiamano anche "apiari collettivi"), costruiti in muratura o scavati nella roccia per contenere arnie di tipo più elementare (arnie villiche, costituite da cassette, cesti, cilindri fittili o altre forme) e fornire un riparo dagli agenti atmosferici.*

*Nelle tavole qui presentate sono riportati vari tipi di apiari rupestri, rappresentati in modo schematico, sintetizzando le caratteristiche delle strutture apistiche finora documentate. Il risultato, per il momento, è stato quello di identificare tre categorie generali di apiari rupestri, gli 'apiari a parete' (categoria a), gli 'apiari a camera aperta' (categoria b) e gli 'apiari a camera chiusa' (categoria c), a loro volta suddivisi in più tipi. Va però tenuto presente*

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*che, in realtà, ogni installazione apistica possiede peculiarità proprie, non di rado associate ad opere in muratura. Dalle ricerche finora condotte risulta evidente che, nel panorama della apicoltura rupestre, non esisteva un modo univoco di alloggiare gli alveari: emerge, infatti, una variegata tipologia che va dalle strutture più elementari (apiari a mensola della Puglia), a quelle più evolute (apiari a camera integrale della Cappadocia). In estrema sintesi, la differenza maggiore riscontrata tra gli apiari rupestri dell'Italia meridionale, da una parte, e quelli di Malta e della Cappadocia, dall'altra, consiste nel fatto che nei primi le arnie erano sempre disposte in modo da avere la bocca posteriore contro la parete di roccia. Tenendo presente che le operazioni inerenti alle ispezioni periodiche e al prelievo dei favi venivano di norma effettuate mediante apertura dell'estremità opposta ai fori di volo e, qualche volta, della parte superiore, risulta evidente che le arnie dovevano, quindi, ogni volta essere sfilate dal loro supporto, con notevole disturbo per le colonie di api. Dunque, il vantaggio degli apiari a camera chiusa (tipo c), presenti a Malta (camera murata) e in Cappadocia (camera integrale), deriva dal fatto che le arnie erano accessibili direttamente dalla bocca posteriore, senza che fosse necessario rimuoverle dal loro alloggiamento, evitando anche che l'apicoltore si interponesse davanti ai fori di volo, riducendo al minimo qualsiasi variazione nella routine degli alveari.*

*Parole chiave: apiari rupestri, classificazione, Malta, Turchia, Italia.*

## Apiaries

The collection of honey by humans, as well as the control of its production, is well known and documented since prehistoric times among different populations and cultures around the world (Crane, 1999), both for food purpose and for its healing properties (Jones, 2009). A painting found at Çatalhöyük (near Konya, central Turkey), attributed to the late Neolithic, seems to suggest the transition from a simple collection phase to that of a first attempt of domestication, or at least, to control the bees (Bortolin, 2008). Since then, the beekeeping knows a long, continuous and widespread evolution, from individual breeding systems handled inside simple hollow logs (in some cases, still used today), to organization in composite systems called apiaries.

We define apiary a set of beehives organised for the breeding of bees in order to product honey and other by-products (wax, propolis, royal jelly, pollen). The beehive, in turn, consists of a container (hive) in which a bee family (colony or swarm) builds with wax its nest (honeycomb) and produce honey to feed the larvae that are born from eggs laid by the queen.

Apiaries may simply be groups of single beehives placed outdoors (open air apiaries) in localized plots of land, as it mainly happens since the middle 1800 following the invention of so-called rational hives used in modern beekeeping (Zappi Recordati, 1980).

In ancient times, in some areas it is attested the placement of hives within specially prepared housings (housing apiaries, that beekeepers call "collective apiaries", too), built in masonry or excavated into the rock to contain the simplest type of hives (villager hives, consisting of boxes, baskets, fictile cylinders or other forms) and provide a shelter from the atmospheric agents. Sometimes, for example in Portugal, the beehives were placed inside imposing structures built with high dry stone walls, usually circular or semicircular, to protect them from attacks by the animals (Guedes et al., 2002).

It has also to be added that between Tenda and Briga, and as far as Realdo (France-Italy), there are *'more than 90 massive stone fences, with a characteristic and distinctive "horseshoe" shape, that were real "sanctuaries" where from 50 to 100 "beehives" were kept, with a summer population that could vary from 1 to 3 million of bees for each enclosure'* (Masetti, 1996, p. 139).

In this article we will consider, according to the general research objectives of Centro Studi Sotterranei, only rock structures, excavated with various techniques in natural rock walls (rupestrian apiaries), thus excluding the masonry apiaries.

## Rupestrian apiaries in Cappadocia (Central Turkey)

The apiaries identified in Cappadocia, in the area between Ürgüp, Üçhisar, Göreme, Ortahisar and Çavuşin (district of Nevşehir), and in the valleys of İhlara (district of Aksaray) and Soğanlı (district of Kayseri) are more than 50, catalogued by Gaby Roussel in 2006 and 2007. From the description (Roussel, 2006, 2008), it appears that each of them, despite having its own peculiarities, has similar general features (apiaries with room fully excavated into the rock), with the two structures documented by Centro Studi Sotterranei in 2001 and 2003 (Bixio et al., 2004, 2009; Bixio & De Pascale, 2009, 2011).

### *Apiary A2, called Niketas*

This structure is located at the head of the valley called Kızıl Çukur (Red Hollow), right tributary of the Meskendir-Zindanonu basin.

It owes its name to the famous hermitage of Niketas the Stylite. His cell is attached to the Uzumlu Kilise, or Church of grapes, both excavated into the rock. Although the names of the ascetic and the donor, a certain Eustrate, army commander, are shown in an inscription, dating is controversial, probably between the sixth and ninth centuries (Jolivet-Levy, 2001). Other spaces, called *şaraphane*, that means 'cellar',

are excavated inside the body of an adjacent pinnacle. The Turkish toponyms suggest, therefore, agricultural activities, perhaps in direct continuation with those of the Byzantine monastic settlement, consisting of vines and apricot trees cultivation. Such activities could also include the production of honey inside the apiary excavated above the cellar.

The operating room of the apiary (Fig. 1), otherwise invisible, is identified by a small door carved high in the rock wall of the pinnacle above the entrance of the cellar, flanked by vertical rows of small holes and slits. It does not communicate with the spaces below, but it is accessible from the outside only by a rudimentary mobile ladder kept by the owner of a nearby closet (Fig. 2).

The space is roughly a rectangular parallelepiped, with a narrowing on the side opposite the entrance. It has a flat ceiling, two metres high on average.

