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THE DIVINE SPIRIT OF BEES.
A NOTE ON HONEY AND THE ORIGINS OF YEAST-DRIVEN FERMENTATION

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One of the earliest domesticated organisms is perhaps the eukaryote microorganism known as Saccharomyces cerevisiae*, or more simply "the yeast". Its role in triggering fermentation as a process useful for agricultural products preservation and transformation into food, though known from the Palaeolithic in the ancient Near East, became decisive in the Neolithic Period. The earliest agriculturalists of the Fertile Crescent triggered fermentation with the addition of honey to fruits juices, as attested to in the archaeological record. The yeast, that lives inside the guts of bees and wasps, is apparently responsible for this fermentation process. Honey contains both yeast and sugar that facilitates yeast growth generating fermentation. The productive capability of the bees let these insects to be credited of a divine spirit.*

Keywords: bees; honey; *Saccharomyces cerevisiae*; yeast; Neolithic

Desiccation, salting and fermentation are efficient methods used in food preservation. Since the early days of agriculture during the Neolithic Period, harnessing and exploiting fermentation, thus, enhanced human capacity in production and storage of food.[1] Transformation of cereals and fruits into edible compounds through fermentation increased their energetic value and prolonged their storage time.

Fermentation happens when a microorganism, through the action of some of its enzymes, transform an organic substance into its simpler components. In particular, fermentation results from the activity of the yeast (*Saccharomyces cerevisiae*), which rapidly grows when sugars are available, producing alcohol and carbon dioxide as by-product of its fermentative metabolism.[2]

Human driven fermentation became a routine with the adoption of agriculture during the Neolithic period, by the early communities who first experimented with overproduction and storage of cereals and fruits.[3] Fermented food is documented in Pre-Pottery Neolithic B (7500-6000 BC) archaeological record from Southern Levant e.g. in Jericho (Tell es-Sultan), where traces of fermented liquids were found in silos and plastered bins.[4] The earliest fermented substances in the Neolithic cultures of the Near East were juices of pulped fruits (e.g. jujubes, dates and figs), while the extraction and fermentation of malt of barley and wheat occurred later, after the invention of pottery, from the Pottery Neolithic Period (6000-4500 BC) onwards, leading to brewing.[5]

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1 Marsit - Dequin 2015, 1-2; Fuller - Gonzalez Carretero 2018, 117.
2 McGovern *et al.* 2009; Hornsey 2012, 19-54; Dozier 2016.
3 Bar-Yosef 1995; Colledge 2001; Kuijt - Goring-Morris 2002, 379; Twiss 2007, 30.
4 Kenyon 1981, pls. 68b, 224, Square FI, Stage XXI, final PPNB.
5 Weiss - Zohary 2011, 243.

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Through observation and experience, the earliest agriculturalists learned how to drive fermentation. They achieved probably unknowingly the most skilful and effective domestication of yeast which eventually was transmitted to the succeeding cultures of the Chalcolithic (4500-3500 BC) and Early Bronze Age (3500-2000 BC). These fermentation skills, first successfully applied to cereals with brewing, were further developed during the Early Bronze Age, when grape started to be systematically cultivated, and when the product of grapes fermentation, wine, achieved an important economic and symbolic value.[6] The earliest evidence of grape intensive cultivation dates back to the 4th millennium BC,[7] though there is evidence of wine production already in the 6th millennium BC[8] and in the Late Chalcolithic period.[9] However, it is only during the Early Bronze Age, when grape became a distinct production of the Levant, that farmers used to trigger fermentation in grapes' juice by mixing it with fig fruits. This is widely attested to in the archaeological records, with some noticeable examples such as the figs found in Canaanite jars that were part of the funerary objects, for use in the afterlife, of King Scorpion in his tomb of Abydos.[10]

Brewing consisted in smashing and pulping fruits (jujubes, carobs, grapes), adding water and figs keeping the obtained liquid in special vessels (like vats or pithoi) where fermentation could be controlled. Through this process, the earliest agriculturalists activated and managed yeast fermentation. Figs (*Ficus carica* L.) triggered the fermentation process most likely because these fruits are pollinated by wasps. Recent studies[11] demonstrated that *Saccharomyces cerevisiae* is found in the guts of bees and wasps; thus, by pollinating figs and other fruit trees, these insects transmit the yeast to these fruits.[12] When yeast is in contact with pulped fruits, spontaneous fermentation starts, but only when an appropriate quantity of sugar is available. The quantity of sugar present in fruit juice depends on several factors such as duration of sunlight exposure, appropriate irrigation, pollination and other conditions.

