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A FOSSIL WALNUT FRUIT (*Juglans* L.) FROM AKÇAABAT (TRABZON) AND ECOLOGICAL-PHENOLOGICAL CHARACTERISTICS OF WALNUT

Un fruit fossile du Noyer (*Junglans* L.) à Akçaabat (Trabzon) et les caractéristiques écologiques et phénologiques du genre

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RESUME

*Le Noyer (*Juglans *L.) a été reconnu depuis le Néogène dans les séries géologiques. Son pollen a été trouvé dans les dépôts du Miocène et du Pliocène de Turquie. Un fruit fossile bien préservé, trouvé dans le Pontien du N.E. de la Turquie est présenté dans cette étude.*

Les recherches palynologiques démontrent que le Noyer a connu une grande expansion géographique en Turquie à la fin de l'Holocène. L'amélioration du climat et sa culture par les civilisations anatoliennes, sont responsables de cette expansion.

Le Noyer produisant des fruits très nutritifs et du bois de grande qualité est aussi un genre tolérant du point de vue de ses exigences écologiques. La température, l'humidité relative, la pluie et le vent semblent être d'importants paramètres contrôlant la dissémination de son pollen.

ABSTRACT

*Walnut (*Juglans *L.) has been recorded since Neogene in the geological record. Its pollen is found in Miocene and Pliocene deposits of Turkey. A very well-preserved fossil walnut fruit, found in the Pontide Belt in the northeastern part of Turkey, is introduced in this study.*

Palynological studies show that walnut attained a widespread geographical expansion during late Holocene throughout Turkey. Amelioration of climate and initiation of walnut cultivation by Anatolian civilizations are responsible for this expansion.

Walnut bearing a high nutritious fruit and a super quality wood is also quite a tolerable plant in terms of its ecological requirements. Temperature, relative humidity, rain and wind appear to be important parameters controlling the dissemination of its pollen.

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INTRODUCTION

Bearing a high nutritious fruit and super quality wood walnut is among the plants which has been the most consumed by mankind. Fruit with fresh and hard exocarp, leaves, stems, roots of *Juglans* L. are consumpted in medicine for curative purposes as well as in chemical and agriculture industries (BAYTOP, 1984). Rapid consumption in Turkey however, consequently resulted in a sharp decline in the number of trees especially the old ones; yet the climate is quite tolerable for the growth of this Asiatic plant. Palynological studies reveal that *Juglans* L. has been existing since Tertiary and it has been growing almost everywhere in Turkey since Late Holocene (the last 3-4 kyrs.) during which the present-day climatic conditions prevailed. In this study: 1) stratigra-phical and geographical distribution of walnut in Turkey is summarized; 2) a fossil walnut fruit found in Akçaabat-Trabzon is introduced; and 3) ecological and phenological characteristics of walnut of Ýstanbul area is presented.

ECOLOGICAL CHARACTERISTICS AND GEOGRAPHICAL AND STRATIGRAPHICAL DISTRIBUTION OF *JUGLANS* L.

Juglans L. is a member of the Juglandaceae family of the Juglandales order. The family is represented by 6 or 7 genera and about 60 species (Yaltýrýk, 1988). *J.regia* L. appears the most distinctive among the species in terms of its fruit quality. Yaltýrýk (1988) defines *J.regia* L. as follows:

'Trees to 25 (-30) m with broad round crown. Trunk upto 1.5 (-2.5) m diam. in old trees. Apical bud terminal. Buds sessile with scales, often with axillary buds. Numerous lentisels visible on thick, cylindrical, grey-brown, bare shoots. Shoot's pith segmented. Three vascular bundle scars on scull-like petiols. Leaves 22-35 cm, leaflets 5-9 (-11), elliptic to obovate or oblong-ovate, acute or acuminate, entire, glabrous except for hairtufts in axils of veins beneath. Leaflets alternate, pinnate, 6-12 cm. Male catkins solitary pendent. Female flowers in few-flowered terminal recemes, on young apical shoots. Fruit a largeindehiscent drupe, with nucleus, exocarp glabrous, green, 4-5 cm diam., more or less spheroidal'.

Places where *Juglans* L. attains widespread geographical expansion and its most fertile habitats are in the terrestrial climatic belt of the world. It grows upto 1500 m in Turkey and 1000-1200 m in European Alps. It can stand minimum – 25 °C and maximum + 38 °C of temperature. Although the most favorable habitats are those valleys with sunny summers and temperate winters protected from cold and chilly winter winds, 800-1000 hours of vernalisation and duration of winter resting period indicate that it can stand to even colder conditions. Permeable, loose gravels at hill toes covered by slacken alluvial soil are among walnut's preferential places for growth; it likes alkaline soils (ÇELEBIOOLU, 1985).

Walnut naturally grows particularly in Eastern and Northeastern parts of Anatolia. Provinces having the most abundant trees in Turkey are Bingöl, Zonguldak, and Bitlis. Based on various studies and observations of DAVIS (1982), the natural distribution of *Juglans* L. in Turkey can be summarized as in Figure 1. Outside of Turkey, natural distribution lies towards the Balkan Peninsula, Caucasus, northern Middle East, Iran, Afganistan and People's Republic of China towards the middle Asia.

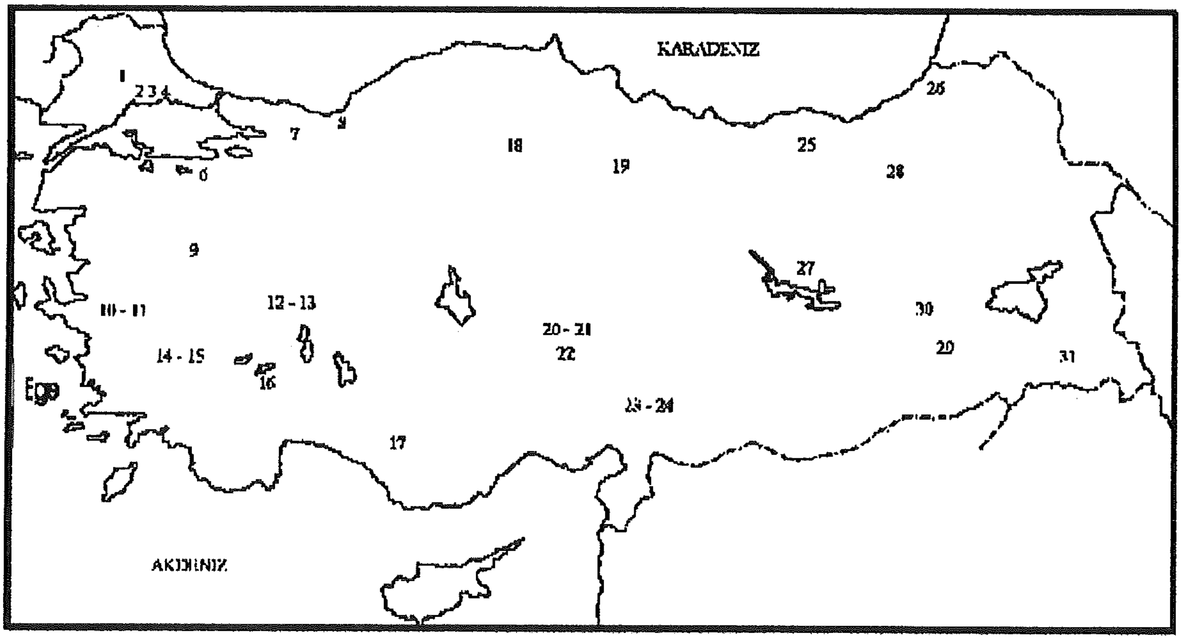

Figure 1: Natural Distribution of Juglans regia L. in Turkey (from Davis, 1982)

Kirklareli: 1 Pinarhisar

Istanbul: 2 Çatalca, 3 Deliyunus, 4 Terkos

Balikesir : 5 Marmara Adasi

Bursa: 6 Uludag - Inkaya

Sakarya: 7 Sapanca

Bolu: 8 Mengen - Yalakkuz

Kütahya: 9 Simav

Izmir: 10 Kemalpasa, 11 Nif Dagi Etekleri

Alfyon: 12 Sultandgi, 13 Dereçine

Denizli: 14 Honazdagi, 15 Arpacik Yaylasi

Burdur: 16

Konya:17 Ermenek Bölgesi

Çorum : 18 Köse Dagi

Tokat:19 Tokat Bölgesi

Kayseri: 20 Erkilet, 21 Gesi, 22 Develi

Maras:23 Sarimsak Dagi, 24 Andirin

Trabzon:25 Maçka - Meryemana Ormani

Çoruh:26 Salalet Ormani

Tunceli: 27 Pülümür Deresi

Erzurum: 28 Olur

Siirt:29 Sason

Bitlis: 30 Hizan - Nazarez

Hakkari: 31 Semdinli - Yüksekova

Juglans regia L. which is readily distinguished by its supreme quality fruit was brought out of its natural distribution area by nomads and tradesmen and by such animals like squirrels and crows. Today it is planted everywhere in the world except the Tropics. During its spreading, for instance towards eastern Asia, ÇELEBIOOLU (1985) mentioned that *J.regia* L. gave rise to new hybrids by abondening some of its characteristics when met with species of different regions, *e.g. J.cathayensis* Dode and *J.manshurica* Max.

