New archaeobotanical data on the cultivation of *Vitis* ssp. at Pyrgos – Mavroraki

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Introduction

The 2004-2008 archeological excavations turned up 41 whole seeds of different varieties of grapes (Tables 1-4) and a number of pedicel fragments, in Stratigraphic Units (SUs) PY04F8L1, PY05GH9L4/5, PY05L4 and PY06L5/2. All these seeds were found near pottery vessels (classified typologically as wine containers).

USPY04F8L1	Le	Wi	Th	Lt	Le/Wi	Wi/Th	Le/Th
1	3.5	5.9	2.3	1.2	0.59	2.56	1.52
2	3.2	5.11	2.15	1.05	0.62	2.37	1.48
3	3.5	6.02	2.28	1.3	0.58	2.64	1.53
4	3.3	5.55	2.19	1.18	0.59	2.53	1.5
5	3.4	5.46	2.16	1.25	0.62	2.52	1.57
6	3.3	5.5	2.21	1.19	0.60	2.48	1.49
7	3.5	6.1	2.4	1.3	0.57	2.54	1.45
8	3.5	6	2.39	1.3	0.58	2.51	1.46
9	3.3	5.52	2.2	1.18	0.59	2.50	1.50
10	3.5	6	2.39	1.3	0.58	2.51	1.46
11	3.4	5.46	2.21	1.26	0.62	2.47	1.53
12	3.5	5.96	2.35	1.3	0.58	2.53	1.48

Table n° 1 - Biometric measurements of morphology roundish to heart-shaped.
Labels: Le = length, Wi = width, Th = thickness, Lt = length of tip.

USPY05GH9L4/5	Le	Wi	Th	Lt	Le/Wi	Wi/Th	Le/Th
1	2.8	5.23	2.16	1.1	0.83	2.42	1.29
2	2.6	5.33	2.18	1.2	0.43	2.44	1.19
3	2.4	5.18	2.2	1.38	0.46	2.35	1.09
4	2.4	5.19	2.18	1.19	0.46	2.38	1.10
5	2.2	5.14	2.13	1.22	0.42	2.41	1.03
6	2.4	5.18	2.2	1.39	0.46	2.35	1.09
7	2.8	5.25	2.18	1.24	0.53	2.4	1.28
8	2.6	5.32	2.22	1.19	0.48	2.39	1.17

Table n° 2 - Biometric measurements of morphology oval to pear-shaped, with distinct elongated. tip.
Labels : Le = length, Wi = width, Th = thickness, Lt = length of tip.

Our morphological characterization of the whole seeds was keyed to a number of distinctive ampelographic features. We sought to distinguish the wild subspecies from the cultivated one, based on the morphological descriptions and biometric measurements reported in the literature (Stumer A. 1911, Schiemann E. 1959, Renfrew J.M. 1973, Nùñez D.G. and Walker M.J. 1989.).

USPY05L4	Le	Wi	Th	Lt	Le/Wi	Wi/Th	Le/Th
1	3.4	5.93	2.31	1.31	0.57	2.56	1.47
2	3.6	6	2.38	1.33	0.60	2.52	1.51
3	2.4	5.18	2.2	1.38	0.46	2.35	1.09
4	2.6	5.32	2.22	1.19	0.48	2.39	1.17
5	3.5	5.96	2.35	1.3	0.58	2.53	1.48
6	3.5	6	2.39	1.3	0.58	2.51	1.46
7	2.8	5.23	2.16	1.1	0.83	2.42	1.29
8	2.9	5.22	2.14	1	0.55	2.43	1.35
9	2.7	5.2	2.18	1.11	0.51	2.38	1.23
10	2.6	5.3	2	1	0.49	2.65	1.3
11	2.2	5.14	2.13	1.22	0.42	2.41	1.03

Table n° 3 - Biometric measurements of morphology intermediate between that of seeds from wild and cultivated grapes.

Labels : Le = length, Wi = width, Th = thickness, Lt = length of tip.

USPY06L5/2	Le	WI	Th	Lt	Le/Wi	Wi/Th	Le/Th
1	2.4	5.19	2.18	1.19	0.46	2.38	1.1
2	3.4	5.84	2.28	1.1	0.58	2.56	1.49
3	2.1	4.98	2	1	0.42	2.49	1.05
4	2.2	5.14	2.13	1.22	0.42	2.41	1.03
5	3.5	5.9	2.31	1.31	0.59	2.55	1.51
6	3.3	5.55	2.19	1.18	0.59	2.53	1.5
7	3.1	5.51	2.16	1.14	0.56	2.55	1.43
8	2	5	1.98	1.1	0.40	2.52	1.01
9	2.3	5.12	2.12	1.15	0.44	2.41	1.08
10	3.5	5.96	2.35	1.3	0.58	2.53	1.48

Table n° 4 - Biometric measurements of morphology intermediate between that of seeds from wild and cultivated grapes.

Labels : Le = length, Wi = width, Th = thickness, Lt = length of tip.