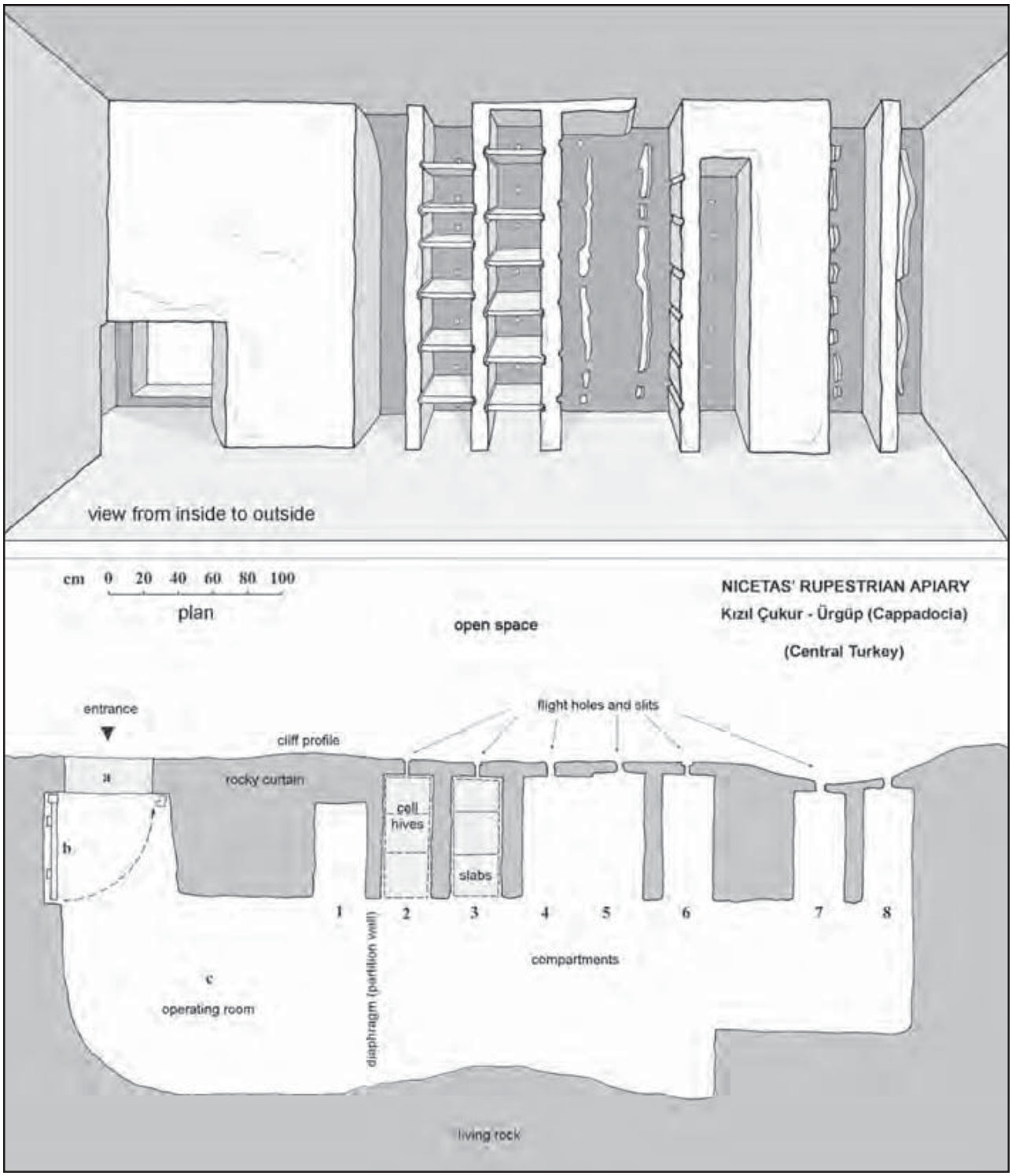


Fig. 1 - Cappadocia. Apiary of Nicetas, plan and inside view (drawing R. Bixio).
*Fig. 1 - Cappadocia. Apiario di Nicetas, pianta e vista interna (grafica R. Bixio).*

In the thickness of the rock curtain overlooking the outside eight high and narrow vertical compartments have been carved out, about 30 cm wide, and separated by 10-cm diaphragms (40 cm between compartments 6 and 7; Fig. 3).


Fig. 2 - Cappadocia. Apiary of Nicetas: a wood ladder allows to enter the small door of the apiary, excavated in the rock wall of a natural pinnacle (photo G. Bologna).
*Fig. 2 - Cappadocia. Apiario di Nicetas: una rustica scala permette di raggiungere la porticina dell'apiario scavato nella parete di roccia di un pinnacolo naturale (foto G. Bologna).*

Fig. 3 - Cappadocia. Apiary of Nicetas: one of the cell-hives still in use, showing on the side the grooves (runners for slabs). To the right, some obsolete basket-hives are visible (photo G. Bologna).
*Fig. 3 - Cappadocia. Apiario di Nicetas: una delle arnie a cella ancora in uso. A lato sono visibili le scanalature (guide) per le lastre. A destra vi sono alcune arnie a cesto in disuso (foto G. Bologna).*

*Cell-hives, fixed*

The first compartment is excavated in a simple way, has neither subdivisions nor holes, and the ceiling is curved. The second and the third are each divided into seven cells by means of six shelves. Each shelf is made of mobile tufa slabs (at least three), inserted through horizontal grooves (runners) chiselled on the side walls of the diaphragms. The slabs are locked into the grooves by means of a sort of plaster. Because of the limited thickness of the vertical diaphragms, the grooves on the adjacent faces are staggered to avoid excessive weakening of the rock divisors (Fig. 3).

The end-wall of each cell is pierced by a small perfectly circular hole, 2,5 cm in diameter, communicating with the outside. From here (flight hole) the bees entered and build their honeycombs directly on the rock, without intermediation of additional containers. Thus, each cell corresponds to a hive. The back mouths of each hive, toward the inside of the operating room, were sealed with a wooden door that was opened only for inspection and the extraction of honey. This system allows optimum operating conditions. Currently, only one of 14 cell-hives is still in use.

*Basket-hives, movable*

This lucky circumstance was crucial for the preservation of those mobile elements (disappeared in the completely abandoned hives) that allow, even if no more used, to perceive the function of the other five compartments.

These elements consist of tubular hives formed by cylinders, open at both ends, about 70 cm long and 30 cm in diameter. Each cylinder is made with interlaced branches, like a basket, and then covered with a sealant layer of *tezek*, that is sun-dried excrement, which is still used today in the nearby villages as fuel for domestic use. Also the circular lid, closing the back mouth of the basket, is constructed in the same way (Fig. 4).

Today, the basket-hives lie piled at the bottom of the operating room, and are not used at all. It has to be

Fig. 4 - Cappadocia. Apiary of Nicetas: ancient tubular basket-hive (photo G. Bologna).
*Fig. 4 - Cappadocia. Apiario di Nicetas: antica arnia a cesto tubolare (foto G. Bologna).*

noted that under the heap at least three wooden boxes can be glimpsed. They are rectangular, long and narrow, of the same size of the compartments, and could represent a further evolution of basket-hives.
These containers, tubular or box-shaped, placed in horizontal position, could be stacked in the compartments without the need for shelves supporting them. Indeed, compartments 6, 7 and 8 are without tufa slabs and the related horizontal grooves (Fig. 5). The grooves are instead present on the two walls of the large central space that, however, is without shelves. It is evident that this space corresponds to the joining of two adjacent compartments, 4 and 5, obtained by the removal of the partition-diaphragm and its horizontal slabs. Originally, these two compartments were clearly structured for the cell-hives use. It is thus clear that this space is the conversion element from a fixed hives use to that of movable hives.

*Slits*
The front mouth of the basket-hives was placed to coincide with the flight holes. Those holes, in compartment no. 6, are still perfectly round. In the other four compartments there is a gradual change, first with larger and squared holes in compartment 7, up to real slits, vertically elongated, in the other three compartments. The profiles of the slits are irregular and broken at several places, as though derived from the progressive and accidental union of the holes. It is likely that the junction initially occurred due to natural erosion preferentially developing along the axis of the discontinuity represented by the flight holes, and then intentionally. It is sure that the slits of Kızıl Çukur apiary A1, that will be discussed later, and those of Göreme have been intentionally and skilfully made.
For completeness we point out that the ancient use of hives with a cylindrical shape, made of different materials (fired clay, tuff or ferula barrel), and arranged in horizontal position, is attested with appropriate differences in various parts of the Mediterranean Basin: for instance, in Sicily (Zappi Recordati, 1980) or in Egypt (Cirone, 2001). The use of tubular hives (fired clay) has been widely analysed in the rupestrian apiaries investigated in the island of Malta (Bixio et al., 2002c). However the use of basket-hives and flight holes in tall and narrow slit shape, at the present state of our knowledge, it seems a prerogative of Cappadocia only. Further, the use of hives obtained directly into the rock (cell-hives), without intermediate containers, does not appear performed elsewhere.