By observing grape or malt juices transformations, the earliest agriculturalists discovered that there was an easier and a more consistent method to trigger and to control fermentation: adding honey in fixed quantities.[13] Honey in facts contains not only yeasts but also the sugar necessary for the yeast growth and stabilization.

Bee products were harvested since the Paleolithic,[14] and their important role is testified by an extraordinary rock art paint with a scene of honey hunting (fig. 1). Scientific and archaeological evidence have now confirmed that the exploitation of honeybee was a

6 Joffe 1998, 300-303.
7 Zohary - Hopf - Weiss 2000, 151-159.
8 McGovern *et al.* 1996; 2017.
9 Barnard *et al.* 2011.
10 Cavalieri *et al.* 2003.
11 Stefanini *et al.* 2012; 2016; Dapporto *et al.* 2016.
12 *Saccharomyces cerevisiae* exerts an aroma (acetate esters) which set communication and mutualism with insect vectors (i.e. *Drosophila melanogaster*, the fruit fly) (Christiaens *et al.* 2014).
13 McGovern - Fleming - Katz 2003; McGovern 2006, 20-24; Hayden - Canuel - Shanse 2013, 108-109; Chelidonio 2015, 69; McGovern - Hall 2016, 607-608; McGovern *et al.* 2017, E10317.
14 Dams - Dams 1977; Crane 2015.

common practice in the communities of the earliest farmers. Bees' products were exploited continuously and extensively by prehistoric farming communities of the Pre-Pottery Neolithic B, e.g. at Jericho, in Palestine, and Çatalhöyük, in central Anatolia, where beeswax residues have been identified in hundreds of pots.[15] Honeycomb-like pattern decoration (fig. 2) was also depicted on the eastern wall paintings of Çatalhöyük earliest shrine.[16] The addition of honey to pulped fruit derivatives rich in sugar to trigger a desired fermentation was thus one of the many proficuous uses of honeybee.

Honey-added fermentation became a standard practice since the Neolithic Period,[17] and bees were considered special creatures, being connected with nature's resurgence in Spring, plants blooming, and producing precious and powerful stuffs: wax, honey, and royal jelly. It is, thus, not surprising that they appear as heraldic animals in the hieroglyphic script next to the name of the pharaohs (fig. 3) and being part of the "throne name" from early Dynastic times in ancient Egypt.[18] Beehives are depicted in Egyptian paintings and reliefs (fig. 4).[19] Furthermore, honey is mentioned fifty-five times in the Bible[20] and in countless administrative, literary, and ritual texts of the ancient Near East, e.g. at Late Bronze Age Ugarit, on the northern Syrian coast.

The addition of honey to fruit juices like grapes wine should no more considered as a way to sweeten them but rather a method to drive fermentation and stabilized the beverage duration. Beekeeping was - in facts - strictly connected with the production of beer and wine, as recent important archaeological discoveries (fig. 5) demonstrated.[21] In addition to its nutritional and curative benefits,[22] honey most likely was collected and employed to promote grapes and cereals juices fermentation. For this reason, bees were kept often in temples or in sacred places, such as in Pre-Pottery Neolithic B Jericho, where one of the oldest hives (fig. 6) was found in the courtyard of the one of the earliest shrines so far known.[23]

Bees became essential to the way of life for the early Neolithic farmers and since then they were deemed an extraordinary manifestation of the divine spirit. This may explain why such super-natural origin was considered typical of these insects.

The divine spirit of bees is frequently referred to in literary sources, from Egypt to the Hittite Empire to the Greek and Roman World.[24]

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15 Roffet-Salque *et al.* 2015.
16 Mellaart 1963, 69, pl. XII.
17 Hornsey 2012, 330.
18 Lobban 1994, 161; Hornsey 2012, 336; Leprohon 2013, 17-18.
19 Crane 1999, 163-164; Hornsey 2012, 336-337.
20 Mazar 2018, 40-41.
21 Mazar 2018.
22 Lobban 1994, 162-163.
23 Garstang *et al.* 1936, 71, pl. XL:b; Nigro 2017, 22-23, fig. 17.
24 According to an Egyptian myth, bees were a divine creation and were created by the tears of the Sun-god Ra (Hornsey 2012, 335; Kritsky 2015):

The god Re wept and the tears
from his eyes fell on the ground
and turned into a bee.

