A LATE-TERTIARY CONIFER-HARDWOOD FOREST FROM THE VICINITY OF GÜVEM VILLAGE. NEAR KIZILCAHAMAM, ANKARA*

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INTRODUCTION AND SUMMARY

It was in 1939 when I first visited Kızılcahamam to see the present conifer-hardwood forest as well as the famous hot springs with my friend Karamanoğlu, a fellow student from the Forestry College. I remember the long bus ride on the dusty old road from Ankara through Kurtboğazı and the dangerous curves of Kargasekmez. That time, Kamil's father Remzi Bey, assessor of the city, kindly invited me to stay in his three-story wooden house built in good taste according to early Ottoman architectural style for the country homes of Ankara. We took daily walks to explore the Scots pine forests associated with firs, aspens and oaks through the valleys as well as to the hot springs and mountain steppes over the gentle hills. In 1968, more than thirty years later, I visited Kızılcahamam again upon a picnic invitation by my old colleagues Mr. H. Aksoy, Prof. K. Karamanoğlu, Prof. N. Sönmez and Prof. O. Düzgüneş, and their families. After driving 14 miles north of Kızılcahamam, down the Çerkeş road, we passed Güvem and reached Beşkonak where we selected a neat meadow by the creek as our picnic site. The western slopes of the Kızılcahamam-Çerkeş road were still devoid of vegetation after the road banks were cut off by bulldozers and both horizontal and vertical layers of lacustrine sediments were exposed freely. A moderate amount of rain had fallen during the previous night. With Karamanoğlu, I walked along the road slopes, examining the fossil fragments by rolling rocks under our feet. The uppermost layer of the laminated diatomaceous earth was oriented vertically and the sheets of these spongy rocks were naturally split into book-size platelets. Due to the absorption of rainwater we could pull out any piece with great ease, just like pulling out books from a library shelf. Every piece of diatomaceous platelet was bearing a beautiful fossil impression.

These fossil deposits are located in a transition zone from montane steppe into a mixed coniferous and deciduous-broad-leaved forest in the northern sector of the Central Anatolian plateau, between 1000-1500 m above sea level. Several fossil sites are scattered in an area 15 km long (north-south) and 7 km wide (east-west). Approximately 5-6 million years ago, this area was occupied by a fresh-water lake and by a lush redwood/oak forest particularly rich in Arcto-Tertiary taxa.

During two brief summer visits to the area, I collected 400 specimens of plant macrofossils (cones, fruits, seeds, leaves and branches) and ca. 50 specimens of animal fossils (skeletal impressions of fishes, frogs and insects at larval and adult stages). During the past few years, I have been studying the plant macrofossils as well as the microfossils such as pollen grains and diatoms preserved in the lacustrine diatomite and paper shales of this area. The results of my preliminary identifications were reported at the floristics section of the XIIth International Botanical Congress (Kasaplıgil, 1975). My collections are confined mainly to the Beşkonak and