ÇELEBIOOLU (1985) and ÞEN (1986) summarized evidences regarding the distribution of *J.regia* L. in historical ages as follows: During holy King Solomon times Hebrews had consumpted walnut fruit. Walnut had been nourishly planted in the alpine meadows of Macedonia along with chestnut and corylus in 375-287 B.C. (Teofratus). Chinese literature cited it was brought to China from Tibet in 150-140 B.C. According to Pliny (23-79 A.D.), it was introduced to Greece from Iran during 700-500 B.C., then proceeded to Roman's Land. Romans envisaged *Juglans regia* L. as a symbol of fruitfullness, treated their guests with walnut and epitheted it 'Jupiter's fruit' (Jovis glans) to intend 'King's Walnut', from which the name 'Juglans' was derived. It was brought into France, Spain, Portugal and South Germany from Italy. There are evidences that it was cultivated in England in 1526 and California (U.S.A.) in 1871.

Juglans' L. pollen was found in the deposits of Black Sea coast of Romania and the Neolithic and Bronze Ages in France (EMBERGER & CHADEFAUD, 1960). Anatomical studies of wood buried in the tomb of King Midas I in Gordion, near Polatlý, Ankara (AYTUO, 1987) revealed that the furniture and the appliances of the King were made of *Juglans regia* L., *Taxus baccata* L., *Cedrus libani* Loud., *Juniperus foettissima* Willd., *Buxus sempervirens* L. and *Pinus sylvestris* L.; *i.e. Juglans* L. have been skillfully carved in Anatolia in 2500 + 60 B.P. Pollen of the members of Juglandaceae family have also been recorded from Neolithic Age (6570 + 140) of Süberde-Konya (AYTUO, 1967).

The presence of walnut before the historical ages is known from palynological studies. Because pollen have a very small size, disseminated by very large quantities by the parent plant and have resistant exocarp (exine), they are found in large quantities and better preserved compared to other parts of plants such as root, stem, leaf or fruit in sediments of non-oxidizing environments. Periporate *Juglans* L. (*J.regia* L., *J.nigra* L.) pollen whose most pores are aligned in the equatorial area can readily be recognized under microscope. Suboblate *J.regia* L. possesses 11-15 pores whereas number of pores of sphaeroidal shaped *J.nigra* L. changes between 16-24 (AYTUO *et al.*,1971). Pollen of *Pterocarya* Kunth., another genus of the family, which is classified as *Polyporopollenites stellatus* (R. POTONIE 1931) Pf. *in* Th. and Pf. 1953 whose most of the pores are aligned in the equatorial region shows a great resemblance to *Juglans* L. pollen; its 5-7, occasionally 3-4 pores are located at the periphery. POKROVSKAIA (1958) indicated one of the main differences between *Juglans* L. and *Pterocarya* Kunth. pollen was that *Juglans* L. exhibits an operculum.

Pollen of *Juglans* L. have been recorded since Oligocene in Europe; Miocene deposits of Portugal and Villafrankian deposits of the Alps yielded *Juglans* L. pollen (EMBERGER & CHADEFAUD, 1960). It is found in Neogene deposits of Turkey, yet *Pterocarya* Kunth. pollen was more dominant and widespread than *Juglans* L. during this period. Palynological studies of the Upper Miocene and Pliocene sediments (TRAVERSE, 1978, ARSLAN, 1979, AKGÜN AND AKYOL, 1987) show that Juglandaceae family was represented dominantly by *Pterocarya* Kunth.; it has not become extinct during Quaternary and at present however declined considerably,

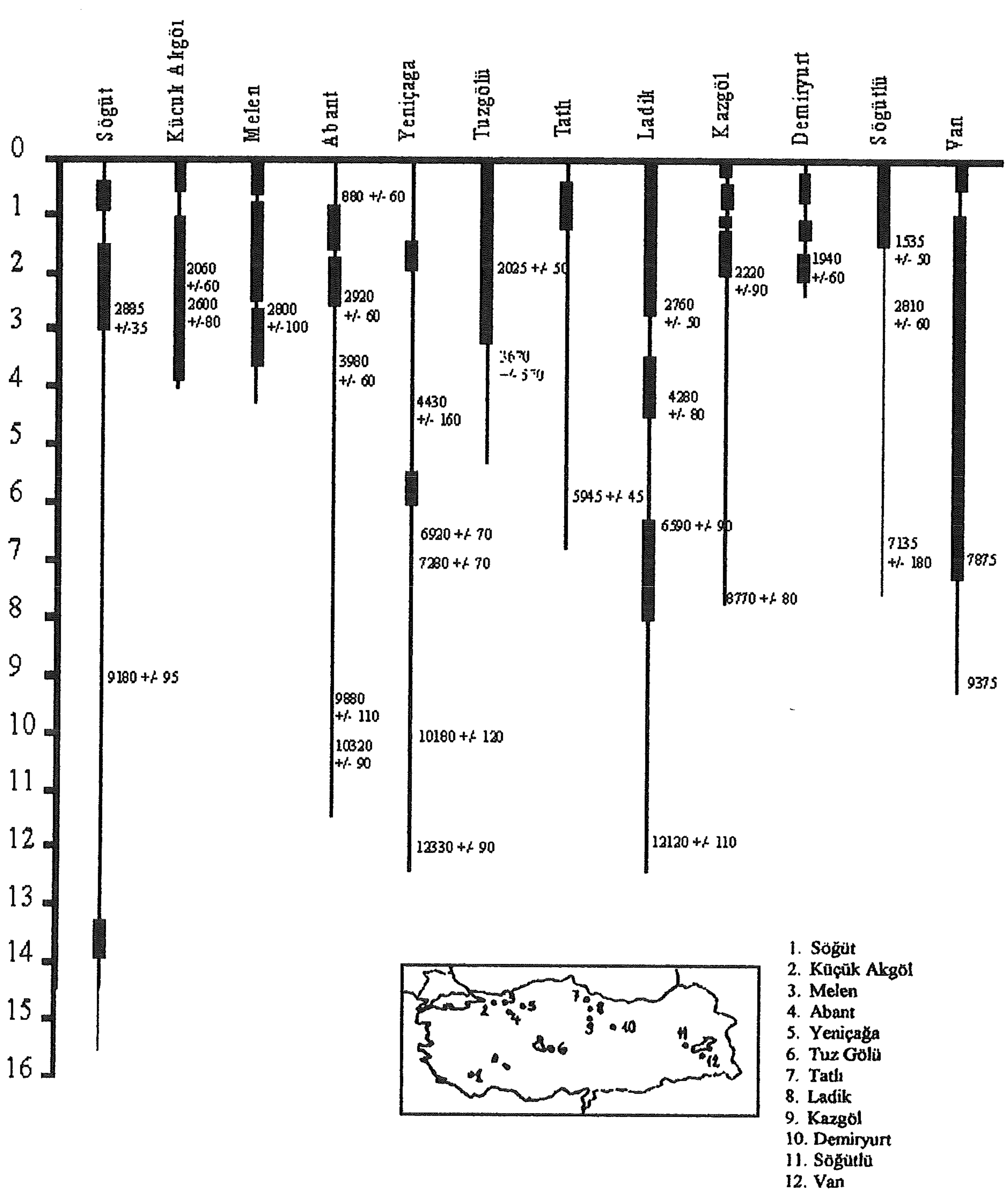

Figure 2.: *Stratigraphic Distribution of Juglans regia L. during Last Glacial and Holocene in Turkey (Various Sources)*

whereas *Juglans* L.has more predominated. Stratigraphical distribution of pollen found in the last Glacial and Holocene lake sediments of Turkey shows that *Juglans* L. was quite abundant during Holocene. Figure 2 shows location and stratigraphical distribution of drill holes of lake deposits [Söðüt Gölü, (ZEIST AND BOTTEMA, 1991), Küçük Akgöl, Melen (BOTTEMA *et al.*, 1995), Abant, Yeniçaða (ZEIST & BOTTEMA, 1991; BOTTEMA *et al.*, 1995), Tuz Gölü (ÝNCEOOLU