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The bee made [his honeycomb]
and busied himself with the flowers of every plant;
and so wax was made
and also honey
out of the tears of the god Re
(Papyrus Salt 825, British Museum n. EA10051,4; Free 1982, 93).

When Ra weeps again the water which flows from his eyes upon the ground turns into working bees. They work in flowers and trees of every kind and wax and honey come into being.
(Salt Magical Papyrus, British Museum n. EA10010,8; Ransome 1937, 33).

Bees played an important role also in the Myth depicting the search for the Hittite god of agriculture Telepinu, one of the Old Anatolian myths (Hoffner 1998, 14-20).
Greek mythology often ascribes divine properties to the bees and many stories mention them
(Deliyannis et al. 2018, 56-59).
Finally, a renowned celebration of bees was demonstrated by the Latin poet Vergilius, in the following famous poem

(Georgica, IV, 219-222):
Led by these tokens, and with such traits to guide,
Some say that unto bees a share is given
Of the Divine Intelligence, and to drink
Pure draughts of ether; for God permeates all—
Earth, and wide ocean, and the vault of heaven —
From whom flocks, herds, men, beasts of every kind,
Draw each at birth the fine essential flame;
Yea, and that all things hence to Him return,
Brought back by dissolution, nor can death
Find place: but, each into his starry rank,
Alive they soar, and mount the heights of heaven. (Translation by LN).

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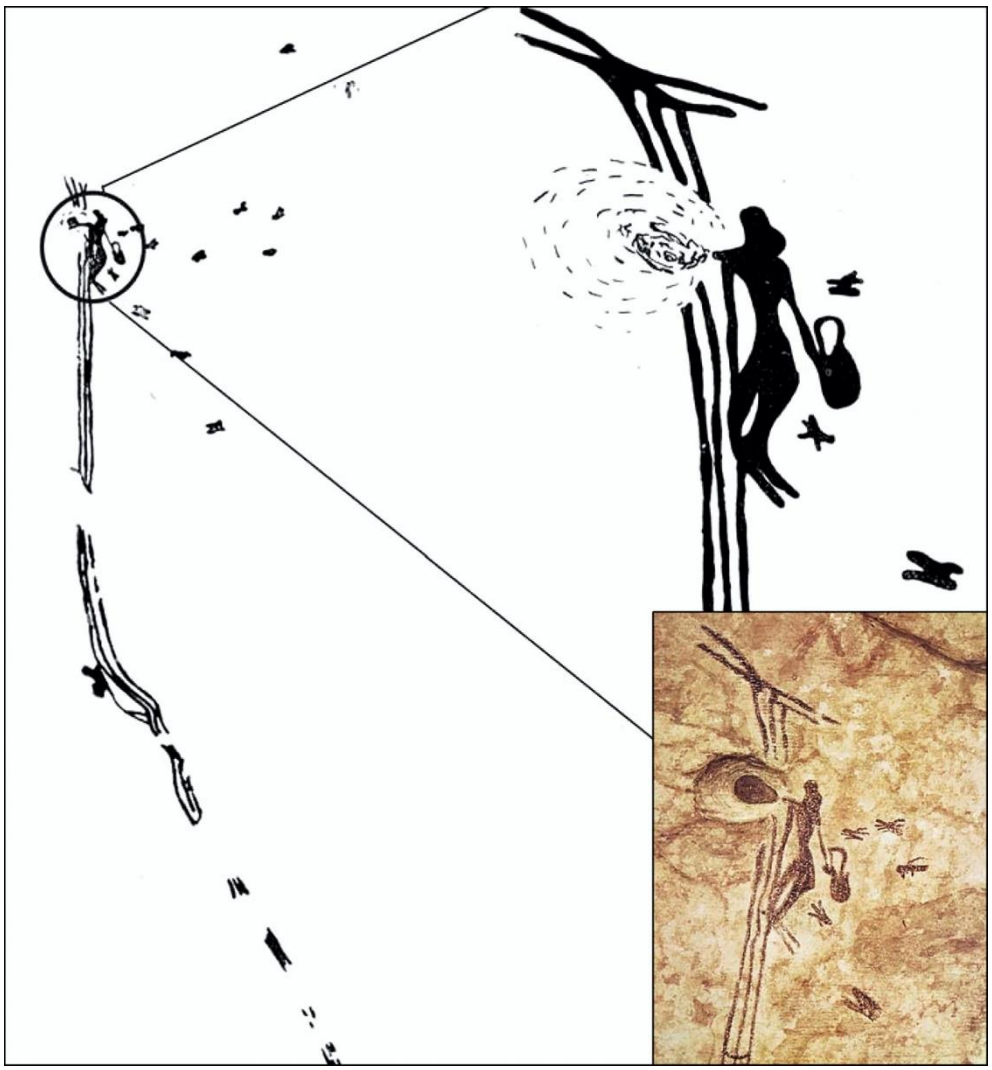