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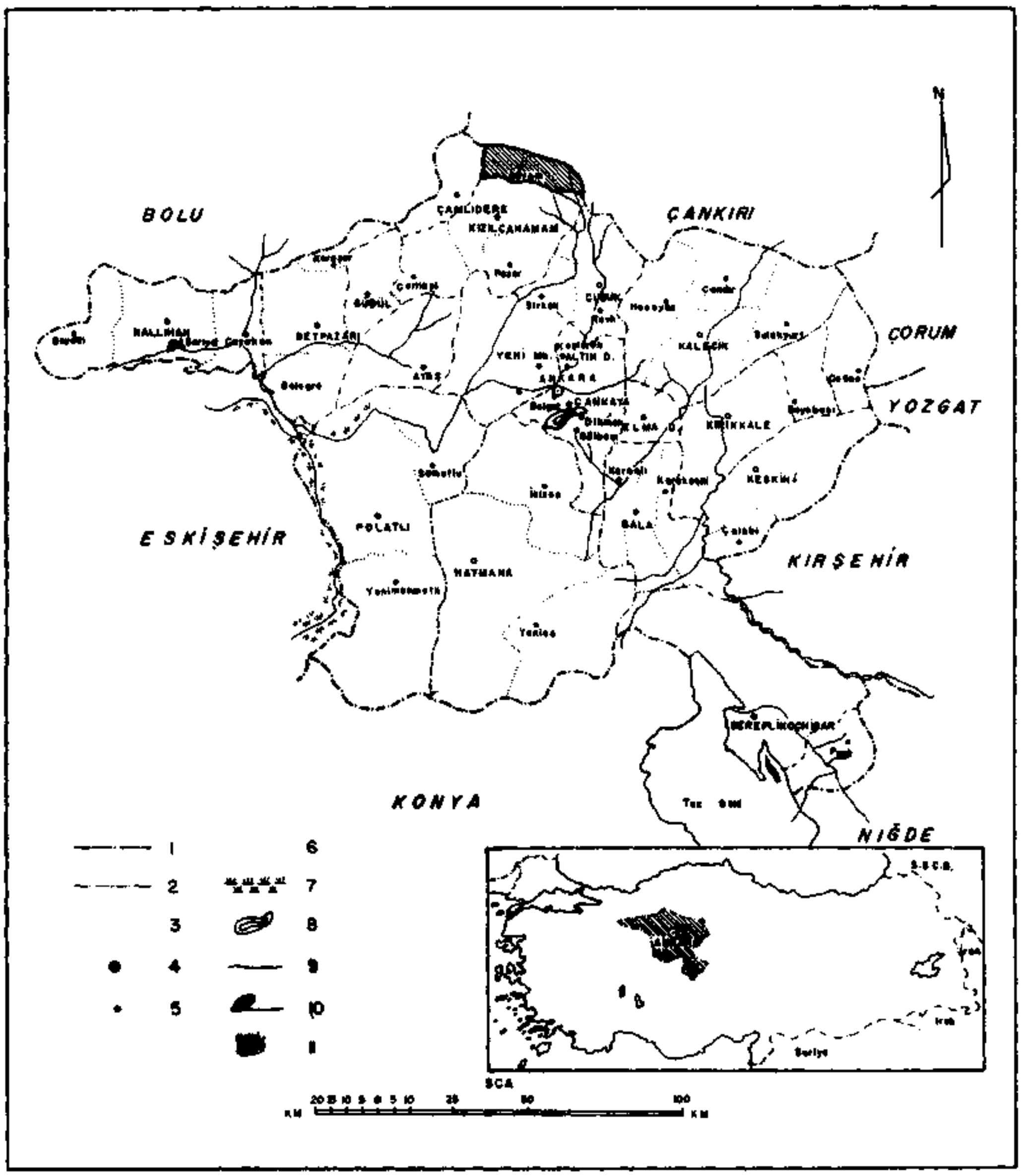

Fig I - Güvem locality (PA-312) is situated 80 km north of Ankara (approximately 90 km by road) and 125 km south of the Black-Sea coast. (Map courtesy of Professor Necmi Sönmez, Agricultural College of the University of Ankara.)

I - Provincial boundary; 2 - District boundary; 3 - Subdistrict boundary; 4 - Prov. capital; 5 - District center; 6 - Subdistrict center; 7 - Swamps; 8 - Hills; 9 - Rivers; 10 - Lakes; 11 - Fortress.

Kadıoğlu sites of Güvem; there are at least six or seven other fossil sites, all exposed by erosion. Further excavations are needed in the unexplored sites to be sure that an adequate sample of this ancient forest biome has been recovered.

A critical survey of the geologic occurrence of the Güvem flora would be most helpful since it would provide us with evidence toward understanding (l) the emergence of present-day forest communities in Asia Minor, (2) the relationship between the Pliocene floras of Romania and Bulgaria in the west and the Pliocene flora of the Caucasus in the east, (3) the evolution of the Colchis flora and its component elements extending from Transcaucasia through the Black-Sea coast of Asia Minor to the eastern Balkan Peninsula, and (4) the factors responsible for the emergence of steppes in Central Anatolia.