Materials and method

Microscopic analyses aimed at identifying the morphological characteristics, biometrics and other measurement of the various artefacts, in order to establish their origin and the technologies used to make them The morpho-biometric study of the different archaeobotanical materials (seeds, pollens and textile fibres), was carried out with an image analyser. The image analysis system was composed of various technical components: a JVC C322 RGB microscope video camera mounted on a J.S. MP 3502M optical microscope and a N.135 optical stereo microscope connected to a computer with a video imaging board and a high resolution monitor in order to characterise the obtained images. A new software programme "Image Analysis and Measurement" (Findlay F., 1995) permitted either black and white or colour pictures to be acquired. The images obtained through the optical video microscope were acquired in true colour, in order to avoid the false colours obtained with commercial software. Pictures were acquired as Raster (binary matrix with an x - y origin) images, which may reach a maximum size of 800 x 600 pixels. A colour threshold (Grieson P., 1986) common to all morphologies was established through operations in which particular areas / zones of the image (Berns R. S., 1999) under study were evidenced. Diameters, numbers, area, radii, and orientation of several morphologic characteristics were extracted automatically. In addition a series of mathematical equalisations, scaled enlargements and geometrical reflections made it possible to evidence particular distinctive structural features both in the archaeobotanical remains.

Besides, the use of fractal dimension method (FD) is a value describing the shape-filling capacity of a rough boundary. The concept of FD is based on the non-Euclidean system of geometry (Mandelbrot B.P., 1992) and it has been used in a number of research applications. Calculating a FD for a given object is a complex procedure based upon the measurement of area, perimeter and segments in terms of decreasing units of measurement, and requires a significant amount of data processing. Although this is essentially a geometric measurement approach it is a method that can be modified for the processing of digitally stored images. Because this factor has been applied in a number of studies its application to fretting particle shape description was attempted in the present study. The system also allows the video images to be saved in B / W or RGB as TIF (Tagged Image Format) files, JPEG (Compliant), RAS (Sun Raster Images), TGA (True vision Images), and so on, which may be opened and read by most digital image non dedicated programs.

The morphology of seeds

The biometric size of 15 of the seeds is small; they are short, their shapes range from roundish to heart-shaped, and their tips are not prominent (Figure 1).

The ventral part is flattish, with very slight protuberances and two deep and narrow furrows separated by a longitudinal bridge. On the dorsal part, there is an evident circular-to-oval depression of the chalaza. These morphological features seem very much like those of wild grapes.

Another group of eleven seeds have a larger biometric size; they are long and slender, from oval to pear shaped and with distinct elongated tips (Figure 2). In the ventral part, the sculpted features are less evident and more delicate.

Figure n° 1 – Grape seed from SU PY05/GH9L4 – Morphology roundish to heart-shaped.

The ampelographic characteristics of this group are very similar to the ones described in the literature for cultivated grapes. The third group's morphological features are midway between those of wild grapes and those of the apparently cultivated grapes. (Figure 3). The seeds in this group probably come from selected ecotypes (gathered in different places and in the process of being domesticated) in a context of segregation of genetic traits characteristic of an anomalous environment such as that of the islands.

Figure 2 – Grape seeds from SU PY06L5/2 – Morphology oval to pear-shaped, with distinct elongated tip.

The carbonization and fossilization undergone by the seeds in silt sediments (Lentini A., 2007) altered their original biometric size. Accordingly, the only dimensions we measured (using an image analyzer- Figure 4 and Image processing 1) were the length, width and thickness of each seed and the length of the tip (Di Vora A. and Castelletti L., 1995). We then calculated the ratios among these dimensions (Tables 1, 2, 3 and 4). The length/width index in particular is considered a statistically significant parameter for the attribution of each seed (Castelletti L., Castiglioni E., Cottini M. and Di Vora A., 1996).

Figure 3 – Grape seeds from SU PY04F8L1 – Morphology intermediate between that of seeds from wild and cultivated grapes.

A seed is thought to belong to the wild species if the index is between 0.76 and 0.83, to the cultivated species if the index is between 0.33 and 0.44, and unidentifiable if the index is between 0.54 and 0.75 (Di Vora A. and Castelletti L., 1995). These preliminary data on the first 41 seeds are not statistically significant, but they can be taken as a preliminary indication of the distribution of the various *Vitis* species at Pyrgos.

Figure 4 - SUs G9L3, G9L4 and G9l7, carbonization seeds of different type of *Vitis* ssp..

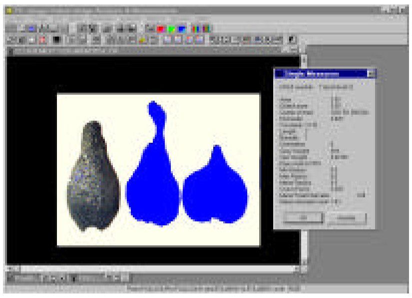
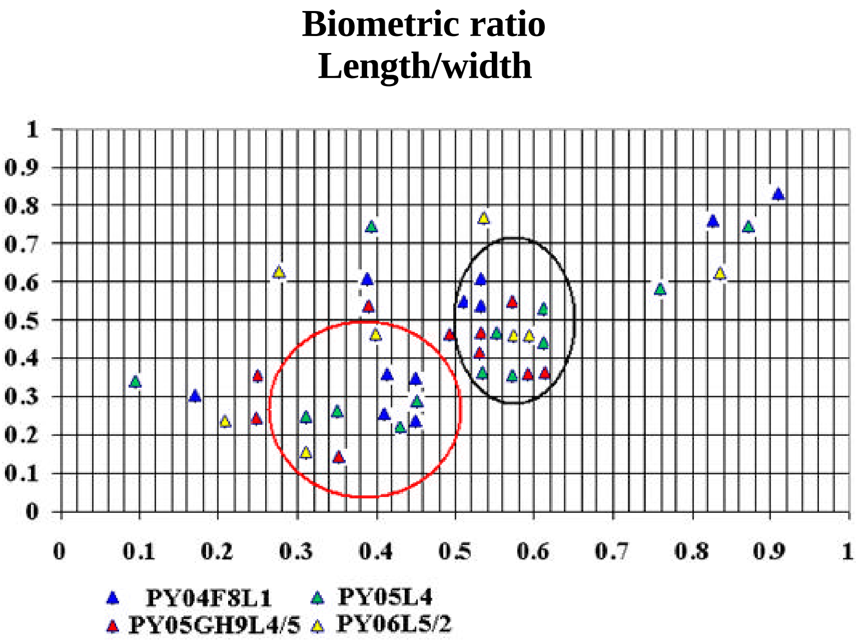