Fig. 1 - Rock painting showing a honey hunter taking honey from a nest and surrounded by angry bees, Cueva de la Araña (8000-6000 BC), Spain (after Dams 1984, 230, fig. 195).

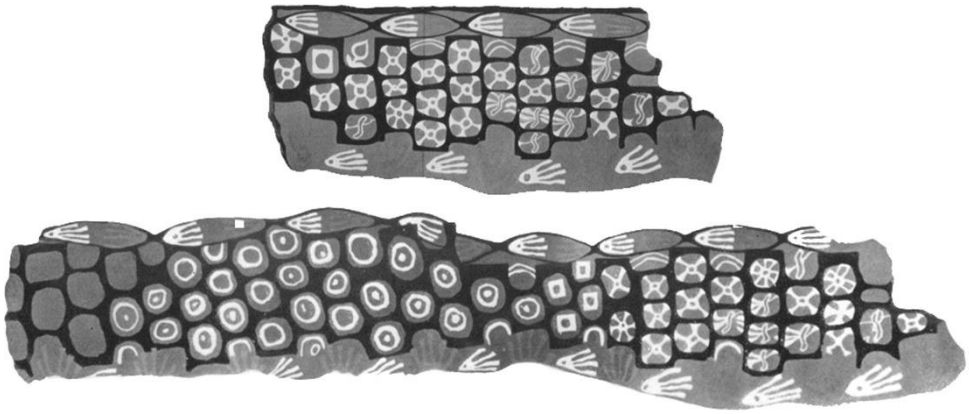

Fig. 2 - Copy of honeycomb and hands pattern depicted on the eastern wall of E VI, 8 shrine (~6500 BC) at Çatalhöyük (after Mellaart 1963, 69, pl. XII:a, c)

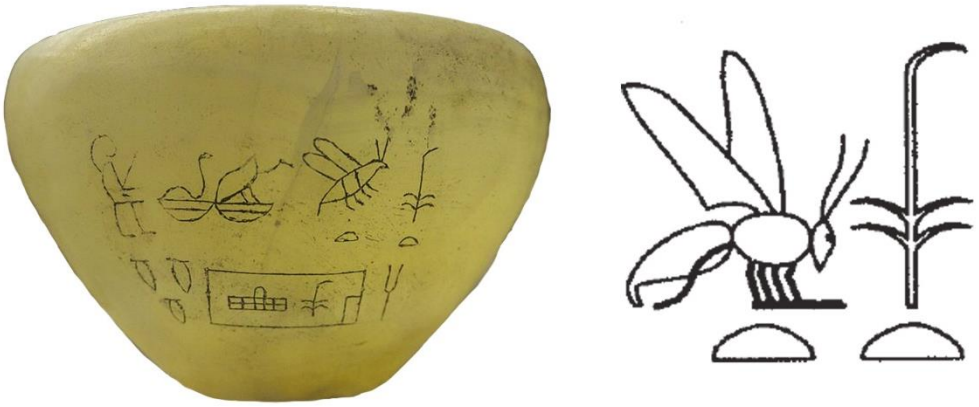

Fig. 3 - The hieroglyph symbol representing the “Throne name”, the royal title *nsw-bity*, which can be translated as “The one of the Sedge and the Bee” and interpreted as the “King of the Upper (the sedge plant) and Lower (the bee) Egypt”; the alabaster vase of Semerkhet attests to the use of the *nswt-bity* crest already during the I Dynasty.