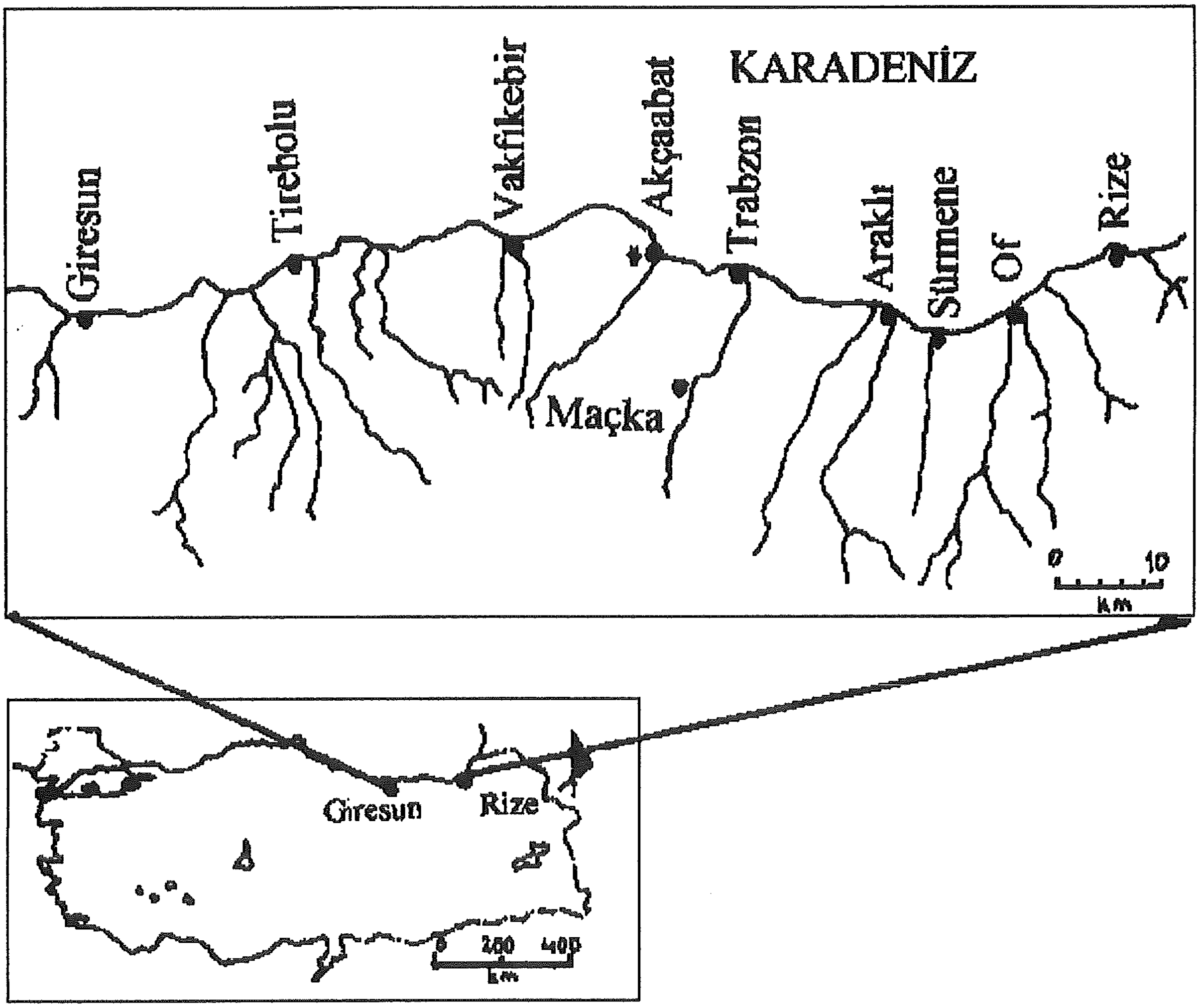

Figure 3.: *Location Map*

AND PEHLIVAN, 1987), Tatlý, Ladik, Kazgöl, Demiryurt (BOTTEMA *et al.*, 1995), Söðütlü, and Van Gölü (ZEIST & BOTTEMA, 1991)].

During glacial periods of Quaternary when much of the earth was covered by intensive ice sheets, many plant species could be able to survive in the refugee areas of Anatolia where had never been covered by permanant ice, particularly in eastern Black Sea and Mediterranean coastal areas. *Pterocarya* Kunth. which had accostumed to mild, temperate climates of Upper Miocene and Pliocene might not have resisted to cold conditions of Pleistocene and left its place to *Juglans* L. during Quaternary. The reason why Anatolia is interpreted as the place of origin for *Juglans* L. in many studies might be because Turkey provided a refugee area for the members of Juglandaceae family as in the case of many other plant taxa. The last glacial which was commenced about 70-80 kyrs B.P., and whose maximum was reached during 22-18 kyrs.B.P., started to cease after *ca.*18 kyr. B.P. During transition from glacial to interglacial after 18 kyr, complete melting of Laurentide and Fennoscandinavian, and partial melting of Antarctic ice sheets caused sea level to rise to the present level by 6-5 kyrs B.P.; cold and arid conditions of the glacial period were replaced by humid and mild conditions of the interglacial. Amelioration of climate and melting of ice sheets resulted in rising of sea level which caused water exchange to restart between Black and Mediterranean Seas via the straits of Dardanelles and Bosporus (EROL, 1992), which consequently derived Anatolia to be influenced by a climate of oceanic characteristics. Upon completion of melting and stabilization of sea level, the climate has become drier and drier which opened a new phase in the vegetation cover of Turkey since 4 kyr B.P.

Increase of *Juglans* L. during Late Holocene was linked to human impact which was typically observed in Bey°ehir Lake sediments by BOTTEMA *et al.* (1990; 1995). The human impact which was started 4 kyr B.P. was quite distinctive at a period between 3535-2185 kyr B.P. which is called 'Bey°ehir Occupation Phase'. Along with *Juglans regia* L., *Castanea sativa* Miller, *Vitis vinifera* L., *Fraxinus ornus* L., *Platanus orientalis* L.were among the plants cultivated by the civilizations of Anatolia.

Juglans L. which was quite abundant in the last 3-4 kyrs. have become lesser and lesser at the present. Natural distribution of walnut is expected more widespread today when viewed from the points that its origin is Asiatic, it was quite common during late Holocene and it is an ecologically quite tolerable plant. Surface samples of lake sediments yielding walnut pollen of the areas where no walnut trees were found in the vicinity (BOTTEMA *et al.*,1995) may imply that the trees were cut by a very recent time ago. Walnut is a tree which can survive 150-160 years and develop a 10-12 m^3 trunk volume; exportion timbers to European countries upto 1950's (DAVIS, 1982) could be a reason for the decline of the number of trees.

DESCRIPTION OF THE FOSSIL WALNUT

A fossil walnut fruit found in Pliocene-Quaternary deposits around Akçaabat-Trabzon is introduced here. The sample is such preserved that it resembles a fresh walnut fruit. Photos 1 a and 1 c show fresh, and 1 b shows the fossil fruits.

The geological unit in which the fossil was found is exposed in a valley where Kalenema Creek is debouched into the Black Sea (Figure 3). The region is subjected to several geological studies because of ore deposits such as copper, lead and zinc found in the region and their relationship with the volcanism which has been active since Upper Cretaceous (M.T.A.,1974; AOAR,1968); industrial materials used in ceramics industry (KÖSEOOLU, 1978); and frequently occuring landslides of the area. The unit in which the fossil walnut fruit was found was defined as Pliocene-Quaternary in age based on stratigraphical relations by AOAR (1968).

The present day yearly average temperature in the region is 14.6 °C and total precipitation is 687.3 mm /yr according to data of Akçaabat Meteorological Station (Bulletin of Meteorology, 1974). The region is under the influence of the category of 'Temperate Winters , Rainy' climate according to Emberger's Principals of Mediterranean Climates.

Fresh walnut fruits are defined according to the form of the fruit and the thickness of exocarp, roughness, color, and its degree of adherence. Length, suture length, longitidunal length, degree of hardness, weight with and without exocarp, oil and protein amounts are also used in defining fresh fruits. Only a few of these characteristics can be determined for the fossil samples. ÇELEBIOOLU (1985) summarizes 7 native and 3 alien, a total of 10, varieties of *J.regia* L. as follows:

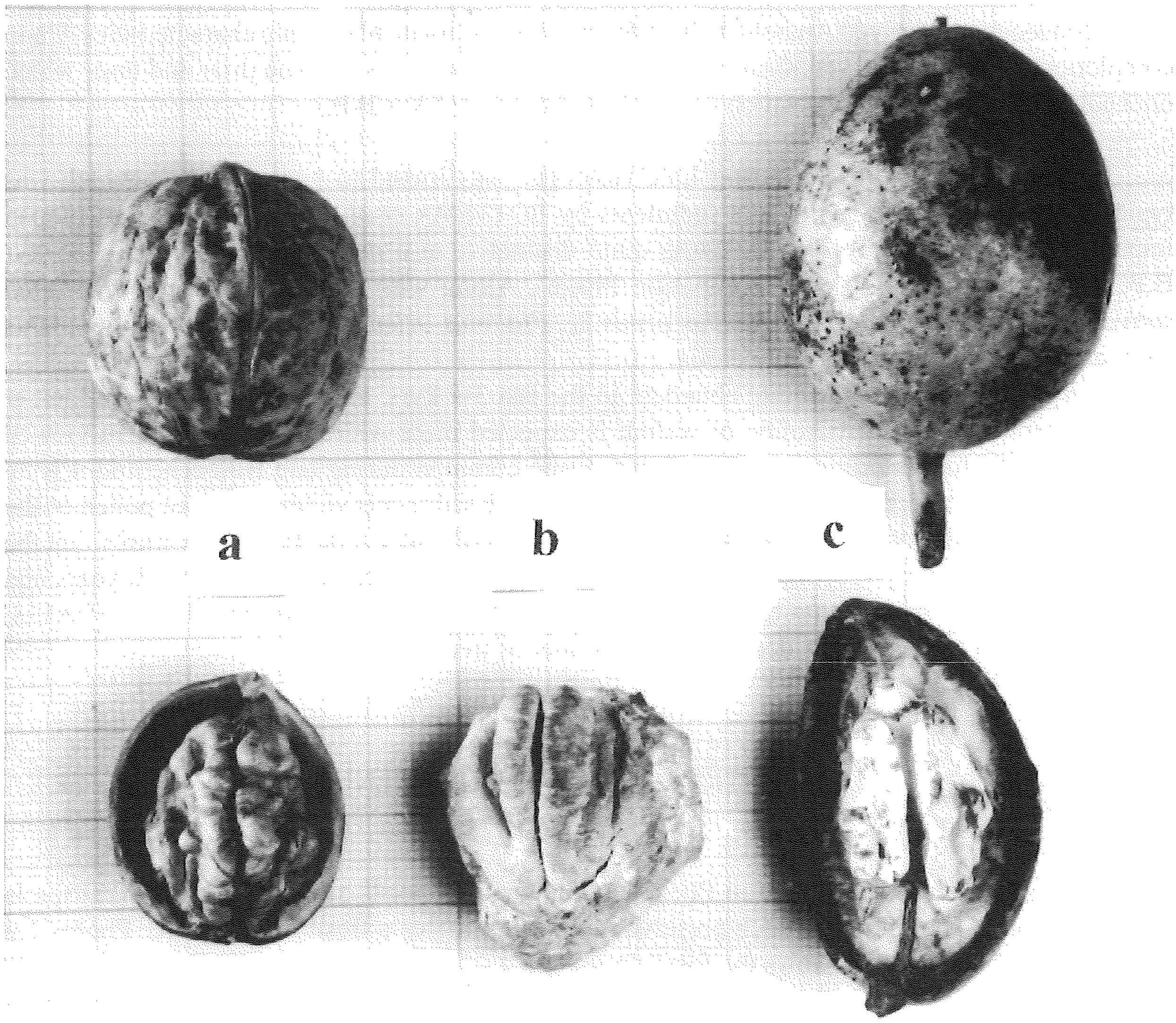

Photo 1.: *Fossil and Fresh Juglans L. Fruits. (1a, c: Fresh; 1b: Fossil)*

	Native	Alien	Average
Length:	4.4, 5.2, 4.3, 4.1, 4.1, 4.0, 5.6,	3.5, 4.3, 4.2	L = 4.37
Diam. (+Suture):	3.4, 3.6, 3.1, 3.6, 3.1, 3.2, 4.0,	2.8, 3.6, 3.5	S = 3.39
Diam.:	3.5, 3.9, 3.3, 3.2, 3.4, 3.2, 4.5,	2.9, 3.6, 3.5	D = 3.50

Measurements of the fossil fruit from Akçaabat is given below (Photo 1 b):

Length (cm): 2.8 cm
Diam. (cm): 2.1 cm
Diam. (+Suture)(cm): 2.1 + 0.13 cm
Exocarp: 0.13 cm
Form: (U/G): 1.3

Measurements of the fossil fruit are smaller compared to fresh fruits' dimensions given above.

PHENOLOGICAL CHARACTERISTICS OF WALNUT IN ÝSTANBUL AREA

Time and duration of flowering, pollinization, fertilization play important role in plant genetics and breeding studies. Phenological characteristics of walnuts based on airborn pollen in Ýstanbul area are studied here.

Airborn pollen data of Ýstanbul was taken in detail by AYTUO *et al.*, (1974). Hourly counts of pollen in unit volume of air (10 lt/hour) of Ýstanbul area, for almost a three years of period, were determined by a Hirst Spore Trap located 1.60 cm above the ground level in the backyard of the Meteorological Station which is 129 m above the sea level, in the Belgrade Forest which covers an area of 5060 hectars, NW part of Bosphorus. During the course of the study which was commenced in 23 rd of March 1966 and ended in 31 st of December 1968, pollen of *Juglans* L. of the vicinity were also encountered. 1) Seasonal distribution of *Juglans* L. pollen; 2) temperature to cause to initiate pollen dissemination; and 3) temperature, relative humidity, precipitation and wind controlling the course of dissemination are evaluated in the following.

SEASONAL DISTRIBUTION OF *JUGLANS* L. POLLEN

Dissemination of *Juglans* L. pollen in Ýstanbul area was commenced and ended in April 9-May 28, April 15-May 29, and April 10-May 27 in the years 1966, 1967, and 1968 which are termed here first, second, and third years, respectively. The daily pollen counts and average temperature (°C), relative humidity (%), precipitation (mm), and wind velocity (m/sec) and direction of these periods are given in Table 1. The hours which no counts could be taken because of technical reasons such as electricity shortcuts are taken into consideration in statistical evaluations and comments; the percentage of these days is 3.8 % in the first, 1 % in the 2nd and 0 % in the 3rd years. The days corresponding to the 5-95 % of the total pollen count are termed as 'Pollen Dissemination Period'. Pollen dissemination periods are in between April 21 and May 21, April 28 and May 22, April 26 and May 07 in the first, second and third years, respectively (Tables 1 and 2). There is a 7 days difference between 1 st and 2 nd, 5 days between 1 st and 3 rd, and 2 days between 2 nd and 3 rd years.

TEMPERATURE, RELATIVE HUMIDITY, PRECIPITATION AND WIND CONTROL-LING THE COURSE OF DISSEMINATION OF *JUGLANS* L. POLLEN

Beginning and ending of life activities of plants every year vary from species to species.

Each of these events, *i.e.* beginning and ending of flowering, maximum flowering, beginning and ending of dormancy, abssicion, maturation of fruits are determined separately in phenological studies.

Temperature so far is known the most important factor controlling both to initiate and the course of dissemination. The commencement of dissemination is determined by the sum of average daily temperatures from the beginning of the month of January of the region where the plant grows. Sum of average daily temperatures since the beginning of January in Ýstanbul in the aforementioned years are 667.2 °C, 508.2 °C, and 596.2 °C, respectively. The earliest commencement and the most abundant pollen dissemination was in the first year; the first years' sum of average daily temperatures is also the highest among the three years; denoting that