Image Processing 1 - Color threshold for the biometric measurements.



Graph 1 – Distribution of length/width measurements.

The distribution graph of the length/width ratios shows a first group of 11 seeds positioned in the 0.34-0.43 range typical of cultivated grapes. A second group of 15 seeds falls in the 0.56-0.63 range, intermediate between wild and cultivated grapes and not identifiable with any certainty. The rest of the samples we examined have more homogeneous biometric traits and fall partly in the intermediate area (proto-domesticated) and partly in the area of wild species. The biotypes in the cultivated-grape range seem to ensure a good epicarp/mesocarp ratio, probably obtained by a mass-based selection from multiple species (Levadoux L., 1956). The morphobiometric variability evidenced by these studies raises a series of questions regarding biodiversity in a territory that forms part of a genetically isolated context.
As regards the taxonomic keys used here, it should be noted that according to *Flora Europea* (Webb D.A., 1968), the species *Vitis vinifera* L. includes the wild grapevine, *Vitis vinifera* L. ssp. *sylvestris* (C.C. GMELIN) HEGI, and the cultivated grapevine, *Vitis vinifera* ssp. *vinifera*. *Vitis sylvestris* C.C. GMELIN is used as a synonym for the wild vine and *Vitis vinifera* L. ssp. *sativa* HEGI as a synonym for the cultivated vine.

Archaeometry and Archaeology

The Smithsonian Institute (1965-1990) began in 1960, the catalogue of the official and informatics Bibliography of the various multidisciplinary systems to characterize the organic material in ancient contexts, helping the invention of new methodologies and analytical instruments. Chemists, physics, biological and mathematical sciences, have therefore supplied to solve archaeological problems offering new possibilities. In particular in the last years chromatography, spectrometry, magnetic resonance, microscopes has been able to give advantage to archaeological investigations. The results obtained under the application of such technologies have given qualitative and quantitative measurements of ancient organic materials even from micrograms.

Many pigments, residual foods, drinks, ingredients for scents and therapeutic substances, founded in special archaeological contexts (dry environment, semi deserted or saturates of humidity, where the microbe activity and the self oxidation are reduced), in state of medium good conservation, could have been analyzed and characterized.

Wine production and consumption at Pyrgos - Mavroraki and Erimi

The sediments on the bottom of a vase, coming from the US Py04 FG8 border 7, have been extracted (elutriation) with H_2SO_4 to 20 %, for ten minutes. Subsequently to the super floating it has been added 0,02 gr. of 0,02 gr. di ß, ß' – binaphtol (Feigl F., 1989). The obtained solution submitted to irradiation with UV lamp of 240-250 nanometres, assumed a green colour under the fluorescent rays. The green coloration of the solution reveals that it contains high rate of tartaric acid, typical of the wine produced in the Mediterranean area. In parallel a certified synthetic sample (Ultra Scientific Italy n° 325 Organic Standards in Organic Basic solution, Oeko-Tex Standard 100 ISO 9001) has been examined with the same procedures analytics of tartaric acid isomer present in nature, under shape of L-(+).

PYRGOS	TARTARIC ACID	RESULTS
PY02IL6 n° 3 - Residues	POSITIVE** GREEN	2
PY03J4L4 n° 4 - Residues	POSITIVE** GREEN	2
PY04F1G8 n° 2 - Residues	POSITIVE*** GREEN	3
PY04F1G8 n° 3 - Residues	POSITIVE**** GREEN	4
PY05JI7-8 - Residues	POSITIVE*** GREEN	3
PY02IL6 n° 3 - Residues	POSITIVE** GREEN	2
PY04FG8 n° 4 - Residues	POSITIVE*** GREEN	3
PY03 J4 L4 - Residues	POSITIVE** GREEN	2
PY05 JI 7-9 - Residues	POSITIVE**** GREEN	4

Table 5 - Residual chemical analyses of the organic matter of some Middle Bronze Age vases coming from Pyrgos.

This technique (Colour Test) seems to be today one of the most efficiency in the study of organic archaeological remains. The same system has been used to analyze more residuals of some Middle Bronze Age vases coming from Pyrgos (Table n° 5) with positive result. After the setting of the methodology other intact sediments coming from the bottom of wine amphorae from Erimi necropolis (Table 6) of different period have been analyzes as at the Limassol Archaeological Museum (Table 7) and at the Cyprus Archaeological Museum of Nicosia (Table 8), with three different residues extracted from Vounous, Kyrenia (drinking horn of 2000 BC), from Soskiou (3000 BC) and from Ayios Tichonas. All the exanimate Cypriote samples gave positive results regarding the tartaric acid..