Fig. 5 - Cappadocia. Apiary of Nicetas: Evolution of two compartments (fusion) and view of the flight holes to house the basket-hives, one exemplar of which is visible to the right (photo G. Bologna).
*Fig. 5 - Cappadocia. Apiario di Nicetas: evoluzione di due compartimenti (fusione) e dei fori di volo in feritoie destinate ad alloggiare le arnie a cesto, di cui sulla destra è visibile un esemplare (foto G. Bologna).*

*Hypotheses on the double system of breeding*
As already said, the basket-hives, though well preserved, are no more used today. To tell the truth, the whole beekeeping system through rupestrian apiaries, seems by now to have fallen into complete disuse in the whole region. The exception is the case of Niketas where, however, only one beehive (a cell-type) of the whole 48 of the apiary is still used by the owner.
It seems clear that in the same rupestrian apiary structure two different and concomitant breeding systems co-existed: one worked through cell-hives which, because of their intrinsic characteristics, were fixed in the operating room and closely associated with circular small flight holes; the second, on the other hand, operated through mobile basket-hives, that used both circular flight holes and larger square openings or vertical slits.
The question naturally arises about the reasons that may have led the ancient beekeepers to adopt a double system of hives in the same rupestrian structure. Lacking any reliable source, it may be assumed that it was functional to the choice of diversification of the breeding techniques, obviously aimed at optimizing the honey production. The cell-beehives, fixed for their nature, could not be used otherwise than to practice sedentary breeding, thus exclusively linked to the flowering area surrounding the place where the apiary had been excavated. At the same time the movable basket-hives could be used in parallel with the fixed ones, also allowing to exercise the so-called nomadic (or transhumant) breeding which consists of systematically moving bees in an area with asynchronous flowering, and then during the cooler seasons bring back in the sheltered rupestrian apiaries of origin, joining them with sedentary hives.

*Diachronic considerations*
There are evidences to believe that the system with basket-hives was introduced later than the use of cell-hives (Demenge, 1995). It is indeed more likely to think that nomadic breeding, characterized by the moving of hives, represents an evolution of the sedentary one, and not vice versa. In fact, once you learn the basket-making technique and notice the increased productivity of nomadic breeding, it would have been illogical and counterproductive to convert a more versatile system (movable hives) in a less flexible (fixed hives). Even if deciding to create a sedentary breeding, however, it would had been more useful to have available movable hives as immediately convertible, if necessary, to noma-

dic breeding, rather than the opposite.
As concerns chronology of the two systems it is crucial the evidence provided by the transformation undergone by the flight holes, which allows to attempt an interpretation of the sequence of evolutionary phases of the apiary, as follows (see Fig. 1 for references).
Phase 1: excavation of the operating room.
Phase 2: excavation of compartments 2, 3, 4 and 5 inside the operating room.
Phase 3: creation of cell-hives through the realization, in each compartment, of (circular) flight holes, horizontal grooves, and lodging of related slabs (see in particular compartments 2 and 3). Sedentary beekeeping.
Phase 4: extension of the operating room. Use of basket-hives and beginning of nomadic beekeeping. New compartments are excavated always with circular flight holes, but without slabs and grooves, as the division shelves are no longer needed (see compartment 6).
Phase 5: in the meantime, the circular flight holes of compartments 4 and 5, perhaps because most exposed to the atmospheric agents or due to a lower thickness of rock, degrade because of the erosion at the outer surface of the pinnacle. The holes become larger and take on a more irregular shape. Probably also the partition between the two compartments deteriorates making them unsuitable for the cell-hives which are replaced with basket-hives.
Phase 6: it was noticed that larger flight holes are more functional for the new type of basket-hives, facilitating the exchange of hives, by then become movable, and improving the flow of bees. So the beekeeper intentionally widens the flight holes of compartment 7 with square mouths.
Phase 7: erosion of the holes continues over time. The holes gradually join along the vertical axis to create long and narrow slits (see compartments 4, 5 and 8). This new arrangement is even more functional for the management of the basket-hives because in the nearby Kızıl Çukur apiary (as well as in other apiaries) the slits are no longer produced by the fortuitous and, in any case, slow action of the atmospheric agents, but are made on purpose, and carved with great care.
It has to be noted that, in chronological order, compartment 1 should be the last made with the aim to further expand the apiary, but suspended during the process of completion. It has neither grooves or flight holes. The curvature of the rock in the upper part is in some ways indicative of the gesture with which it was dealt the blow of the digging tool.

### *Apiary A1, called Kızıl Çukur*

Another structure, located about 750 metres downstream of apiary A2, is in general similar to it, but made with greater accuracy (Bixio et al., 2002a, b). The operating room is divided in two parts (Figs. 6-7): on one side, four compartments with cell-hives are present (Fig. 8), quite identical to those inside the apiary of Niketas. On the other side four slits are excavated

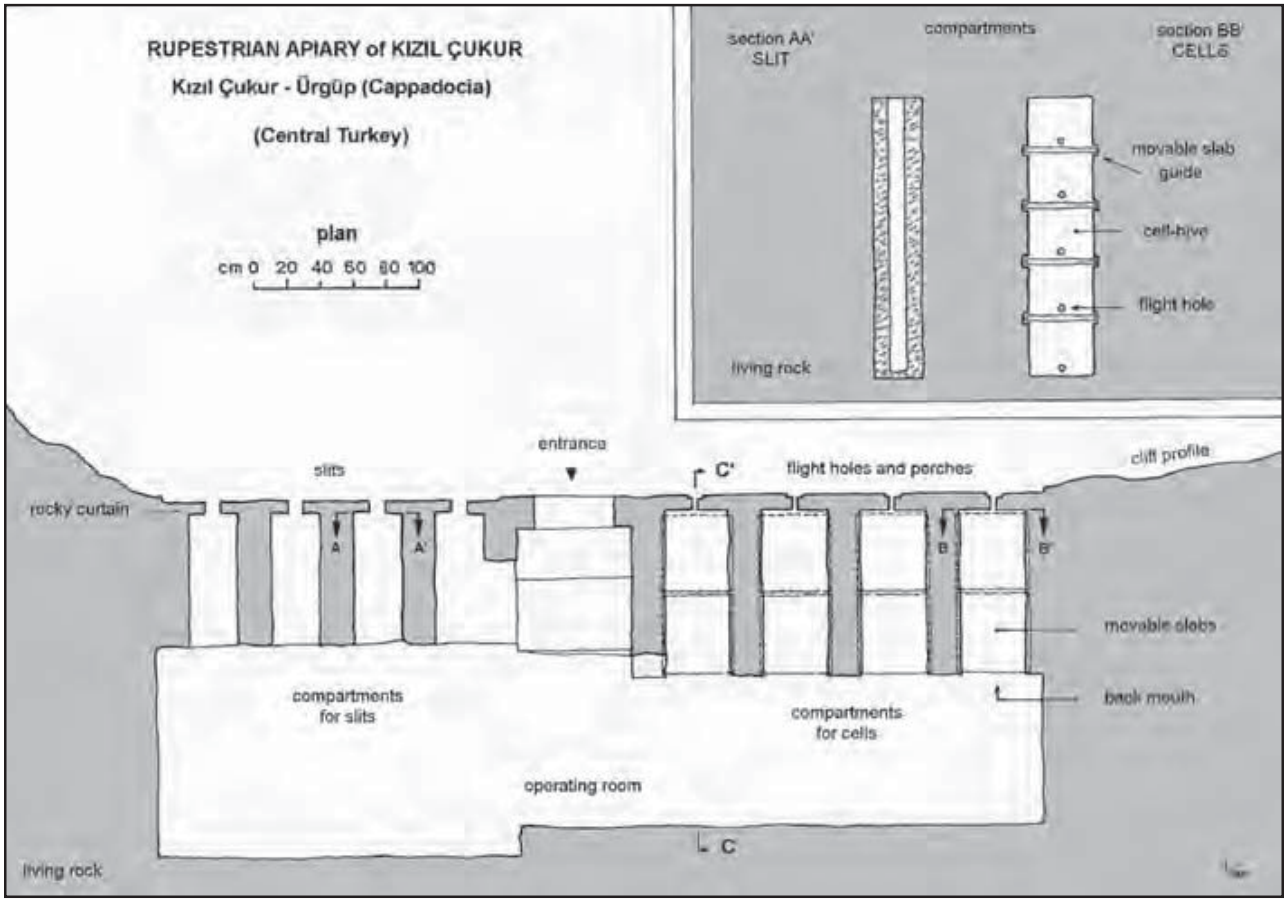


Fig. 6 - Cappadocia. Apiary of Kızıl Çukur: plan (drawing R. Bixio).
*Fig. 6 - Cappadocia. Apiario di Kızıl Çukur: pianta (grafica R. Bixio).*