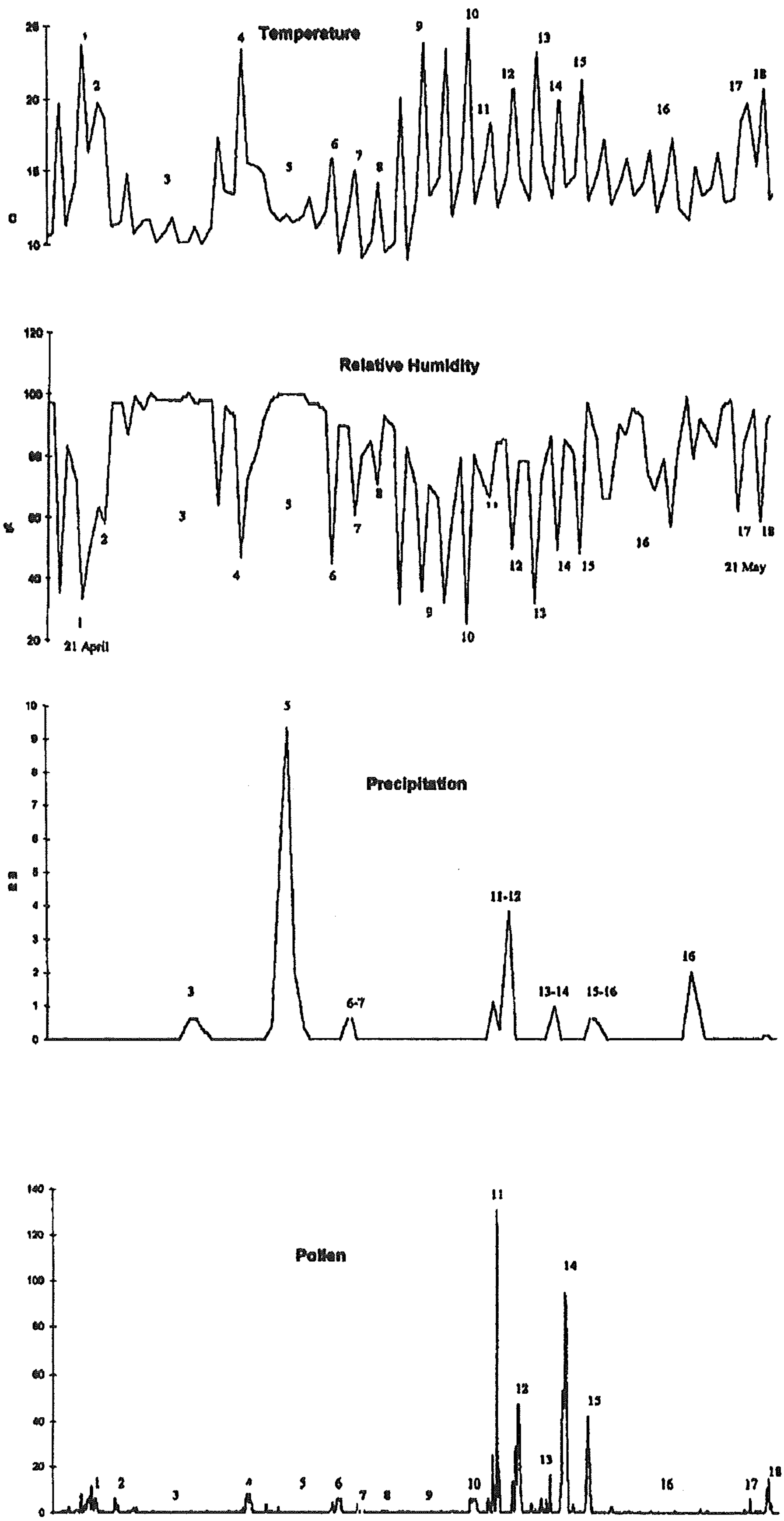

Figure 4.: *Temperature, Relative Humidity, Precipitation and Pollen Amount during Dissemination Period in the First Year*

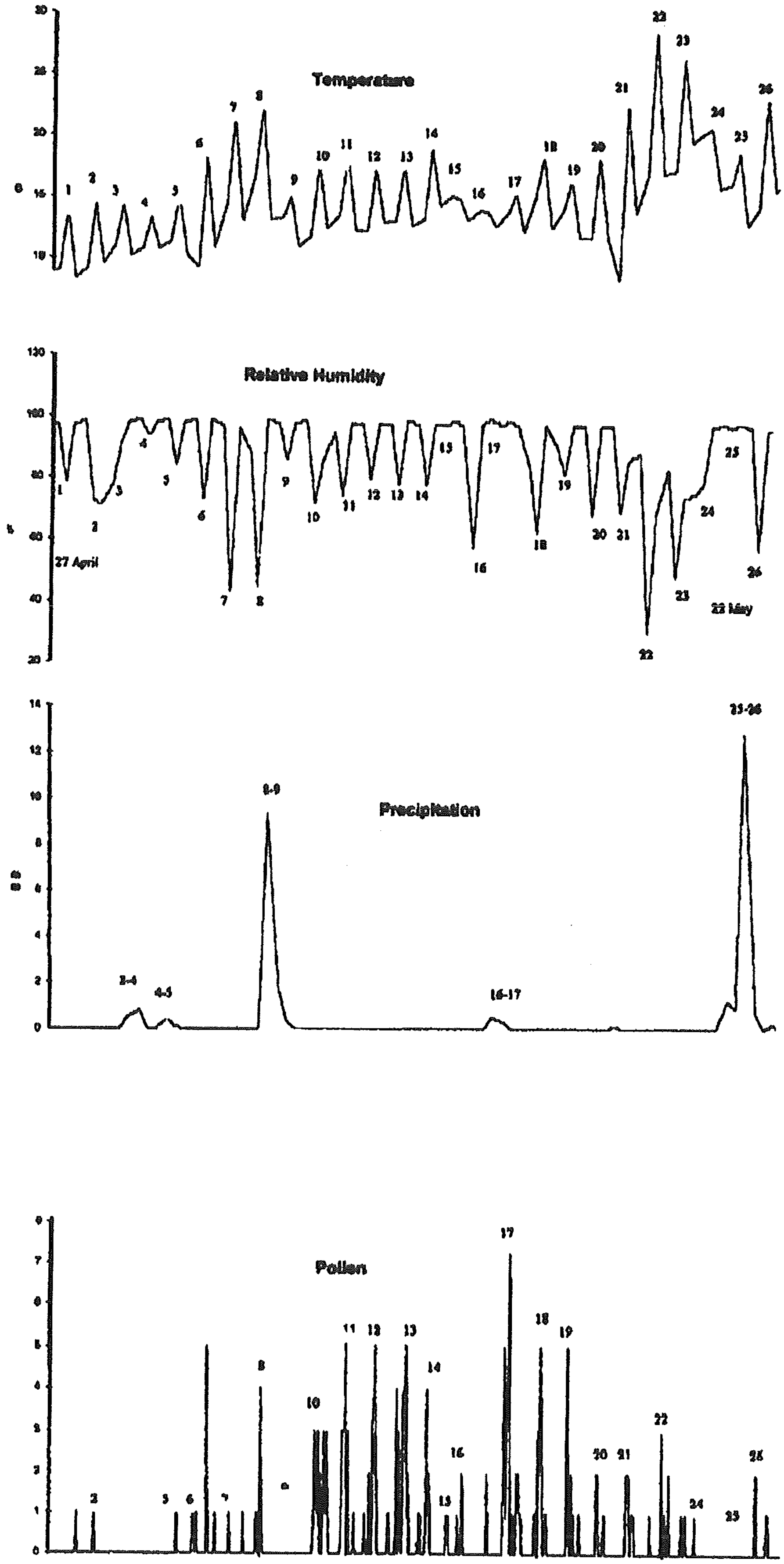

Figure 5.: *Temperature, Relative Humidity, Precipitation and Pollen Amount during Dissemination Period in the Second Year.*

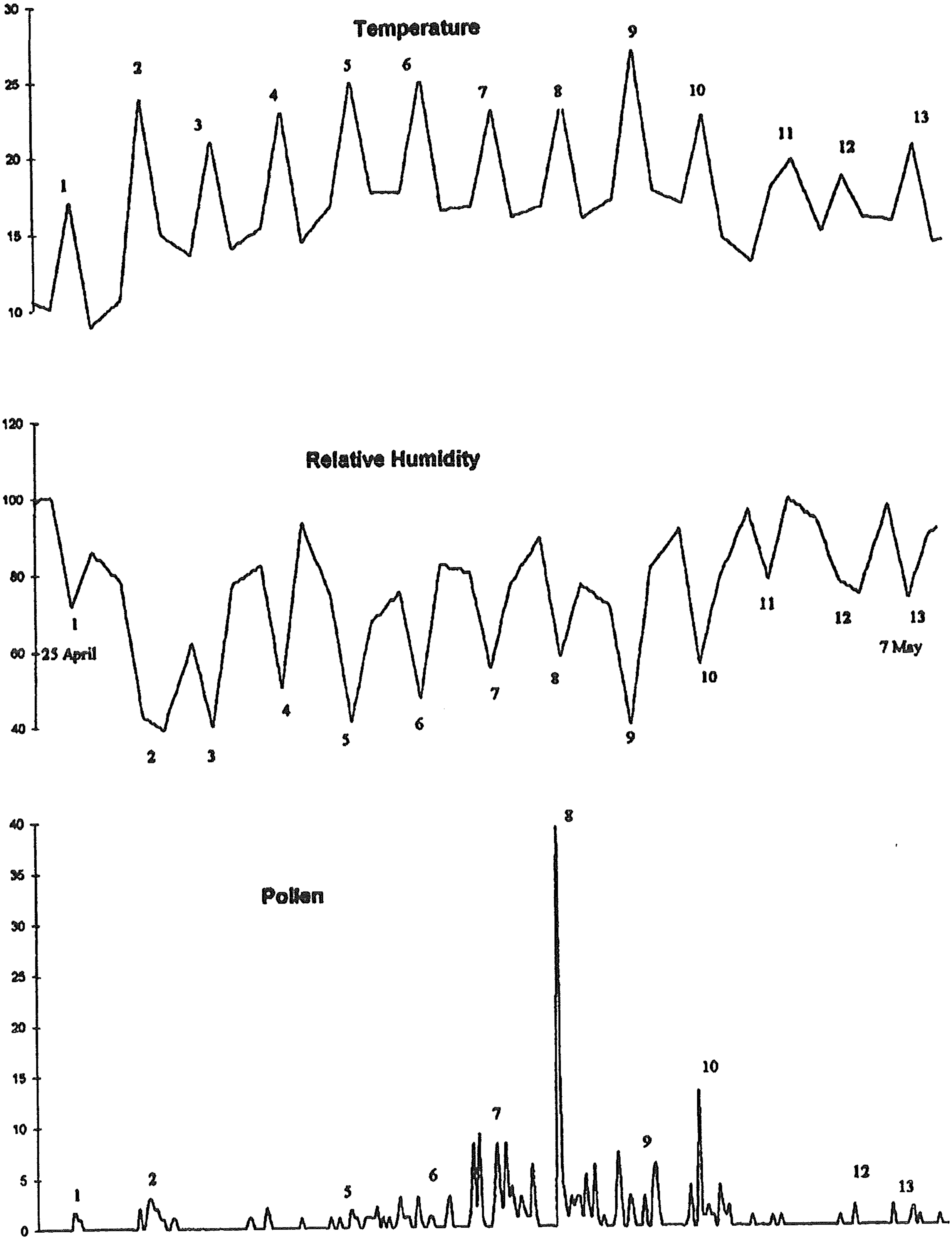

Figure 6.: *Temperature, Relative Humidity, Precipitation and Pollen Amount during Dissemination Period in the Third Year.*