I D	TARTARIC ACID	RESULTS
ERIMI NECROPOLIS - GRAVES 115 n° 1	POSITIVE **** GREEN	4
ERIMI NECROPOLIS - GRAVES 52 n° 3	POSITIVE ** GREEN	2
ERIMI NECROPOLIS - GRAVES 105 n° 7	POSITIVE **** GREEN	4
ERIMI NECROPOLIS - GRAVES 121 n° 1	POSITIVE **** GREEN	4
ERIMI NECROPOLIS - GRAVES 118 n° 1	POSITIVE **** GREEN	4
ERIMI NECROPOLIS - GRAVES 115 n° 13	POSITIVE **** GREEN	4
ERIMI NECROPOLIS - GRAVES 97 n° 5	POSITIVE ** GREEN	2
ERIMI NECROPOLIS - GRAVES 115 n° 11	POSITIVE ** GREEN	2
ERIMI NECROPOLIS - GRAVES 115 n° 14	POSITIVE ** GREEN	2
ERIMI NECROPOLIS - GRAVES 112 n° 2	POSITIVE ** GREEN	2
ERIMI NECROPOLIS - GRAVES 92 n° 3	POSITIVE **** GREEN	4
ERIMI NECROPOLIS - GRAVES 119 n° 1	POSITIVE **** GREEN	4
ERIMI NECROPOLIS - GRAVES 115 n° 2	POSITIVE **** GREEN	4

Table 6 - Residual chemical analyses of the organic matter coming from some vases of the Erimi Necropolis.

I D	TARTARIC ACID	RESULTS
ERIMI 1933 - RESIDUES AMPHORA	POSITIVE * GREEN CLEAR	1
ERIMI N° 7 - RESIDUES AMPHORA	POSITIVE **** GREEN	4
ERIMI n° 6 - RESIDUES AMPHORA	POSITIVE **** GREEN	4
ERIMI n° 4 - RESIDUES AMPHORA	POSITIVE **** GREEN	4
ERIMI n° 127 EX - RESIDUES AMPHORA	POSITIVE * GREEN CLEAR	1
ERIMI n° 3 EX - RESIDUES AMPHORA	POSITIVE **** GREEN	4
ERIMI n° 9 EX - RESIDUES AMPHORA	POSITIVE **** GREEN	4
ERIMI n° 127 EX 3 - RESIDUES AMPHORA	POSITIVE * GREEN CLEAR	1
ERIMI n° 127 EX 2 - RESIDUES AMPHORA	POSITIVE **** GREEN	4
ERIMI n° 127 EX 1 - RESIDUES AMPHORA	POSITIVE **** GREEN	4
ERIMI NR-RA 2 EX - RESIDUES AMPHORA	POSITIVE **** GREEN	4
ERIMI EX 5 - RESIDUES AMPHORA	POSITIVE **** GREEN	4
ERIMI n° 140/160 - RESIDUES AMPHORA	POSITIVE **** GREEN	4
ERIMI n° 127 EX 4 - RESIDUES AMPHORA	POSITIVE * GREEN CLEAR	1

Table 7 - Residual chemical analyses of the organic matter coming from Erimi at the Limassol Archaeological Museum.

The glycolysis or fermentation of the sugars is the natural production of energy for the maintenance of life. But every product deriving from the fermentation of organic material in aerobic environment transform itself in short time like the wine in vinegar. In particular, the juice of the grape ferments for the presence of natural yeast and tartaric acid, transforming own sugars in alcohol (Pisani P.L., 1991), until the alcoholic rate extinguishes the action of the yeast. The process therefore continues transforming the wine in vinegar.

I D	TARTARIC ACID	RESULTS
AYIOS TICHONAS 2005	POSITIVE**** GREEN	4
KYRENIA (DRINKING HORN)	POSITIVE **** GREEN	4
SOUESKION (277)	POSITIVE * GREEN CLEAR	1
VOUNOS N° 61	POSITIVE **** GREEN	4

Table n° 8 - Residual chemical analyses of the organic matter coming from Archaeological Museum of Nicosia.

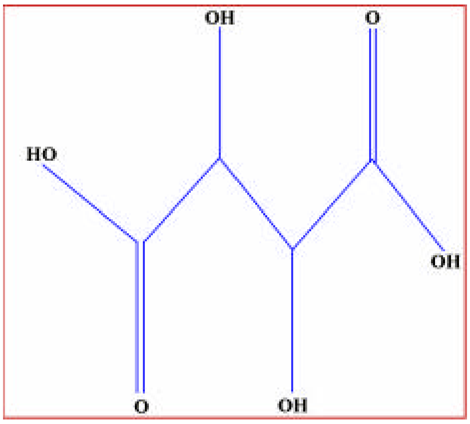
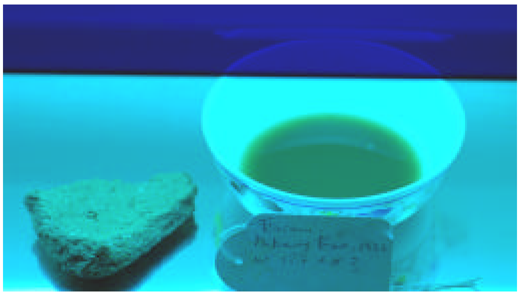


Figure 5 - Chemical structure of tartaric acid, generally in nature is found like dextro-rotary stereoisomer (if illuminated with polarized light rotates towards right). During the fossiliz*ation* it is transformed in a racemic acid.