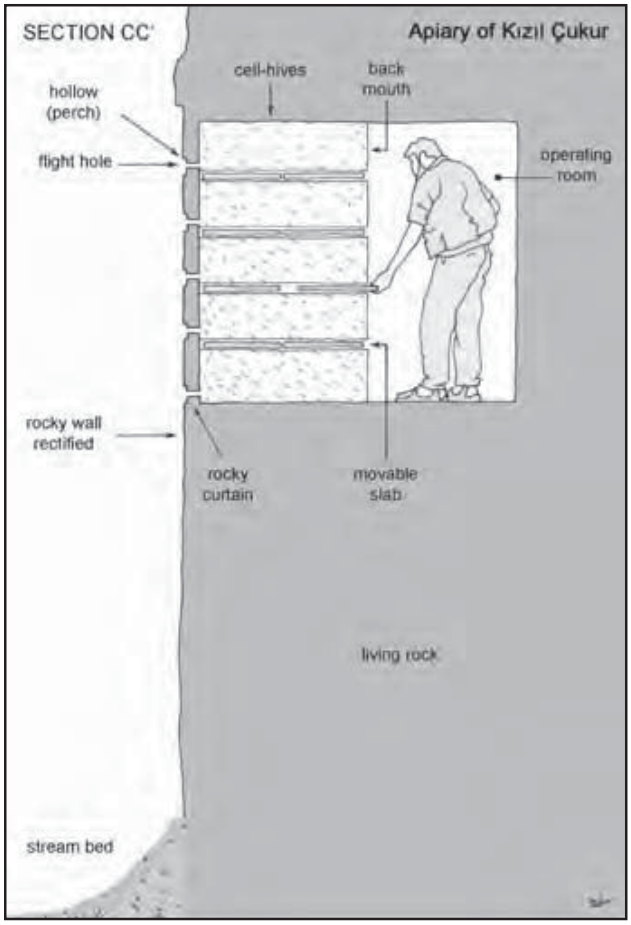


Fig. 7 - Cappadocia. Apiary of Kızıl Çukur: cross section (drawing R. Bixio).
*Fig. 7 - Cappadocia. Apiario di Kızıl Çukur: sezione trasversale (grafica R. Bixio).*

Fig. 8 - Cappadocia. View inside the apiary of Kızıl Çukur, showing some compartments subdivided in cell-hives, with grooves and remains of slabs (photo M. Traverso).
*Fig. 8 - Cappadocia. Interno dell'apiario di Kızıl Çukur: sono visibili alcuni compartimenti suddivisi in celle per arnie, con scanalature e resti di lastre (foto M. Traverso).*

Fig. 9 - Cappadocia. Apiary of Kızıl Çukur: the cliff hosting the apiary. In the centre of the picture, the small door is visible. To the left, rows of flight holes; to the right, four vertical slits (photo A. Carpignano).
*Fig. 9 - Cappadocia. Apiario di Kızıl Çukur: la falesia in cui l'apiario è stato scavato. Al centro è visibile la porticina, a sinistra le file dei fori di volo, a destra quattro feritoie verticali (foto A. Carpignano).*

with great accuracy: perfectly vertical and parallel, unbroken in height, even in width and thickness. Also the exterior façade has been regularized (Fig. 9). All of these appear as carefully designed and executed devices. Here, the basket-hives had to be placed, but no evidence of them is left.

As concerns the apiary of Kızıl Çukur, it is therefore possible to assume that while the section where the cell-hives are placed might be more or less coeval with that of the structure located further upstream (Niketas), and in any case preceding the introduction of nomadic beekeeping, the system with slits had to be added at a later time. Further, it is also likely that it was following the introduction of basket-hives in the apiary of Niketas where, as we have seen, the slits are more irregular and discontinuous, beside coexisting with intermediate forms such as circular or square flight holes.

We consider the apiary of Niketas as the prototype in which the most archaic phases of the technology necessary to practise nomadic beekeeping have been developed, before being extended to other nearby apiaries.

In fact, even if dating is controversial, the nearby rock hermitage of Niketas seems to be the oldest monastic settlement in the valley. However, we stress that the actual relationship between the beekeeping structure

and the cell of the Byzantine monk has still to be ascertained; the same is true for that between the apiary of Kızıl Çukur and the nearby underground church of Columns.

***Industrial and home beehives***

Nevertheless, even with some doubts, both hives seem to be directly related with the monastic settlements. Whether cenobitic or hermitic, the relative sizes of apiaries were still considerable. With a simple calculation, there are 40 hives in apiary A1 and 48 in A2. The number suggests, therefore, a production that was to go beyond the mere personal or family consumption to meet size that could be called industrial. The production of the two structures in question, therefore, does suggest a possible source of commerce (not unusual even today).

The industrial nature of some apiaries is highlighted by the identification of other apiaries that we can consider for home use. For example, the apiary near the intercepting channel called *Maggiociondolo (Laburnum)*, in the upper part of the Meskendir valley, is located inside a rock room, and not solely dedicated to breeding bees. It occupies a very limited space inside the room: a square niche divided by a cross-like arranged partition in order to obtain four cell-hives, enough to meet the needs of one family that, in this case, breed the swarms in the same place where it lives.

## Rupestrian apiaries in Malta

In 2002, together with Raffaele Cirone (Italian Federation of Beekeepers of Rome) an investigation was conducted in Malta to document some ancient rupestrian apiaries (Bixio et al., 2002c).

***The island of Melita***

The Romans, at the time of their occupation, called the island of Malta 'Melita', a name evidently derived from the Latin *mel*, meaning honey. Several localities are still today identified with toponyms that recall products such as honey and wax, so valuable to be used, together with the salt, as exchanging coin. The site of Imgiebah, near the town of Xemxija, in the northern part of the island, has a more specific designation, also reported by ancient maps: his translation from the "Malti" (a Semitic language) means 'apiary'.

As everybody knows, the whole island of Malta, and not only the locality of Imgiebah, contains archaeological remains of considerable importance and antiquity through the millennia. People coming from Sicily lived, around 5200 BC, inside the simple rock shelters that dot the limestone cliffs of the island. Between 4100 and 2500 BC an extraordinary megalithic architecture developed: many temples were built and the suggestive underground site of Hal Saflieni, where the cult of Mother Earth is attested, was excavated. Around 1000 BC, it was frequented by Phoenicians and Carthaginians that increased trade and agriculture. From 218 BC the island fell under the influence of the Roman Empire. The breeding of bees quickly became a significant economic activity and the excellent honey produced on the island became one of the most famous products, to be praised even by Cicero.

Coming back to our main subject, the ancient production of honey is not only cited in literature, but it is also tangibly demonstrated by material findings. In fact, the ancient rupestrian structures, recently rediscovered in Imgiebah and exploited by the locals, relate precisely to beekeeping, still practiced today in Malta with great profit.

***Stone houses for bees***

The site of Imgiebah lies on the hill overlooking the bay of St. Paul, behind the last houses of Xemxjia. The barren slopes are characterized by limestone scarps where shallow caves open and by terraces bordered with extensive dry-stone walls. The surrounding area is rich in ancient remains. The road climbing toward the summit, partly carved into the rock, is attributed to the Roman period, as the remains of a 'villa', with a Punic tomb identified nearby.

At a sharp bend in the road, tens of mouths (niches), opening on a rock wall overlooking an esplanade, identify one of the apiaries of Imgiebah. Instead of being made up of the usual movable wooden boxes, it is entirely realized into the stone with a not ordinary technique. Actually the apiaries are three, located on contiguous and overlooking terraces, partly hidden by a giant millennial carob tree.

The lower one, more exposed to view, extends along a front of twelve meters. It consists of a wall about three metres high, with exposed stones, carefully restored in recent times with mortar. It has three rows of overlapping niches, for a total of forty-seven mouths of various sizes. It is divided into two sectors that are accessed through two low small doors placed in the centre (points 1 and 2 of the plan in Fig. 10).