initiation of pollen dissemination is positively related to sum of temperatures. The ending of dissemination are 21 st, 22 nd, and 08 th of May in the 1 st, 2 nd, and 3 rd years, respectively, and sum of temperatures until the end of these periods are 1276.4 °C, 1006.5 °C, and 958.6 °C. Temperature sum until the end of dissemination is also the highest in the first year. Temperature, relative humidity, precipitation (rain), wind velocity and direction and the pollen counts of the corresponding years are given in Figures 4, 5, and 6. The meteorological data are measured by Bahçeköy Meteorological Station at 07^{00}, 14^{00}, and 21^{00} o'clocks. Some numbers on the graphics in Figures 4, 5, and 6 are put to facilitate correlation.

Average temperatures during pollen dissemination periods are 14.3 °C, 14.5 °C, and 17.6 °C in the 1 st, 2 nd, and 3 rd years, respectively. Average temperature is highest in the 3rd year; 3rd year is also the year whose dissemination period is the shortest (12 days). The highest temperatures in the first year occurred 9 days between 5-13 th of May. Average temperature of this period is 15.8 °C; *i.e.* higher than the average temperature (14.3 °C) of the pollen dissemination period. Maximum dissemination, 73.4 % of the total pollen disseminated throughout that year, occurred in the last 5 days of the 9 days. The most abundant pollen was disseminated in 2-21 th of May in the second year. Average temperature during this period is 15.0 °C which is higher than the average temperature (14.5 °C) of the pollen dissemination period. Maximum dissemination occured in 5 days between 30 th of April and 4 th of May in the third year. Average temperature in these 5 days is 18.6 °C which is higher than the temperature (17.6 °C) of the pollen dissemination period. Based on these data, it can be stated that maximum dissemination occurs in the warmest days of the pollen dissemination period.

When relative humidity graphics in Figures 4, 5, and 6 are analysed in the periods aforementioned above, a negative correlation between temperature and relative humidity becomes evident; in the days when relative humidity increases, total pollen decreases.

When wind velocities are examined in Table 1 at 07^{00}, 14^{00} and 21^{00}, it can be seen that pollen dissemination is higher during the middle of the day when velocity of wind is stronger. Sum of wind velocities in the pollen dissemination period in three years are 148.5, 144.4 and 150.1 m/sec at 14^{00} while these values are 21, 81.9, and 95.2 m/sec at 07^{00} , and 64.8, 60.8, and 84.7 m/sec at 21^{00}. Wind facilitates opening of pollen sac; therefore a positive relationship exists between wind velocity and dissemination.

Precipitation (rain) sporadically occurred in the first and second years, and in the third year, only a 0.13 mm of drizzle was recorded in the 3 rd of May. It was recorded three times, in the first year, between 5-13 of May when dissemination was highest; 3.9 mm in 9-10 May, 3.2 mm in 11-12 May and 0.4 and 0.7 mm in 13 and 14 of May. These are represented by numbers 11-12, 13-14 and 15-16 on the precipitaion graphics in Figure 4. The maximum dissemination of the first year occured just after these moderate rains. Dissemination ceased completly after the heavy rain (9.3 mm) in the 4 th of May in the second year, maximum dissemination occurred after the slight rain (0.5-3 mm), and dissemination stopped for three days after the intensive rain (12.8 mm) in 22-23 rd of May. Hence, it can be stated that pollen dissemination increases after short durated and slight rains and decreases or even stops completely after vigorous precipitation. Washing out of pollen could be a reason for this ceasing or decreasing. If male flowers are not mature enough or if the number of pollen in the spore case is diminished, no matter how eligible the weather conditions, *i.e.* temperature, relative humidity, rain and wind, are dissemination is expected to be less. This fact is to be considered when pollen counts are compared to such weather parameters.