Until the roman period the vinemakings didn't know any inhibitor to arrest the process, as the sulphur (Seltmann C., 1989) and it's probable that various systems have been experimented to conserve the wine unaltered. Perhaps the more used system has been the resin. In the analytical investigations conduct on various typologies of organic and inorganic materials from Pyrgos (2003-08), (Belgiorno M.R., Lentini A. and Scala G, 2006) and in the samples taken inside pottery probably related to the wine, have been found resins of Coniferae, *Pistacia* ssp. and *Amygdalus communis* L., probably used like inhibitors of the fermentation (Mllis J. and White R., 1989).



Figures 5 and 6 - The archaeological sediments on the bottom of a vase, coming from Erimi, have been extracted (elutriation) with H_2SO_4 to 20 %, for ten minutes. Subsequently to the super floating it has been added 0,02 gr. of 0,02 gr. di ß, ß' – binaphtol. The obtained solution submitted to irradiation with UV lamp of 240-250 nanometres, assumed a green colour under the fluorescent rays. The green coloration of the solution reveals that it contains high rate of tartaric acid, typical of the wine produced in the Mediterranean area.

In particular the resin of turpentine tree (*Pistacia terebinthus* L.), characterized many times (Lentini A. and Scala G. 2004) at Pyrgos - Mavroraki, during the analyses and confirmed the presence of *Pistacia terebinthus* pollens in the stratigrafic section PY04 US J4, (-180 -230 cm, figure 6), is composed from groups of triterpenoids compounds generally unsaturated. Such compositions are generally a group of polycyclic unsaturated, and has the function of anti-oxidants.

Figure 7 – Pyrgos, Stratigraphic Units PY J4, levels -180 to -230 cm, pollens of *Pistacia*.

The triterpenoids of the Anacardiaceae family (*Pistacia*) are rendered some and are all acide, thenames (oleanolic acid, masticadienonic acid, iso-masticadienonic acid) of it suggest the uses, the sources and the possible effects in the long term (Al-Said M.S., Ageel A.M., Parmar N.S and Tariq M., 1986).
They are constituted from a fix units of isoprene, characterized by five atoms of carbon, that is the base of the "mastica", the natural gum, (chew) (Pedretti M., 1997), used still today to cure pathologies of the digesting apparatus (Marone P., Bono L., Leone E., Bona S., Carretto E. and Perversi L., 2001).
The turpentine instead is obtained under boiling the resin, taken from the *Pistacia terebinthus* L. (turpentine of Cyprus or Chio), typical of the biome of Cyprus (Zohary M., 1973). The turpentine has been always used in the production of the resin wines (Mllis J. and White R., 1989). The extractive process consisted in the boiling of the resin in water. Subsequently, after the cooling, it was filtered with vegetable cloth, and the accumulation of the resin emanated scent of fennel (Benigni R., Capra C. e Cattorini P.E., 1997). The essence could be used also blended with other scents.
The comparison between the preliminary analytical results of Pyrgos and Erimi and the evidences coming from the analyses of Godin Tepè in Iran (Weiss H. and T. Cuyler Young, Jr., 1975 - Biers W. R. and McGovern P., 1990 - Badler V., 1991) is of particular archeometric interest. In fact, in both cases, the analytics procedures employed substantially agree, even if in the case of Godin Tepe the analyzed material has been characterized also with spectroscopy **FT-IT/ATR** (Biers W. R. and McGovern P., 1990). However it should be considered the fact that the fragments of Godin Tepe pottery come from the same jar (dated between the 3100 - 2900 a.C.), while the organic residuals from Cyprus come from 41 different objects found in four sites.
Of these, 16 come from Erimi, Chalcolitich jars (half of IV the millenium BC, Museum of Limassol), 13 from Erimi Necropiolis, 9 from Pyrgos-Mavroraki (beginning II millenium BC, Museum of Limassol), 1 from Vounous, Kyrenia (drinking horn of 2000 BC, Cyprus Museum) and 1 from Soskiou (3000 BC, Cyprus Museum, Nicosia). As under the statistical aspect as under the qualitative aspect the Cypriote tests seem more concrete and they refer to a large chronological arch supported by a meaningful evolution of the pottery destined to the wine.

Geobotany and biodiversity

Vitis micro-remains were found in the past at the Middle Bronze Age site of Marki Alonia, near Nicosia (Adams R. and Simmons D., 1996), but because of the lack of detailed descriptions and biometric measurements, at present they cannot be compared from the taxonomic and morphological standpoint with the seeds found at Pyrgos. These micro-remains raise a series of environmental questions regarding the geographic distribution of *Vitis* on Cyprus (biogeography), biodiversity in the natural landscape, and species imported or partially domesticated-adapted by human activities. In this context, the oldest plant macro-remains seem to belong to the least defined probable biodiversity levels (Medail F. and Quezel P., 1997). In effect, it is very hard to judge biodiversity in archaeological contexts, due mainly to the fact that no certified methods exist yet for classifying these paleo-environmental structures, because the principal recognizable units represent different sectors of a highly variable anthropized environment.