After entering the inner rooms we realize that the structure consists of a natural cave, against which a composite masonry structure was put in place. The cave, or to better say the rock shelter, irregularly extends along the whole length of the front, with a depth of about 1-2 metres (Fig. 11): a kind of room, long and narrow, sheltered by a roof of living rock, jutting out, and closed at both ends by walls. Its genesis is related to natural erosion of the limestone, without human intervention. Localized excavations, to obtain the space for bench and small shelves to lay oil lamps and tools suitable for the apiary management, are visible today.

The masonry is more significant, consisting of ashlars of various sizes, that is rock nearby quarried and purposely squared. It consists of *globigerina* limestone, still used in building industry, very soft to cut, which then hardens on air exposure. The rock shelter was thus enclosed by a lengthwise wall, advanced a few metres with respect to the natural room. The two spaces thus obtained (operating rooms) are in turn divided into parallel compartments by orthogonal partitions formed by rows of ashlar and covered with masonry supported by opposing (*Cappuccina* covering) or horizontal (lintel) slabs, arranged between the partitions (Fig. 12).

In some ashlars of the outer wall, niches have been

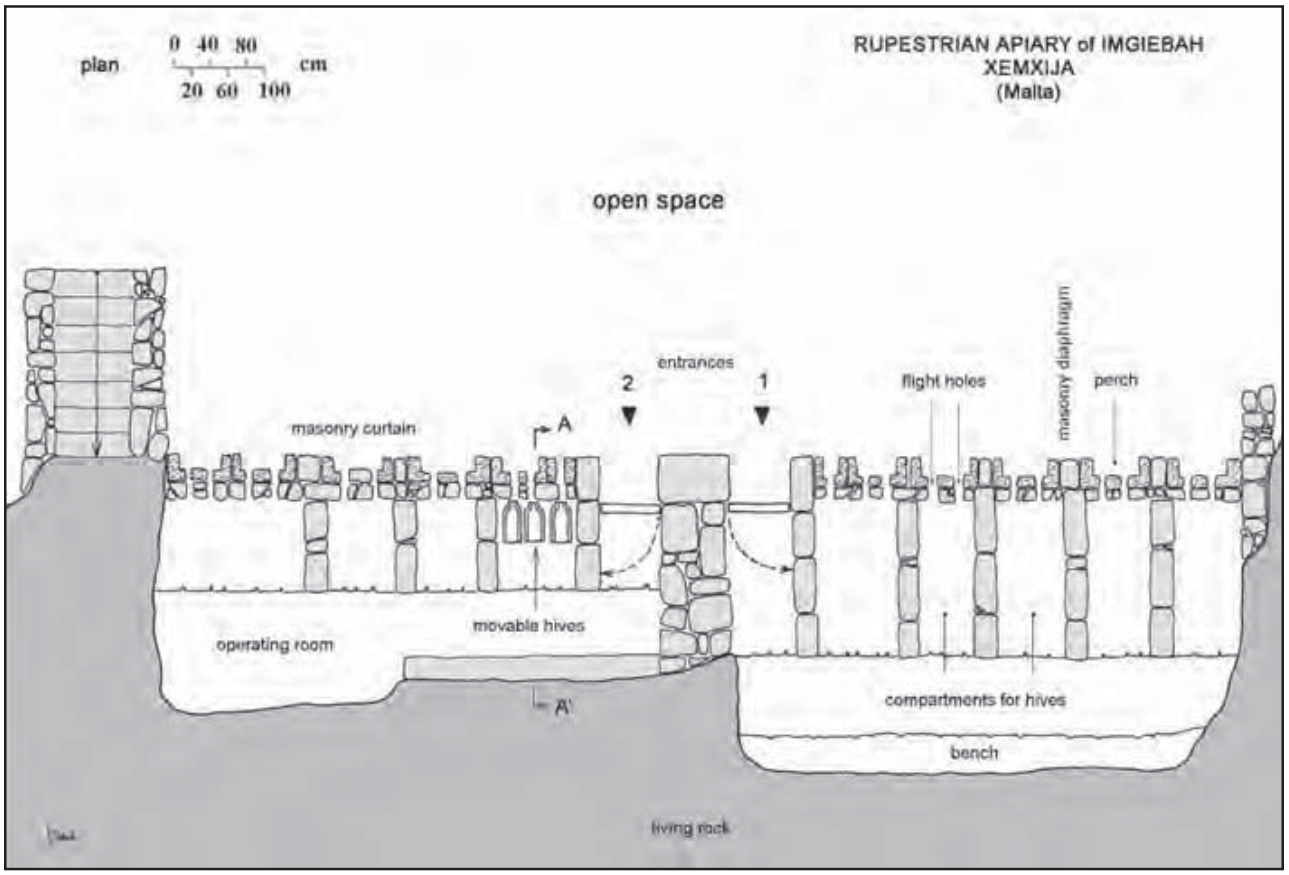


Fig. 10 - Malta. Apiary of Imgiebah: plan (drawing R. Bixio).
*Fig. 10 - Malta. Apiario di Imgiebah: pianta (grafica R. Bixio).*

carved, arranged in three, locally four, superimposed horizontal rows starting from the ground surface. The openings, except for some rectangular, have the appearance of oven mouths with the upper profile like a flat arch (Fig. 13). They penetrate the limestone ashlar for about thirty centimetres forming a shelf that could serve as a perch for the bees coming from the outside. On the wall closing the bottom of each compartment two squared holes (flight holes) were carved, piercing the diaphragm of stone. The inside is covered by a second wall, leaning against the first, of rougher dry stones, arranged to reduce the span of holes to prevent that the hives placed on the other side could be removed from the outside.

The hives are made of cylinders of fired clay, open at one end and closed on the side of the short narrowing that forms the stumpy neck (Fig. 14). Five small holes are here present to allow the entrance of bees (flight counter-holes). The tubular hives, made of fired clay with a system still in use by beekeepers in North Africa, were horizontally placed in the compartments defined by internal partition walls, in superimposed rows resting on movable horizontal stone shelves, supported by vertical side slabs and locked with clay. Each row could contain, depending on the number of outer holes, two or more hives side by side. The open side of the cylinder (back mouth of the hive) was facing the interior (operating room). It was closed with a wood stopper and sealed with propolis (by bees) and wax (by

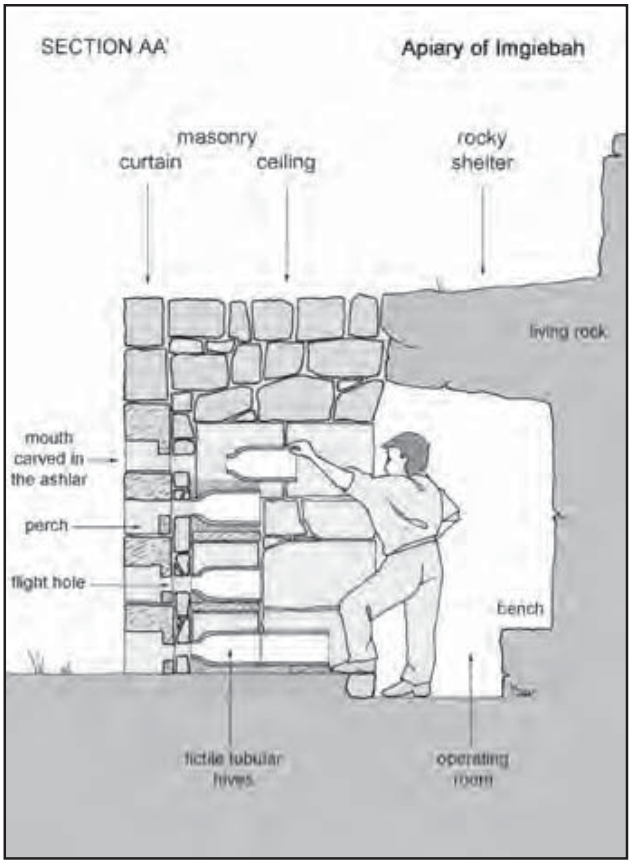


Fig. 11 - Malta. Apiary of Imgiebah: cross section (drawing R. Bixio).
*Fig. 11 - Malta. Apiario di Imgiebah: sezione trasversale (grafica R. Bixio).*

man). The honeycomb cover tablet (stopper) was removed during the honey collection. Technical operations (inspections, fumigation, honey collection) took place in the operating room with all comfort for the beekeeper (and for the bees).