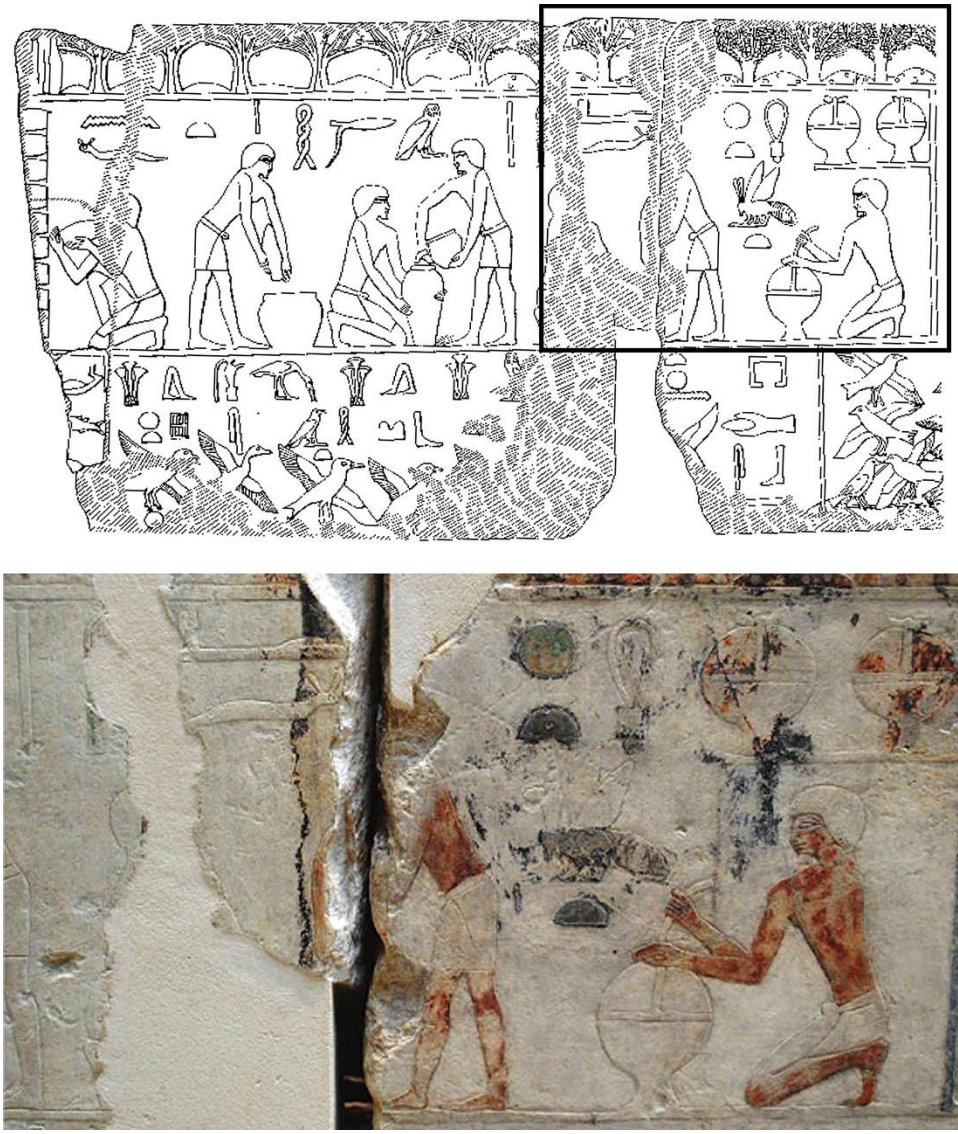

Fig. 4 - Relief from the Temple of the Sun-god Ra of king Ne-user-re at Abu Ghorab, Lower Egypt, V Dynasty, ca. 2400 BC, with the earliest known representation of beekeeping (after Crane 1999, fig. 20:3a; Kritsky 2015, pl. 4).