Archaeobotanical, paleopalinological and sedimentological investigations plus exploration in the areas adjacent to the Pyrgos site (Lentini A. and Belgiorno M. R., 2008) have evidenced a series of environmental discontinuities that make Cyprus's natural landscape a highly varied one, thereby confirming indirectly the preliminary analytic results of the first investigations of stratigraphic sections (PY04G7 – 8) dating from between 1950 and 2000 B.C.

For the purposes of an initial comparison of the archaeobotanical data, we updated a map of rainfall distribution on Cyprus (Zohary M., 1973) with rainfall and temperature data for the period from 1973 to 2007, to produce an updated view of possible microclimates on the island. These data were collected at 25 weather stations (Figure 8) located irregularly across the island, some concentrated in the central part (the Mesaoria plain, from Nicosia to Famagosta), others on the West coast (from Morocampos to Episcopi) and still others near the heights of the Trodos mountains (from Platania to Trimiklini), with significant absences in the North East, the North West and on the southern coast. The weather data were processed with the aid of the Köppen formula (McKnight T.L. and Hess D., 2000):

$$I_a = \left[\frac{P_1}{T+10} + \frac{12P_2}{t} \right] : 2$$

P_1 = rainfall in mm
T = average annual temperature (°C)
P_2 = average rainfall in the driest month
t = average temperature in the driest month

Indexes <10 = arid climate

Indexes between 10 and 20 = subarid conditions
Indexes between 20 and 30 = subhumid conditions

The updated climate data – processed on the basis of contour lines obtained from cartographic elements reported in the past (Zohary M., 1973) show a distribution in eight microclimates that reflects the island's geological and altimetric features. In fact, some areas are marked off by geographic barriers (the Trodos and Kyrenia mountains) and their characteristics of their plant populations are allopatric, while others are marked off by abiotic factors (climatic elements and soil characteristics) that operate in the same geographic area with various sympatric plant species.
On the northern side of the island, the Kyrenia mountain range about 100 km long and rising to over 1000 meters runs parallel to the coastline and forms a sort of natural barrier between the coast and the interior. The Kyrenia mountains are the Southernmost part of the Alpine-Himalayan range; they are made up mainly of Mesozoic limestone and are characterized by low precipitation and thermoclastic phenomena. The Kyrenia rocks have low thermal conductivity values (Malikkides C., 2006), which explains why large temperature differences occur between their outer and inner parts, generating stress that causes the rocks to crumble. Three microclimates were identified in this area (Figure 8), and are also found beyond the Mesaoria plain. The most extensive one, referable to the Kyrenia weather station (Fig. 8, no. 2), includes the mountainous area that slopes down to the

sea, and is characterized by soils consisting for the most part of Dolomitic limestone with a high degree of salinity. Here the most representative biome is made up of *Juniperus phoenicea* (the Syriac element) and various seasonal halophytes, while *Pinus brutia* is present at the medium-to-high altitudes.
The second microclimate, referable to the Haleuga station (Fig. 8, no. 3), is divided into three small areas, distant from each other, at the highest altitudes in the Kyrenias; here the ground is rocky (sub-acid limestone) and there is no significant stable vegetation.
The third microclimate characterizes a large area with allopatric features, the northwest-northeast area between Kormakiti and the tip of Cape Andreas. It is monitored by only one weather station, at Vahlia (Fig. 8, no. 6). It is separated from the rest of the same distribution range by the Mesaoria plain to the south (Fig. 3) and southeast; by the desertified area monitored by the Morphou station (Fig. 8, no. 7) to the northwest; and, in the southern part of the island and to the southwest, by the lower reaches of the Trodos mountains, which slope down to the sea. Almost all the weather stations covering this microclimate are located along the coasts: at Ktima, Paphos, Morocampos, Patria tou Romiou and Episcopi in the southwest (Fig. 8, nos. 20-24), near Limassol in the south (Fig. 8, no. 25), and at Larnaca in the South East (Fig. 8, no. 14). Generally speaking, the soils in these areas have a medium texture; in the more internal areas they have a high carbonate content and are subject to frequent leaching phenomena, while in the areas adjacent to the coastline they are characterized by high percentages of sodium and potassium. The native vegetation consists of Irano-Turanic species (*Cupressus sempervirens, Pinus halepensis* and *Cedrus* ssp.) and Mediterranean species (*Prunus, Pistacia, Olea europea* L., *Quercus, Ceratonia, Myrtus* and *Laurus)* variously distributed across the territory according to local variables (Meikle R. D., 1977, 1985). Growing near the short streams are *Popolus, Salix, Miriophyllum* ssp. and other aquatic grasses.
The fourth microclimate, with less than 300 mm of rainfall per year, according to the data reported by the Morphou weather station (Fig. 8, no. 7), is the island's only desertified area. As the soil is made up of calcareous sands with a high degree of salinity, it is subject to evapotranspiration phenomena. The vegetation that grows here during short periods of the year consists of alophytes (Chenopodiaceae, Amaranthaceae and *Salsola* ssp.).
The fifth microclimate is one of the island's largest; it includes the Mesaoria plain, which has the highest concentration of weather stations, at Kokkini Trimithia, Nicosia, Athalassa, Prastio and Famagosta (Fig. 8, nos. 8-12). This territory, nearly all irrigated and farmed, is the one that has been most intensely affected by human activities over the course of history. It has a record of deforestation (Gomex Campo C., 1985), wildfires and farming methods that have eroded and impoverished the soil, leading to the formation of garrigues associated with anthropocore species, mainly *Quercus coccifera, Olea europea* L., *Olea europea* L. var. *sylvestris* (wild olive), *Ceratonia* ssp. (carob), Graminaceae, *Genista* ssp., *Calycotome* ssp., Chenopodiaceae-Amaranthaceae, Asteraceae, Labiatae and Compositae. The garrigue is the next to last stage in the regression of Mediterranean phytoclimatic associations, after the Oleo-Ceratonion xerophile scrub and before the steppe. Its widespread presence in a Mediterranean region can be taken as an indicator of desertification.
Also present in this microclimate are some wetlands that are considered marginal, including streams and lakes near Famagosta. They are characterized by associations of halophytes (*Juncus* ssp., *Spartina* ssp., *Salicornia fruticosa* and *Arthrocnemum fruticosum*). In this area too, there is a disjunction toward the southeast, near the border between Kiti and Larnaca. In the spring, the vegetation here consists mainly of *Ulva* ssp., *Enteromorpha* ssp. and *Chaetomorpha* ssp.
The other three microclimates are located in the Trodos mountains, at altitudes between 1600 and 1900 meters, and on up to the highest peak of Mt. Olympus (1952 meters). They are monitored by weather stations at Platania, Prodhromos, Stravos, Trimiklini and Lania (Fig 8, nos. 15-19). The limestone foothills are subject to Karst phenomena, with the formation of dolines and sinkholes. Sandstone and conglomerates are present in some parts of these areas. The vegetation on these