		1.Yr.								2.Yr.								3.Yr.						
		Temp.	R.Hum.	Prec.	Wind			Pollen	Abs. Hours	Temp.	R.Hum.	Prec.	Wind			Pollen	Abs. Hours	Temp.	R.Hum.	Prec.	Wind			Pollen
		C	%	mm	07	14	21			C	%	mm	07	14	21			C	%	mm	07	14	21	
April	9	11,7	74,2	0,03	0,6	2,3	0,6	3																
	10	14,1	66,5	0,05	C	3	1,4	1										6,5	83	1,41	2,8	2,5	3,3	1
	11	15,1	85,4	1,43	2,3	3,3	0,8	0										7,2	80,8	0	C	2,7	4,8	0
	12	13,6	85,2	4,1	C	3,6	1,1	0										7,8	93,6	0,09	3,2	3,6	C	0
	13	13,9	78,4	0,49	C	2,4	C	0										8,9	93,9	0,28	1,4	3,3	1,6	0
	14	15,1	69,3	0,06	C	4,4	2,7	3										10	88,1	2,04	1,3	2,3	2,9	0
	15	10,9	95,5	1,98	C	3	2,4	0		13,7	84	0	1,3	4,8	1,6	3		9,5	91,9	0	4,6	4,7	4,9	0
	16	14,7	77,9	0,31	1,5	4,8	0,6	13		12,4	92,7	0	3,4	2,2	0,9	0		9,8	93	0,36	3,9	6,6	3,9	0
	17	17,8	56,7	0	2,1	8,4	2,9	0		12,4	89,5	0,18	1,9	6	1	0		8,9	89,9	1,69	4,9	3	1,5	0
	18	16	61,1	0,62	1,2	3	2,3	5		12,9	84,3	0	C	3,6	C	0	10 Hr	9,1	91,9	0	1,3	2,4	3,1	0
	19	12,2	83,1	0	C	2,3	0,5	5		11,6	95,5	1,5	C	3	2,2	0		9,3	82,2	0	5,8	7,4	3,3	0
	20	13,5	74,5	0	C	0,3	C	5		5,1	89,1	3,36	2,3	3,1	0,7	0		9,8	90,8	0,07	3,5	3,4	2,8	0
	21	17,3	55	0	C	2,4	1,2	81		6,6	74	0,14				0	24 Hr	9,9	92,3	1,07	3,9	3,8	2,2	1
	22	16,4	70,2	0	1,7	2,5	0,9	19	8 Hr	9,2	84,3	0,57	1,4	9	1,4	8		9,9	91,5	0	2,1	3,1	1,8	0
	23	12,2	94,5	0	2,7	3,4	6	8		12,1	97,6	2,72	1,9	1,8	3,1	0		10,6	80,3	0,04	3	2,9	C	2
	24	11,1	97,6	0	1,4	2,4	2,7	1		9,7	84,7	0,55	2,5	4,4	0,9	0		11,7	82	0	C	3,3	2,4	5
	25	10,8	98	0,01	2,6	2,7	3,1	0		9,3	83,7	0	C	3,8	C	0		11,9	87	0	3	2,2	C	4
	26	10,4	98,3	0,45	0,9	3,3	1,1	3		9,8	94,8	0	2,7	3,5	3,1	0		15,3	57,7	0	C	1,7	1,3	17
	27	13,3	87,4	0,03	1,1	2,4	C	3		10,1	91,5	0	2,6	3,4	1,6	0		16	56	0	C	2,6	C	0
	28	16,9	74,2	0	C	2	0,3	49		10,7	82,6	0	2,3	2,4	2,3	2		17,2	75	0	1,2	2,6	C	6
	29	14,2	88,8	0,26	2,6	3,6	2,6	7		11,5	87	0,15	1,3	2,2	1,3	0		19,1	64,3	0	C	4,4	C	13
	30	11,7	99,8	5,52	0,9	1,5	C	0	24 Hr	11,4	96,8	0,31	1,2	3,4	1,1	0		19,4	68,1	0	1,6	2,3	C	19
May	1	12	98,2	0,27	1,1	2,7	1,5	0		11,9	94,2	0,16	C	1,8	1,3	1		18,2	72,2	0	1,2	2	2	63
	2	12,5	79,1	0,25	1,8	2,4	0,5	44		12,4	91,3	0	C	1,9	0,5	5		18,3	75,2	0	C	2,9	C	83
	3	13	78,7	0,39	1,1	2,9	2,1	22		15,7	80,9	0	3,4	2,8	C	3	10 Hr	19,3	65,6	0,13	0,7	3,9	C	34
	4	11	82,7	0	2	3,8	C	7		16,9	79,3	2,52	1,7	2,1	1,6	7		17,7	76,5	0,01	1,3	1,7	C	33
	5	12,7	71	0	0,3	1,2	0,9	3		13	94,6	1,46	C	2,3	C	0		16,2	89,8	0	2,2	3,3	2,2	3
	6	16	61,7	0	0,9	1,8	1,5	1		13,7	87,5	0,87	3	2,7	2,1	21		16,5	84,2	0	1,6	2,7	4,4	3
	7	16,3	54,7	0	C	2,7	1,4	5		14,3	88,9	0	C	3,8	1,5	19		16,5	85,8	0	2,3	3,9	3	7
	8	17	62,2	0	0,8	2,7	C	52		13,8	92,7	0,7	2,1	3	2,7	17		17,3	86	0	2,1	1,8	1,2	2
	9	15,3	73,1	0	C	3,8	1,7	230		14,2	92,4	0	1,3	2,2	2,4	26		18,6	80,3	0	C	2,5	C	0
	10	16,3	73,3	1,37	3,8	3,6	C	221		15	92,2	0	2,4	2,4	3,6	10		16	91,6	0	2,3	2,8	2,3	1
	11	16,8	64,1	0,03	2,6	3,6	0,6	56		14,4	97,3	0	1,3	2,2	0,8	3		15,8	94,5	0	3,4	3,7	1,6	2
	12	15,7	74,7	0,32	0,9	4,1	C	273		13,4	85,3	0,14	5,3	5,8	1,6	3		17,1	91,7	0	2,7	2,2	2,2	1
	13	16,1	77,1	0,19	1,4	3,5	0,6	135		13,7	98,1	0,14	1,1	4,2	2,1	30		16,3	92,5	0	3	2,2	3,8	1
	14	14,8	76,8	0,19	4,1	3,6	2,9	6		15	83,3	0	2,4	4,6	2,9	17		16,6	88,9	0	2,4	3,4	C	1
	15	14,3	89,4	0	3	3,6	1,7	1	9 Hr	13,9	91	0	5,1	4,2	2,3	10		17,4	89,9	0	4,5	2,4	2,6	3
	16	14,2	81,8	0	3,3	3,7	3,3	1		13,5	89,3	0	1,4	1,2	C	5		16,1	96,8	1,66	3,3	7,4	2,2	0
	17	14,4	73,5	0,05	5,1	4,5	3,6	1		14,3	88,8	0,03	1,7	1,8	C	9		17,3	88,9	0,1	C	2,1	2,2	0
	18	13,2	90,3	0,95	1,1	4,2	1,8	3		19,9	64,7	0	C	0,9	1,1	4		17	91,2	0,03	3	2,1	1,4	0
	19	14,2	90	0	2,1	1,8	C	0		20,3	69,9	0	0,7	3,9	3,1	5		16	94,8	0,59	2	6,2	1,2	0
	20	16,4	84,7	0	1,1	1,2	C	11	5 Hr	19	83,5	0,03	2,2	2,2	2,2	0		18,3	77,2	0,03				0
	21	16,7	83,5	0,03	1,2	1,8	C	46		15,8	98,6	4,09	1,6	4,3	C	0		20	70,1	0	C	2,7	C	0
	22	15,3	91,3	0	C	2,6	2,1	10		17,1	86,1	1,4	C	1,8	C	4		23,1	67,3	0	C	1,3	0,7	0
	23	15,5	92,5	0	1,5	3,3	1,2	0		17,6	89,9	0,03	2,6	4,1	0,9	8		21,5	77,4	0	1,3	2,4	1,7	1
	24	15,8	75,9	0	2,1	1,8	C	7		18,9	79,3	0,03	3,3	6,9	3,6	8		17,9	85,7	0	2,5	2,5	2	0
	25	17,8	71,4	0	0,3	1,5	0,8	31		15,1	80,6	0,22	4,3	4,7	1,7	0		18,9	87,8	0	3,6	2	3,1	0
	26	17,5	82,5	0,06	C	1,5	C	1		17,2	82,5	0,01	2,1	4,3	1,1	1		19,5	92,4	0	3	4,6	3,1	0
	27	19,4	65,1	0	C	1,8	0,6	7		14,2	81	0,23	4,5	1,7	0,6	6		18,8	89,8	0,16	4,4	7,5	3,3	2
	28	22	45	0	1,1	3	3	6		14,7	84,5	0	C	2,5	C	0								
	29									15,8	92,5	0,06	C	1,6	C	1								
	30																							
	31																							
Total		733,5			21	148,5	64,8			613,4			81,9	144,4	60,8			720,2			95,2	150,1	84,7	

Table 1.: *Airborn Juglans L. Pollen in Istanbul and Avg. Temperature, Relative Humidity, precipitation and Wind*

Temperature and relative humidity are correlated with pollen sum in the days when maximum dissemination occurred and the results are shown in the following graphics (Figure 7). For such comparisons, the days of maximum pollen dissemination, namely May 9, 10, 12, and 13 are chosen from the first year which is the the year comprising maximum pollen amount among the three years. Amount of pollen in these 4 days corresponds to 69 % of the pollen entrapped in that year (Table 3).

The relation between temperature and relative humidity, and the pollen sum is investigated by regression analysis. In the regression formula which is expressed by y = a + bx, y is the dependent variable, x is the independent variable, a is the intersection point and b denotes the regression coefficient. Regression equations and correlation coefficient values of each day

	1.Year	2.Year	3.Year
April	09	15	10
May	28	29	27
Total Pollen	1385	225	310
Total Days	50	45	48
Total Hours	1200	1080	1152
Absent Hours	46	44	0
Absent Hours %	3.8	4.0	0.0
* %5 Pollen Amount	69	11	15
** April	21	28	26
** May	21	22	07
Total Pollen	1247	203	280
Total Days	31	25	12
*** %5-95 Absent Hours	46	10	0
*** % 5-95 Absent Hour %	3.8	0.9	0.0

* Pollen number corresponding to 5 % of the total pollen count.
** Pollen dissemination period corresponding to *5-95* % ofthe total pollen number.
*** Absent hours and their percentages in pollen dissemination period corresponding to 5 - 95 % of total pollen number.

Table 2.: *Three years of dissemination periods of Juglans L. Pollen in Istanbul area*

	Temperature °C Avg.	Max.	Min.	Relative Humidity % Avg.	Max.	Min.	Precipitation mm Avg.	Max.	Pollen Amount
May 09	15.3	18.6	12.5	75.1	85.0	67.0	0.50	1.10	230
May 10	16.3	21.2	13.4	73.3	86.0	50.0	1.30	3.90	221
May 12	15.7	20.4	13.2	74.7	87.0	50.0	0.32	1.00	273
May 13	16.1	21.3	13.0	77.1	98.0	49.0	0.19	0.70	135