Before assuming my teaching position at Mills College, and prior to my F.A.O. assignment in Amman, Jordan, I taught at the University of Ankara for many years, during which time I also studied the forest floras of Asia Minor and published the results (Kasaplıgil 1947, 1952, l960, 1961). My present investigation reported in this paper would provide me with an insight toward a better understanding of the vegetation history of the area and the causes of climatic and geologic changes that have influenced the present life forms.

HISTORICAL BACKGROUND

During the summer of 1964, I had the opportunity to visit the Caucasian region of Asia Minor to study the evolution and distribution of the genus Cory/us. In the Hatila Valley near the Russian border, I came across a remarkably little disturbed relict Tertiary forest. I collected specimens of surviving Tertiary elements such as *Picea orientalis, Abies nordmanniana,* Toxus *baccata* among gymnosperms and *Fagus orientalis, Zelkova carpinifolia, Carpinus orientalis, C. betulus, Ostrya carpinifolia, Alnus glutinosa, Fraxinus oxycarpa, Juglans regia, Pterocarya pterocarpa, Ulmus montana, Acer campestre, A. cappadocicum, Diospyros lotus, Tilia caucasica, Quercus petraea* subspec. *İberica* among angiosperms. Four years later, when I visited Güvem for a picnic with my old colleagues from the University of Ankara, our car was stopped by village children selling beautiful preserved leaf and cone impressions collected from the vicinity. My curiosity aroused, I inspected the collecting sites with Karamanoğlu. One site was situated along the banks of a new road, exposed by bulldozers during construction; the other site was in a gulley near Kadıoğlu where strata of diatomaceous earth rich with fossil imprints were exposed due to erosion. That afternoon I collected 125 specimens, mainly belonging to *Glyptostrobus, Sequoia, Zelkova, Fagus, Carpinus, Ulmus, Quercus, Tilia* and *Acer.* The broad-leaved elements of this ancient forest were remarkably similar to those found living in Hatila Valley today. However, *Sequoia* and *Glyptostrobus* are not represented at Hatila today, having disappeared there a long time ago.

I showed my collections to the late Professor Ralph Chaney who greatly encouraged me to study the Güvem flora. Dr. Wayne Fry of the University of California, Berkeley, made a subsequent collecting trip to the same locality in 1969 and now has a small collection of fine specimens. Dr. Fry was kind enough to lend me his collections from Güvem. Professor Axelrod of U.C., Davis, was the most encouraging person, allowing me to use his laboratories and personal library for the identification of my specimens, as well as sharing with me his broad experience in the field of Paleobotany. During subsequent years, I received additional specimens from Turkish colleagues by mail and the collections ghew steadily. Last summer, after attending the Botanical Congress in Leningrad, I revisited, Güvem locality. Additional new materials have been collected whose occurrence in Asia Minor has not previously been reported. Through my personal contacts, I also discovered fossil collections made recently from Güvem by the following institutions:

1. The Natural History Museum of the Miaeral Research and Exploration Institute in Ankara (M.T.A.). A fairly extensive collection of excellent specimens which are unidentified but numbered and registered.

2. Institute of Forestry Research, Ankara. A small collection of unidentified specimens of fossil trees.

3. National Park in Soğuksu, Kızılcahamam. A small public display of petrified wood and fossil imprints of leaves. None of the specimens are identified.

4. Herbarium of the Faculty of Forestry, İstanbul. Several hundred specimens, not identified, cleaned or trimmed.

5. College of Pharmacology, University of Ankara. Largest collection of plant fossils from Güvem with 800 unidentified specimens, stored under poor conditions.

The heads of these departments are willing to allow me to identify their collections at their own museums. It would take me at least five or six weeks to catalogue these collections, which provide me with additional paratypes to understand the extent of variation in any fossil taxon.

A SYNOPTIC SURVEY OF THE PLIOCENE FLORA OF GÜVEM

This preliminary description deals with a few examples of a rich Arcto-Tertiary flora preserved in lacustrine sedimentations in the vicinity of Güvem and Beşkonak villages approximately 90 kilometers north of Ankara along the road between Kızılcahamam and Çerkeş (Fig. l). The macrofossils represent the remains of a conifer-oak forest of a humid temperate climate around a Pliocene fresh-water lake. Fossil imprints of plant and animal remains are preserved mainly in laminated diatomaceous earth and paper shales. The vertical orientation of the sediments along the main road indicates subsequent faulting. Volcanic activity is evidenced by numerous hot springs and enormous basaltic eruptions (Fig. 7) in the immediate vicinity of the locality. Flint-like, colorful cherts, apparently formed by metamorphism of diatomaceous sediments under molten lava, contain partly carbonized but well-preserved foliage of broad-leaved trees and twigs of conifers.