lower slopes consists of evergreens (*Cupressus sempervirens* and *Juniperus phoenicea*), semi-deciduous trees (*Quercus coccifera* and *Quercus infectoria*) and *Arbutus andrachne*. Along the streams that flow down from the higher altitudes are large woods made up of *Popolus, Salix* and *Alnus*. At the lowest altitudes, near the sea, the beds of these streams usually remain dry during the spring and summer. At altitudes of around 900-1000 meters, *Vitis vinifera* L ssp. *sativa* HEGI is cultivated on manmade terraces with the "little tree" method (Figure 7). The vines, each one set in a small hollow that protects the grapes from the hot winds, are pruned to a height of 30-40 centimeters. A few "branches" grow on each "tree," each branch is left with one or more shoots, each shoot with one or two buds.

Figure 8 – Cultivation of *Vitis vinifera* L. ssp. *sativa* HEGI by the "little tree" method at an altitude of 900 - 1000 meters (Trodos mountains).

The territories lying above 1000 meters in the Trodos mountains are made up of igneous and pillow-lava formations originated by molten lava that poured into the sea as the Eurasiatic plate drifted away from the Arabian plate.

The biome most representative of these areas is the vast pine woods, made up mainly of *Pinus brutia* and the endemic species *Cedrus brevifolia*, associated with *Quercus alnifolia,* likewise an endemic species. At the higher altitudes near Mt. Olympus are *Pinus palladiana* woods, with *Juniperus foetidissima* present in the glades.

The pine forest was Cyprus's original biome, and in the past it probably covered a large part of the island (Quezel P., 1979). At present this biome occupies some residual areas near Paphos (at sea level), as well as the areas at the highest altitudes. In the past, human activities and climate changes seem to have drastically impoverished the original biome (Lentini A. and Belgiorno, 2008).

Overall, the vegetation on Cyprus, as in other Mediterranean areas, is the result of glacial movements in the Quaternary era, when species native to continental Europe retreated to territories on the Mediterranean Sea. Besides furthering the preservation of these northern species, the Mediterranean areas became the evolutionary environments of individual species (Strasburger E., Noll F. and Schenck H., 1990). Cyprus was one of the Mediterranean islands whose particular orographic features encouraged the phylogenetic evolution of many species, and today it is especially rich in endemic species (Pantelas V., Papachristophorou T. and Christodoulou P., 1993). Endemisms are widespread on many Mediterranean islands (Sardinia, Corsica, Sicily, Malta, Cyprus, Crete, Zante), where conditions are favorable for speciation, due to the presence of geographic and abiotic barriers that hinder dispersion of the original genetic makeup. They are especially numerous on the islands that have been separated longest from the mainland. The great diversity of habitats and microclimates on Cyprus makes for an abundance of native species. Their number is estimated at 179 (Pantelas V. et alii., 1993), and their distribution ranges from the Trodos mountains (87) to the Kyrenias (57) and the Akamas peninsula (35). Systematic botanists consider some of them, such as the Cyprus cedar (*Cedrus brevifolia)* and the Cyprus oak (*Quercus alnifolia)* to be living fossils (Pantelas V. et alii., 1993). The aromatic species *Nepeta troodi, Teucrium cyprium, Teucrium micropodioides, Thymus integer, Salvia willeana* and *Origanum cordifolium* are thought to be among the major evolutionary lines of the officinal species that are most widespread and best known in the Mediterranean region. Very rare bulb species such as *Cyclamen cyprium*, *Tulipa cypria, Crocus cyprius, Crocus veneris, Chionodoxa lochiae* and *Gagea juliae* have sometimes been used as officinal species (IUCN - Centres of Plant Diversity, 1994), and on some occasions in the past were pictured on pottery, mosaics and other objects of high artistic value (Codex Julianae Aniciae). Cyprus's location at the southeastern boundary between the Mediterranean region, the Pontic region (the Irano-Turanic element) and the Near East (the Syriac and Nubo-Sindic elements) (Zohary D., 1996) does not seem to have effectively influenced the most important endemic species; they were probably preserved by the island's microclimates and particular edaphic conditions.