Fig. 12 - Malta. View inside the apiary of Imgiebah, showing the compartments for hives built with squared stones. The flight holes are visible against the light in the ashlars (photo M. Traverso).
*Fig. 12 - Malta. Interno dell'apiario di Imgiebah, con i compartimenti per le arnie costruiti con pietre squadrate. I fori di volo sono visibili in controluce nei conci esterni (foto M. Traverso).*

Fig. 13 - Malta. Apiary of Imgiebah: the masonry curtain with oven mouth-shaped niches carved in the ashlars (photo M. Traverso).
*Fig. 13 - Malta. Apiario di Imgiebah: la cortina in muratura con le nicchie a bocca di forno scavate nei conci (foto M. Traverso).*

Fig. 14 - Malta. Reconstruction of the housing system for the fictile tubular hives in the apiary of Imgiebah (photo M. Traverso).
*Fig. 14 - Malta. Interno dell'apiario di Imgiebah: ricostruzione del sistema di alloggiamento delle arnie tubolari fittili (foto M. Traverso).*

The scheme just described is essentially the same in the other two hives, although some structural changes have been detected. For instance, the upper apiary, which appears more archaic, consists of a single room housed in a much larger rock shelter (more than three meters wide), entirely covered by the overhanging roof of living stone. For this reason there are no orthogonal partitions, or supporting slabs for the natural cover, but only the longitudinal closure wall. Here, the hives were resting on shelves obtained in the wall itself, in arched niches, instead of movables slabs. The openings in the outer ashlars are rectangular rather than oven-like mouth, but always with two flight holes each. Inside the middle apiary there are not mouths, but the flight holes are obtained directly in the ashlars of the drywall, at the horizontal joints.

## Proposal for a typological classification of the rupestrian apiaries

Schematic representations of several types of rupestrian apiaries are shown in figures 15 and 16, combining and summarizing the characteristics of the beekeeping structures documented in Cappadocia and

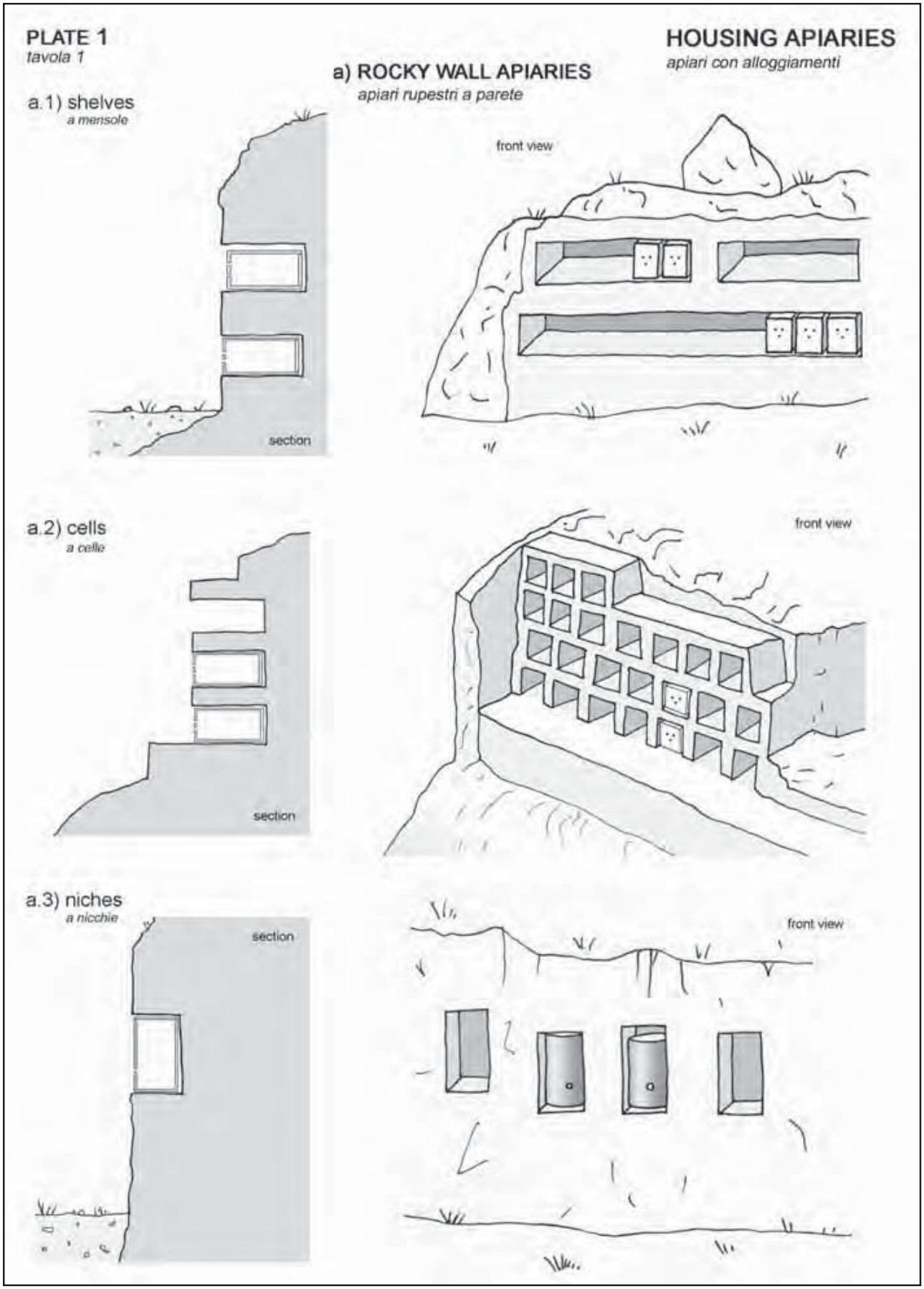


Fig. 15 - Plate 1. Categories and types of rupestrian apiaries (drawing R. Bixio).
*Fig. 15 - Tavola 1. Categorie e tipologie degli apiari rupestri (grafica R. Bixio).*