The plant macrofossils include branches, leaves, cones, cupules, flowers, fruits and seeds. The animal fossils consist of fish and frog skeletons, Nematoceran flies, mosquito larvae, aquatic and terrestrial beetles, dragonflies and various other insects. The microfossils forming the bulk of the sediments are diatoms, pollen grains, spores of the lower vascular plants and protozoa. Extensive diatomaceous beds are covered by younger alluvial deposits in the flatland, but they are exposed through erosion on the gentle slopes of the hillside located east of Güvem village (Fig. 2-6).

The most abundant gymnosperm in the flora is *Glyptostrobus* europoeus (Fig. 8, 9), represented by 25 specimens of juvenile and adult branches with characteristic foliage and bearing microsporangiate and megasporangiate strobili. Trimorphic leaves and the crenate scales of the ovulate cones leave no doubt about the correct identity of this species of redwoods. In every respect, it is almost identical with the extant species of *G. lineatus* (Fig. 10) native to eastern

China. Other dominant species of gymnosperms are *Sequoia langsdorfii* (Fig. II) (represented by sterile branches identical with those of *Sequoia sempervirens* native to the coastal regions of California and Oregon), *Pinus pinaster fossilis* (a two-needle pine represented by a cone), *Pinus canariensis fossilis* (Fig. 12, 13) (a three-needle pine represented by a large, closed cone), *Pinus massoniana fossilis* (a diploxylon pine represented by several cones, branches and cluster of five needles), *Pinus morrisonicola fossilis* (Fig. 15) (a haploxylon pine represented by several cones, branches and cluster of five needles), *Picea* sp. (represented by a leafy branch with sharply pointed needles, hence not related to *Picea orientalis), Tsuga* cf. sect. Hesperopeuce (represented by sterile branches with needles all around the stems), *Ephedra* aff. *major* (Fig. 14) (represented by macrofossils and pollen grains). The ovulate cones of the pines have been studied through the replicas prepared with sodium alginate and silica gel.

The oaks are the dominant angiosperms, represented by 43 specimens. Apparently, the Tertiary oaks had as much hybridization as the extant species today. The common occurrence of intermediate leaf forms among various oak species creates an enormous task for correct identification. Since the cupules are detached in all fossil specimens, my only reliable tool for attempting a correct diagnosis was the comparison of gross morphological features of the leaves together with the patterns of major and minor venations. For this purpose, the foliage leaves of possibly related extant species *of Quercus* have been cleared with sodium hydroxide and chloral hydrate solutions, stained with safranin and mounted in microslides. Although this method proved to be a valuable tool, the epidermal replicas I prepared from the fossil leaf surfaces did not reveal any satisfactory anatomical detail useful in verifying identifications. The following provisional list enumerates the oak species of this flora: Quercus *sderophyllina* (Fig.32), *Q. drymeja* (Fig. 30), Q. *heidingeri, Q. kubinyi* (Fig. 16, 34, 35), Q. aff. *lonchitis,* Q. aff. *polycarpa* (also with strong affinity to Q. *petraea), Q.* cf. *semecarpifolia* (native to the Himalayan region), *Q. seyfriedii* (Fig. 31) (with strong affinity to Q. *phellos* which is native to the eastern U.S.A.), Q. *sosnovskyi* f. *angustifolia* (Fig. 29), Q. *stranjensis* (with strong affinity to Q. *hartwissiana),* Q. aff. *trojana.* Other fagaceous genera include *Fagus, Castanea, Castanopsis, Lithocarpus* and *Pasania.* Presently, *Fagus orientalis* and *Castanea sativa* are among the major trees of the broad-leaved forests along the Black-Sea coast of Asia Minor and eastern Thrace, while *Castanopsis, Lithocarpus* and *Pasania* are extinct in the area.