Our analysis of the seeds of the various species of *Vitis* found at Pyrgos, taken together with the results of the sedimentological and paleopalinological tests, indicates that optimal conditions existed for the cultivation of *Vitis* at low altitudes (100 – 200 m) near the sea (4 km away), in an environment very different from the one in which *Vitis vinifera* L. ssp. *sativa* HEGI is cultivated today on the slopes of the Trodos mountains, at much higher altitudes (900-1100 meters). The preliminary results obtained at Pyrgos suggest that the local climate was cool and moist, as has been found at other southern Mediterranean sites dating from 1900-2000 B.C. (Palmieri A. M., 1980; Belluomini G., Esu D., Mandra L. and Matteucci R., 1980; Bar-Yosef O., 1990; Lentini A. and Palmieri A. M., 1993; Palmieri A. M. and Lentini A., 1994; Rögl F., 1999). In those environmental conditions, when the climate was cool and moist, the vegetation now found at medium and high altitudes likely grew at lower altitudes closer to the sea. Later on, due partly to the evolution of the climate and the environment in all the Mediterranean territories toward sub-arid periods (Barbero M. and Quezel P., 1979), and partly to increasingly intense human activities, the most representative biocenoses gradually moved to higher altitudes, where the environmental conditions were still cool and moist.

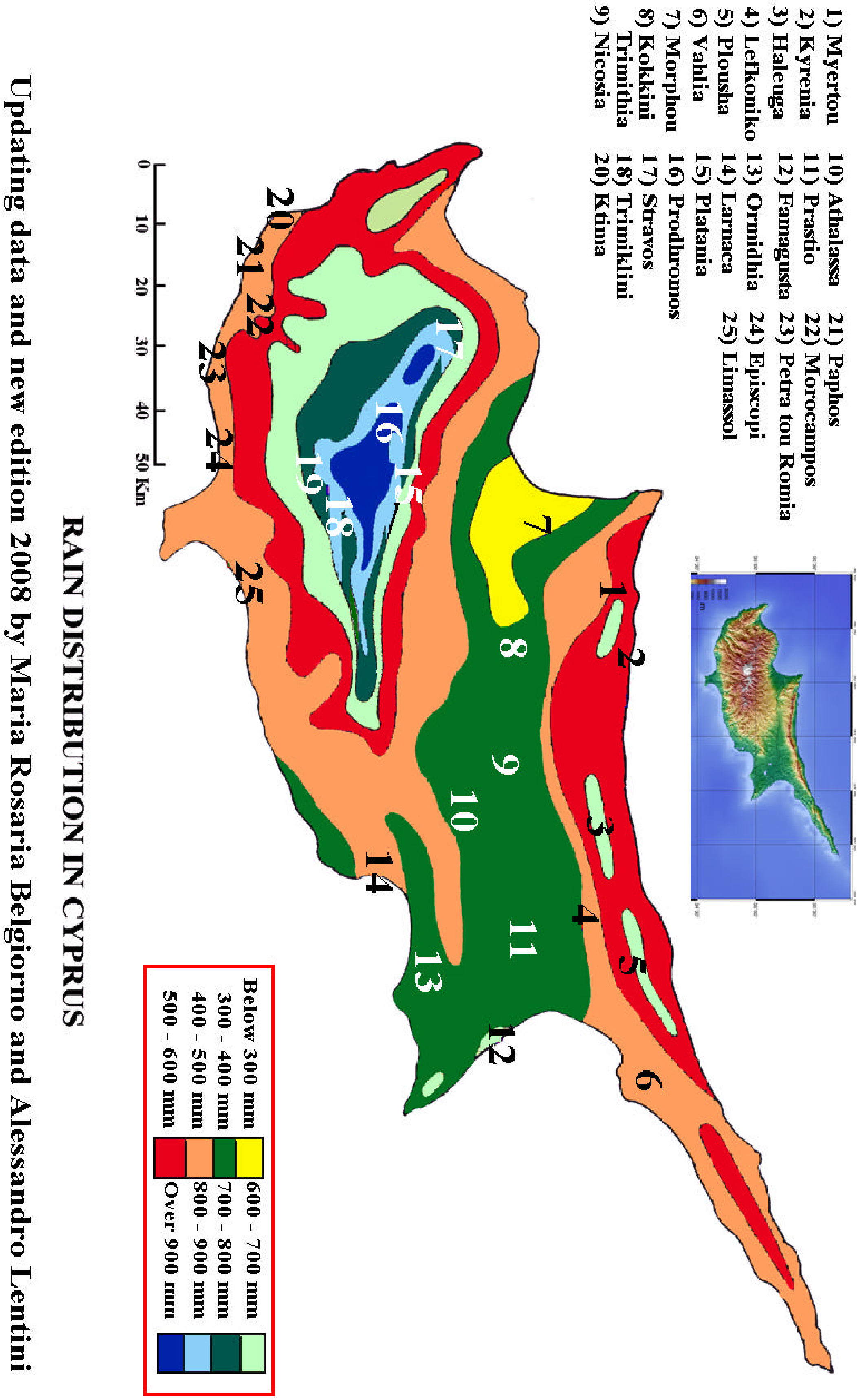


Figure 9 – Rain distribution in Cyprus.

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