Tabl3.: Data of Some Selected Days In the First Year

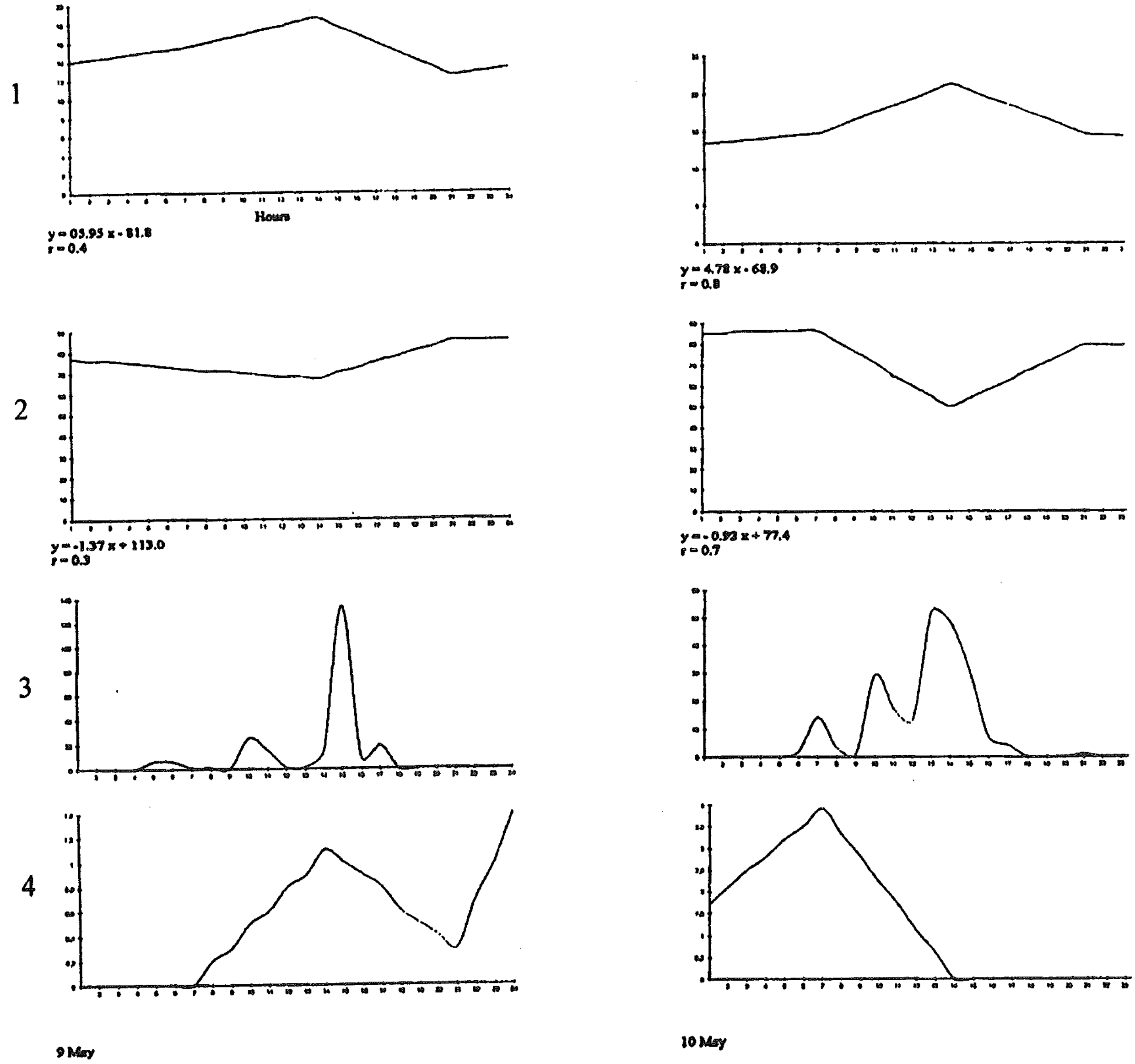

Figure 7.: *Temperature (1), Relative Humidity (2), Pollen Amount (3), and Precipitation (4) in Some selected days in the first year*

are given in the graphics in Figure 7. A positive relationship between the pollen sum and the temperature and a negative relationship between the pollen sum and relative humidity are evident on the graphics. Dissemination increases when temperature is increased, descreases when relative humidity is increased.

Graphics in Figure 7 also show how hourly distribution of pollen dissemination took part. Dissemination starts at 05^{00}-06^{00} in the mornings and ends at around 18^{00} in the evening. The maximum dissemination occurs at 14^{00} and 15^{00}. These hours are also the hours of highest temperatures of the day.

REFERENCES

AOAR, Ü.,(1968).Akçaabat civarý jeolojisi hakkýnda rapor. M.T.A. Raporu, Arþiv No: 4233, 7p.

AKGÜN, F., & AKYOL, E., (1987). Akhisar (Çýtak) çevresi kömürlerinin palinolojik incelemesi. *Türkiye Jeoloji Kurumu Bülteni*, 30, 35-50.

ARSLAN, R.,(1979). Kütahya-Tunçbilek sahasýndaki sondaj örneklerinin palinoloji incelemesi. *Türkiye Jeoloji Kurumu Bülteni,* 22, 1, 135-141.

AYTUO, B.(1967). Konya-Süberde dolaylarýnda Neolitik Çað florasýnýn incelenmesi. Ý.Ü. *Orman Fakültesi Dergisi,* A, XVII, 2, 1-13 .

AYTUO, B.,(1987). Le mobilier funeraire du roi Midas I. *Pact*, 22, VI.2, 357-368.

AYTUO, B., AYKUT, P., MEREV, N. & EDIS, G.,(1971). *Ýstanbul çevresi bitkilerinin polen atlasý.* Ýstanbul Üniversitesi Orman Fakültesi, Ý.Ü. Yayýn 1650, Orman Fak. Yayýn No: 174, 330 p.

AYTUO, B.,AYKUT, P.,MEREV & EDIZ, G.,(1974). *Belgrad Ormaný'nýn ve Ýstanbul Çevresi bitkilerinin polinizasyon olayýnýn tesbiti ve deðerlendirilmesi.* TBTAK Yayýn No:221, TOAG, 29, 700 p.

BAYTOP, T.,(1984). *Türkiyede bitkiler ile tedavi.* Ýstanbul Üniversitesi Yayýnlarý, No: 3255, Eczacýlýk Fakültesi, No:40, 520 p.

BOTTEMA, P., ENTJES-NIEBORG, G, & VAN ZEIST, W.,(1990). Man's role in the shaping of the Eastern Mediterranean landscape. In: Proceedings of the INQUA/BAI symposium on the impact of ancient man on the landscape of the eastern Mediterranean region and the near east. Groningen, Netherlandp. 6-9 March 1989.A.A.Balkema/Rotterdam/Brookfield, pp. 231-265.

BOTTEMA, P., WOLDRING, H. & AYTUO, B., (1995). Late Quaternary vegetation history - of northern Turkey. Palaeohistoria. *Acta et Communicationes Instituti Bio-Archeologi Universitatis Groninganae.* 35/36, 13-72.

ÇELEBIOOLU, G.,(1985). Ceviz Yetiþtiriciliði. Bursa Teknik Ziraat Müdürlüðü Yayýnlarý. Yayýn No.1, 64 p.

DAVIS, P.H.,(1982). *Flora of Turkey and east Aegean Island.* Edinburgh University Press, Vol.7, 947 p.

EMBERGER, L. & CHADEFAUD, M.,(1960). *Traité de botanique systématique.* Tome II. Les vegetaux vasculairep. Fascicule I. 753 p.

ERDTMAN, G.R. & WODEHOUSE, P.,(1954). *An introduction to pollen analysis.* Waltham, Masp., U.P.A., Chronica Botanica Company. Stockholm:Almqvist & Wiksell., 239 p.

EROL, O.(1992). Çanakkale yöresinin jeomorfolojik ve neotektonik evrimi. *Türkiye Petrol Jeologlarý Derneði Bülteni*, 4/1, 147-165.

INCEOOLU, Ö. & PEHLIVAN, P.,(1987). Ýç Anadolu bölgesindeki Tuz Gölü Kuvaterner tabakalarýnda palinolojik bir araþtýrma. *Doða Tu Botanik Dergisi*, 11, 1, 56-86.

KÖSEOOLU, A.,(1978). Doðu Karadeniz Bölgesi hammadde yataklar ile ilgili derleme. M.T.A. Raporu, Arþiv No:6320, 48 p.

Meteoroloji Bülteni.,(1974). T.C. *Gýda Tarým ve Hayvancýlýk Bakanlýðý, Meteoroloji Ýþleri Genel Müdürlüðü*, T.B.No:448, Ankara, 676 p.

M.T.A., (1974). Report on geological survey of Trabzon Area, norteastern Turkey. Phase 1. Metal Mining Agency of Japan, Japan International Cooperation Agency, Government of Japan, 88 p.

POKROVSKAIA, (1950). Analyse Pollinique (ed: E.Boltenhagen). Annales du service d'information geologique du B.R.G.G.M., CNRS.

ÞEN, P.M.,(1986). *Ceviz Yetiþtiriciliði.* Eser Matbaasý, Samsun. 229 p.

THOMSAN, P.W. & PFLUG, H.D.,(1953). Pollen und Sporen des Mitteleuropaischen Tertiar. *Palaeontographica*, B 94, 119-130.

TRAVERSE, A.,(1974). Palynological investigation of two Black Sea corep. In: *The Black Sea-Geology, Chemistry, and Biology.* Memoir No:20, The American Association of Petroleum Geologists, pp.381-388

TRAVERSE, A.,(1978). 44. Palynological analysis of DSDP Leg 42B (1975) cores from the Black Sea. Initial Reports of the Deep Sea Drilling Project, Vol.XLII Part 2, Washington, Ross D.A., Neprochnov,Y.P., et al., 993-1015 p.

YALTÝRÝK, F.(1988). *Dendroloji Ders Kitabý II. Angiospermae (Kapalý Tohumlular) Bölüm I. Amentiferae, II.Floriferae:Apetalae*). Ýstanbul Üniversitesi, Orman Fakültesi Yayýnlarý, Ý.Ü.Yayýn No: 3509, O.F: Yayýn No: 390, 256 p.

ZEIST, VAN W. & BOTTEMA, P., (1991). *Late Quaternary vegetation of the Near East.* Beihefte zum Tübinger Atlas Des Vorderen Orients, Reihe A (Naturwissenschaften) Nr.18, Dr.Ludwig Reichert Verlag, Wiesbaden, 156 p.