Fig. 5 - The Iron Age (1000-800 BC) apiary found at Tel Rehov/Tell es-Sarem and a modern clay hive in a village of Lower Galilee (after Mazar 2018, figs. 4, 9).

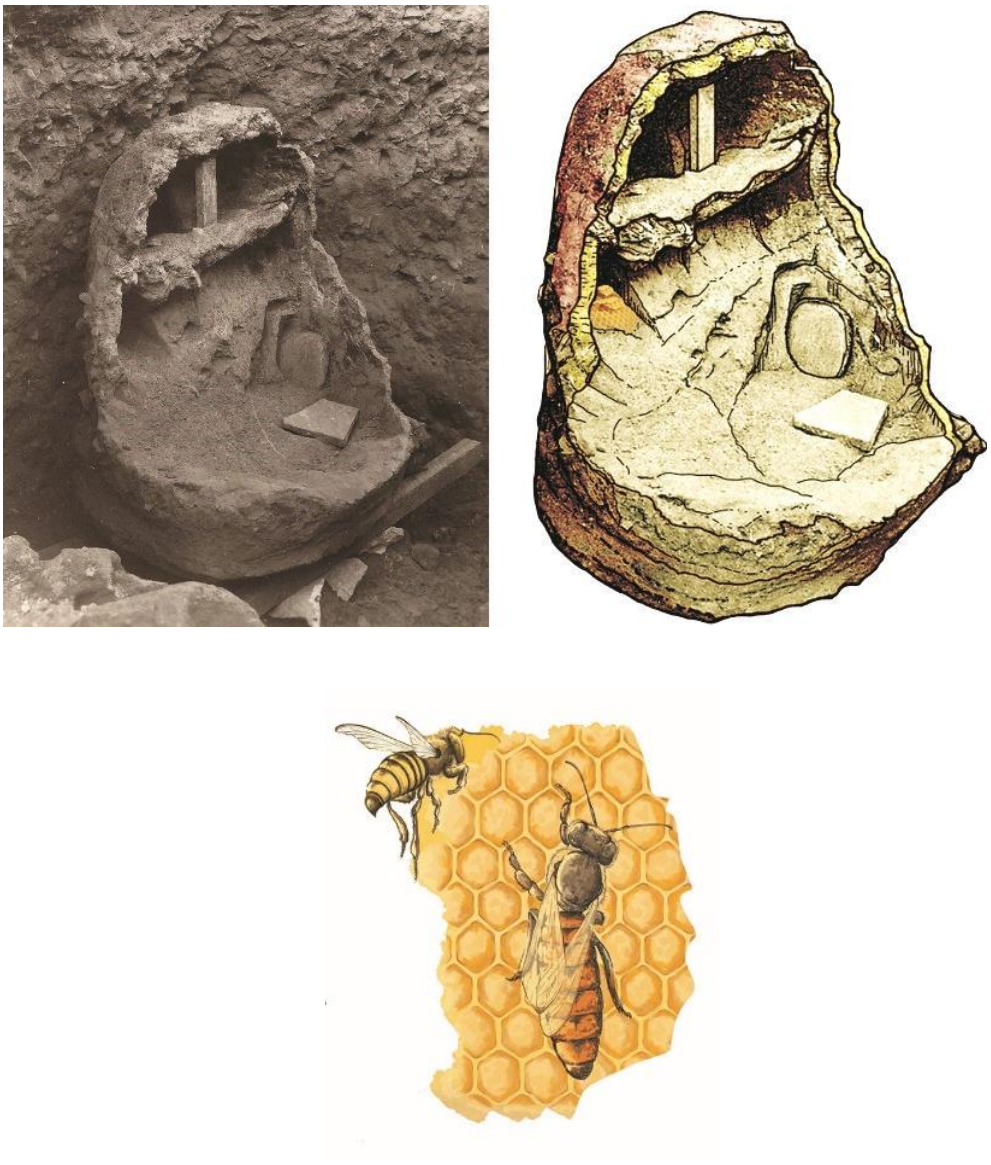

Fig. 6 - Sun-dried clay beehive found in the Level IX (Pre-Pottery Neolithic B, 7500-6000 BC) of the NE Trench at Tell es-Sultan/ancient Jericho (after Garstang *et al.* 1936, 71, pl. XL:b; drawing by Lorenzo Nigro).