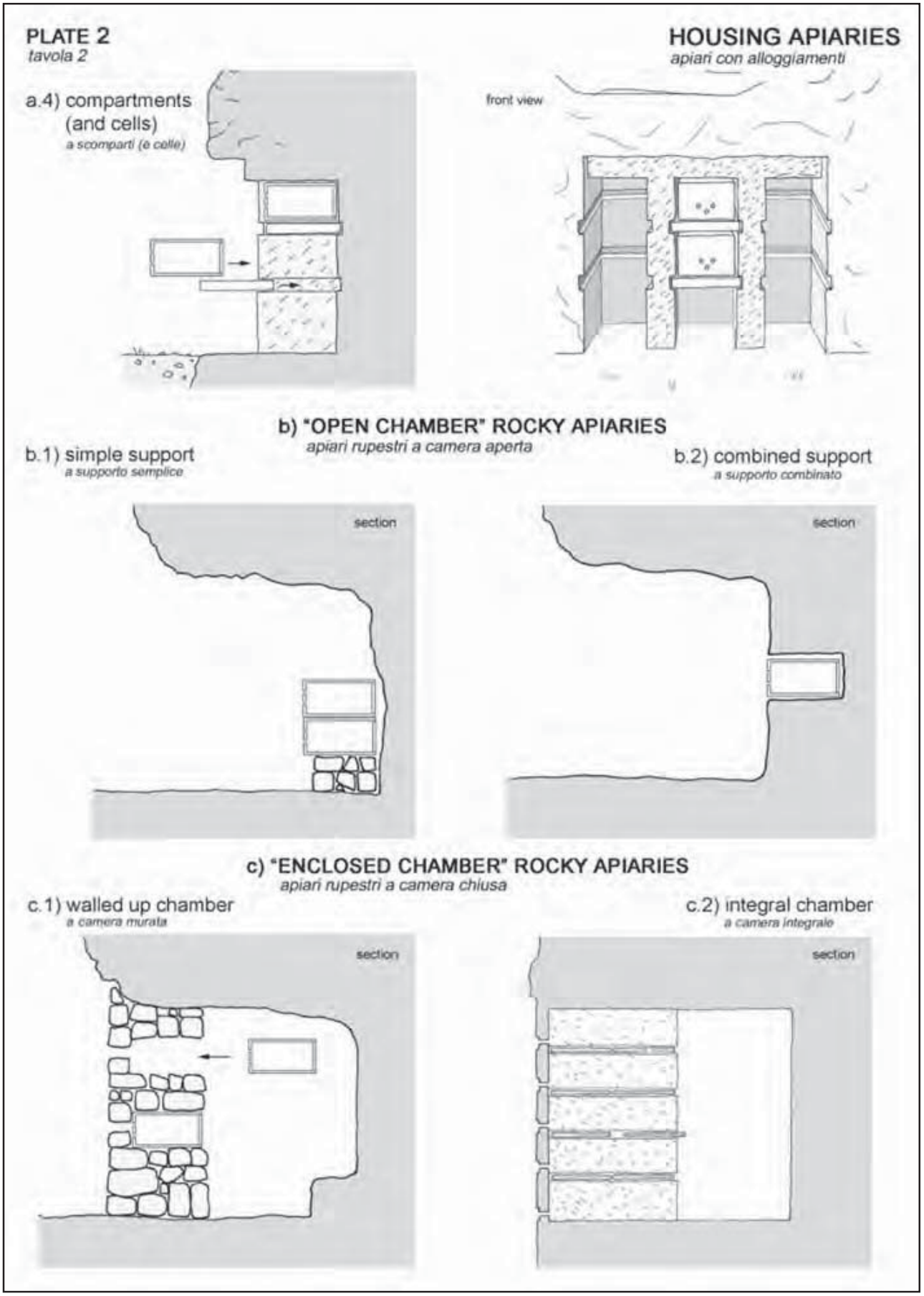


Fig. 16 - Plate 2. Categories and types of rupestrian apiaries (drawing R. Bixio).
*Fig. 16 - Tavola 2. Categorie e tipologie degli apiari rupestri (grafica R. Bixio).*

Malta, described above, with those existing in the territory of central-southern Italian regions (Latium, Sicily and, especially, Apulia, with particular reference to the evidence gathered by Greco, 2001). The purpose of our attempt of synthesis is to identify general patterns in order to determine the types that may be used and integrated with likely new varieties that might be found in future investigations. So far, three general categories of rupestrian apiaries have been identified: the wall apiaries (category a), the open chamber apiaries (category b), and the enclosed chamber apiaries (category c); each of them is, in turn, split into several types. It has, however, to be reminded that every apiary has its own peculiarities, often associated with masonry.

*Rock wall apiaries (category a)*
Rock wall apiaries are those structures in which the housing for the hives was obtained by excavating a more or less vertical rock cliff. This cliff may be natural or obtained by rectifying the roughness of the rock. According to the shape of the structure, the wall apiaries are classified in 4 types.

*Shelves apiary (type a.1)*
It is the simplest housing type obtained by excavating in the rock a horizontal parallelepiped, with one of the long sides opening toward the outside. In this sort of shelf the hives are located side by side. The apiary can be formed by a single shelf, or by more shelves superimposed and/or staggered.
Examples in the following localities in the province of Taranto (Apulia): Fantiano and Malabarba (Grottaglie), Triglie (Crispiano), and S. Vito (Mottola).

*Cells apiary (type a.2)*
A little more skill is required to realize an apiary with cells. These are obtained from excavation of single and/or overlapping parallelepipeds, similar to stacked boxes, separated by thin curtains obtained by saving the rock from excavation. Since it is clear that producing a continuous shelf (a.1 type), it would be easier and faster than digging the same volume divided into several units, we assumed that housing in cells perhaps had the advantage of ensuring a greater thermal inertia to beehives.
Examples in the following locality in the province of Taranto (Apulia): Crispiano.

*Niches apiary (type a.3)*
We will call 'niches' the parallelepipeds carved out vertically, and shallow. Those in the province of Viterbo have height between 76 and 84 cm, width between 37 and 51 cm, and are deep between 38 and 43 cm (Bortolin, 2008). The rupestrian apiary with niches is made up of individual cavities, excavated side by side on vertical natural rock walls. In each one, a single hive is vertically housed.
In France there are examples of apiaries with niches obtained on regularized surfaces of old abandoned stone quarries. The apiary at Ver dates back to 1793. From the description, the niche itself, closed by a small door, provided with flight holes and hinged on the rocky frame, served as a hive, without the need of additional containers (Masetti, 2000). Next to this, a system of housing is briefly described, which seems more likely that of the rupestrian apiaries with integral chamber (see § "Enclosed chamber rock apiaries, category c").
The housing system with niches is considerably more common in masonry structures and is very popular in England (Crane, 1983).
Examples in the following localities: Castello and Pian Castagno (Soriano nel Cimino, Viterbo province, Latium), Quarry of Estel (Vers, Gard, France).

*Compartments and cells apiary (type a.4)*
This is a more complex structure of the previous ones: it consists of compartments, i.e. large vertical niches, adjacent to each other, separated by rock diaphragms obtained by saving the rock from excavation of a short antechamber slightly behind the vertical of the outer wall of the cliff. The diaphragms are also provided with parallel grooves (runners), carved on both sides, so that horizontal shelves can be inserted to divide into multiple overlapped cells each compartment for the housing of the hives.
This type of installation, as well as representing a combination and evolution of types a.2 and a.3, can be considered a form of transition from rock wall apiaries to those with open chamber (type b.2), with some similarities to those with integral enclosed chamber (type c.2).
Examples in locality Masseria S. Angelo (Massafra), in the province of Taranto (Apulia).

***Open chamber rock apiaries (category b)***
These are installations in which the housing for the hives are no more obtained in the external walls of the cliffs, but placed inside an underground void in the rock mass, with the side walls and its own rock coverage that define the upper part of the apiary, high at least as a man, or more. This space can consist of a pre-existing natural cavity, or may have been purposely excavated, in part or totally, by the beekeeper obtaining a service area for the management of the beehives.
We define as 'open chamber' a cavity which entrance does not have any closure. Thus, it is completely open and the room is merely an additional shelter for the hives that are housed on various types of supports placed inside, leaning against the back or the sidewall.
Open chamber apiaries can be distinguished into two types:

*Simple support apiary (type b.1)*
The hives are simply laid, if necessary on superimposed rows, on the floor of the cavity, isolated by a simple planking or raised off the ground by a dry stone wall, without any additional infrastructure.
Examples in the following localities: Madonna della Scala and Masseria S. Angelo (Massafra, Taranto province, Apulia), S. Lania (Lentini, Catania province, Sicily) (F. Dell'Aquila, personal communication).

*Combined support apiary (type b.2)*
In this case, on the back wall of the cavity, or even on

the sidewalls, some houses for hives have been excavated. Very similar to those described above as rock wall apiaries, they are usually horizontal shelves for hives. Examples in the following localities in the province of Taranto (Apulia): Masseria Torretta (Massafra), and Masseria Vicentino (Grottaglie).

A special case is described as type a.4 at Masseria S. Angelo (Massafra, Taranto province, Apulia), consisting of a shallow antechamber and more complex compartments and cells. As already mentioned, it can be considered a form of transition.

***Enclosed chamber rock apiaries (category c)***

In this case the cavities housing the hives are closed on all sides, with the entrance to the chamber allowed by a door.

We decided to distinguish these apiaries in a specific category, rather than to aggregate them with the 'open chamber' in a generic category of 'chamber apiaries' tout court because this type of structure requires a substantial change in the management of the beehives. In fact, the hives are no longer leaning against the walls of the cavity, but are inserted in the (masonry or rock) curtain wall closing the external front of the chamber (operating room). In this way the access is granted directly to the rear part of the hives without having to remove them from their housing, unlike to what happens in the wall or open chamber apiaries described above.

Enclosed chamber apiaries are described on the model of those documented in the island of Malta and in Cappadocia (see § "Rupestrian apiaries in Cappadocia, Central Turkey" and "Rupestrian apiaries in Malta").

*Walled up chamber apiary (type c.1)*

This is the case of the apiaries documented in Malta, in the site called Imgiebah (see § "Rupestrian apiaries in Malta"). Several apiaries are there present, variously structured, and essentially consisting of small natural rock shelters that have been closed on the outer side by dry-stone walls, obtaining one or more rooms (operating rooms), with access through a small door. Some of the exterior ashlars were carved in order to obtain small niches (to be used as perches) and passing holes (flight holes). The hives were located in the back of the masonry curtain, matching the flight holes, supported by horizontal shelves inside vertical compartments divided by partitions, or by oven-like mouth cells, purposely built with dry stones. The back mouth of the hive, enclosed by a wooden lid, was thus accessible for the beekeeper, thus allowing him to proceed to normal operations without removing the container (tubular fictile beehives), minimizing the nuisance to the bees.

*Integral chamber apiary (type c.2)*

In the valleys of Cappadocia, in central Turkey, more than fifty apiaries were identified (see § "Rupestrian apiaries in Cappadocia"), conceptually equivalent to those at Malta. The main difference lies in the fact that the Cappadocian structures do not exploit existing natural cavities, but are fully obtained by the excavation of the tufa walls on cliffs and pinnacles, also closed on the external side by a natural wall of rock, internally divided by vertical compartments, obtained by saving the rock from excavation. From the outside they are recognizable by a small door obtained into the wall, usually a few meters off the ground, lined with rows of holes (flight holes) and, in several cases, by vertical slits. These devices represent a peculiarity of Cappadocia: they have the same function as flight holes, but were destined for a different type of hive. In fact we have found that, inside the operating room, while fixed hives formed by slabs placed in horizontal grooves (runners) carved on the sides of the diaphragm and closed by wooden lids (cell hives) correspond to circular holes, superimposed rows of movable tubular hives, made of interlaced branches (basket hives), or box-shaped, were instead leaning against the slits.

Further, it would be appropriate to investigate more thoroughly some of the apiaries called by Masetti *ruches-placards*, that is wall cupboard-hives, made in the rock wall of an abandoned quarry - already mentioned in the § "Niches apiary (type a.3)" - which, from the short description, seem quite similar to the Cappadocian. In the quarry an inner chamber would be excavated, while the cells for the hives would be obtained in the thickness of the rock curtain. The hives would have the entrance for bees (flight holes) on the outside, and the taking mouth on the opposite side, inside the chamber (Masetti, 2000).

## Discussion on rupestrian apiaries

From the comparison of the brief descriptions above we can proceed to some considerations. First, it is clear that in the rupestrian beekeeping panorama there was not a unique way to house the hives but rather a wide assortment of types, ranging from the most basic structures (shelves apiaries of Apulia) to the most evolved (integral chamber apiaries of Cappadocia), has to be observed.

As already pointed out, the greater difference was found between the rupestrian apiaries in southern Italy, on one hand, and those at Malta and Cappadocia, on the other. In the case of Apulia, Latium and Sicily, in all types of considered housing, wall or chamber, the hives were always arranged with the back mouth against the rock wall. Bearing in mind that the operations related to periodic inspections and honeycombs taking were normally carried out through the opening of the end opposite to the flight holes and, sometimes, through the upper side (G. Pavanello, personal communication), it is clear that the hives had to be removed every time from their support, with considerable disturbance to the colonies of bees. Thus, the main advantage of the enclosed chamber apiaries (type c), that we found only in Malta (walled up chamber) and Cappadocia (integral chamber), derives from the fact that the hives were accessible directly from the back mouth, without any need to remove them from their housing, also avoiding that the beekeeper interposes himself before the flight holes, minimizing any variation in the routine of the beehives.

We report - even if not exactly rupestrian - the existence of enclosed chamber beehives in the territory of Portodemouros, Portugal, locally called *alacenas*, obtained inside the walls of farmhouses. These structures, that conceptually have the same functioning and organization of those rupestrian in Malta and Cappadocia, had the advantage 'to protect the beehives from the cold and water. They were usually located in the wall of the main rooms so that the hives could use the heat of the stables that as a rule were below the main room [...] The *alacenas* were arranged so that the hole, or entrance of the beehive, would be toward the outside, facing south to receive maximum sunlight. The body of the beehive remained enclosed in the wall and the honeycombs were accessible through a little wooden door from inside the room. Sometimes the door would not completely close so the bees could enter the room' (Guedes et al., 2000; editor's translation).

A masonry enclosed chamber apiary, a real bee house, is described by Cirone at Zeitun, in the island of Malta. It is a two-storey building, with housing for the beehives in the lower part and the laboratory for the extraction of honey from the honeycomb in the upper part (Cirone, 2001). It is conceptually identical to the walled up chamber apiary of Imgiebah and to the Portuguese *alacenas*, with the flight holes on the outside and the back mouth for the gathering manoeuvrable from inside the room, without removing the hives.

This system was already described by Olivier De Serre in *Theatre d'agricolture et mesnage des champs*, published in 1600 (Masetti, 2000).

Going back to rupestrian apiaries, other differences between the various types concern the structural aspects. In particular, chamber apiaries (types b and c) allow the operations of hives management also with bad weather. Moreover they could be used as a shelter for equipment, avoiding the construction of a building, that is needed, on the other hand, for the wall apiaries. Even the walled up or integral chambers (type c) were much easier to build that any masonry structure. In addition, being equipped with doors, they provided greater protection against theft not only for the equipment, but also for the beehive themselves. It has to be noted that the integral chamber apiaries of Cappadocia are, for the most part, placed on overhanging walls of cliffs, at heights difficult to reach without a ladder.

Finally, in the particular case of the Cappadocian apiaries, we must register at least two specific differences with those Italian and at Malta.

The first is the fact that, at least in the two apiaries documented in detail (and described in § "Rupestrian apiaries in Cappadocia, Central Turkey") the cells obtained in vertical compartments through the insertion of horizontal slabs in the grooves, worked directly as hives, without the need to add further containers, thus avoiding the construction of a double structure.

<table>
<tr><td colspan="4">APIARI - APIARIES</td></tr>
<tr><td>A CIELO APERTO<br>Open air apiaries</td><td colspan="3">in spazi liberi (in open spaces)<br>in recinti (in enclosures)</td></tr>
<tr><td rowspan="8">IN ALLOGGIO<br>o apiari collettivi<br><br>Housing apiaries<br>or collective apiaries</td><td colspan="3">IN MURATURA<br>Masonry apiaries</td></tr>
<tr><td rowspan="7">RUPESTRI<br>Rupestrian apiaries</td><td rowspan="4">a) A PARETE<br>Rock-wall apiaries</td><td>a.1) a mensole<br>Shelves</td></tr>
<tr><td>a.2) a celle<br>Cells</td></tr>
<tr><td>a.3) a nicchie<br>Niches</td></tr>
<tr><td>a.4) a scomparti<br>Compartments</td></tr>
<tr><td rowspan="2">b) A CAMERA APERTA<br>Open chamber</td><td>b.1) a supporto semplice<br>Simple support</td></tr>
<tr><td>b.2) a supporto combinato<br>Combined support</td></tr>
<tr><td rowspan="2">c) A CAMERA CHIUSA<br>Enclosed chamber</td><td>c.1) a camera murata<br>Walled-up chamber</td></tr>
<tr><td>c.2) a camera integrale<br>Integral chamber</td></tr>
</table>

This arrangement obviously had the disadvantage that the hives were not removable and, therefore, suitable only for sedentary beekeeping.
It is our opinion that this handicap was overcome by the creation of compartments with vertical slits, which several Cappadocian apiaries have, associated with rows of flight holes, which were used to stack another type of hives, basket or box, movable, and, therefore, suitable for a possible form of nomadic beekeeping, maybe exercised simultaneously with the sedentary one.
However, it is also possible that the evolution from flight holes to slits, caused by natural erosion of the rock, has prompted the creation of movable containers (hives), to replace the fixed, coincident with the cells and become unusable, thus avoiding to leave the old apiary and to excavate a new one. This system would have then been extended throughout the region even during the construction of new compartments in case of expansion of the apiary, having also the advantage of making unnecessary to carve the grooves and horizontal slabs.

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