Zelkova ungeri (Figures 20-23) is represented by 22 specimens many of which are excellent fertile branches with complete foliage and berries attached to them. It is very similar to the extant species *Z. carpinifolia,* distributed from northeastern Turkey to the Caspian coast of Iran, and to *Z. serrata* of China", Korea, japan and possibly Formosa, and finally to *Z. cretica* from the mediterranean island of Crete. Most likely, all of these taxa are reducible to a single species.

Other broad-leaved trees of this Tertiary forest are *Acer angustilobum* (Fig. 26), *A. trilobatum* (Fig. 25), *Alnus, Astronium* (represented by a flower), *Betula* aff. *luminifera* (Fig. 40), *Carpinus miocenica* (Fig. 39), *Cercidiphyllum trenatum* (Fig. 27), *Cercis* (Fig. 17), *Comptonia, Diospyros* aff. *miokaki, Ilex gracilis* (Fig. 18) (related to /. *serrata* var. *sieboldii* from Japan), *Magnolia sprengeri* (Fig. 28), *Menispermum, Myrica banksiaefolia* (Fig. 24), *Persea indica fossilis* (Fig. 19), Plotonus, *Populus tremula fossilis* (Fig. 41), *Platycarpa miocenica, Pterocarya pterocarpa fossilis, Salix, Smilax aspera fossilis* (Fig. 16), *Sorbus* aff. *aucuparia, Sophora* aff. *miojaponica, Tilia* aff. *platyphyllos, Ulmus* sp.-Presently, the following fossil species are represented by a single, sterile specimen: *Cryptogramma* aff. *crispa, Salvinia, Berberis* aff. *chinensis, Ficus, Liquidambar europaeum, Ailanthus* aff. *altissima* and the aquatic plants such as *Potamogeton, Naias, Typha, Egeria* aff. *densa* and several other unidentified hydrophytes.

The pollen grains have been extracted from all three major substrata through a standard technique using a sequence of treatments with 10 % HCl, 10 % KOH, HF, 10 % HNO_3 and thorough washing between each step. Following a dehydration with tertiary butyl alcohol, stained or unstained materials were mounted in silicone oil. Among gymnosperms, the pollen grains of both haploxylon and diploxylon pines are predominant while taxodiaceous pollen grains are quite scarce. Other gymnosperms represented in the pollen flora are Cedrus, Piceo and Ephedra. The last one is a small xerophytic shrub which occurs commonly in the present steppic vegetation of Central Anatolia. Its association is very puzzling. First I thought that Ephedra pollen grains might have been transported into the fossil beds from a distant area of xeric vegetation. But the discovery of the megafossils verified the pollen record. Additional specimens are required to determine the distribution frequency and ecological relations of this Ephedro. The tentative list of angiosperm pollen grains include the, following genera: Alnus, Betula, Ilex, Menispermum, Nysso, Pterocoryo, Quercus (abundant), Salix, Tilla, Typha, *Ulmus* (?), Zelkova. The last named two genera are hardly distinguishable from each other on basis of their pollen grains.

The diatomaceous earth consists mainly of pennate forms as exemplified by Epithemia sorex, Fragilaria leptostauron, Hontzcio amphioxys, Opephoro, several species of Navicula, Cymbello, and a few centric forms such as Cyclotello and Melosiro spp. These microfossils have been studied through a light microscope as well as through a series of scanning electron micrographs. These findings are based on the examination of a few fragmentary specimens. Hence the survey of the microflora is very incomplete.

The composition of Güvem flora shows a remarkable affinity to the late Tertiary of the Taurus region (Engelhardt, 1903), Sofia (Stojanoff, 1929), Valea Neagra in Romania (Givulescu, 1962), and the Kodor River flora, east of Batumi (Kolakovski, 1964) on the one hand, and to the Far Eastern Tertiary floras on the other (Hu & Chaney, 1940; Miki, 1941; Tanai, 1961; Tanai & Suzuki, 1963; Tralau, 1963). The recognition of Astronium (Fig. 24) in Güvem flora presents a problem. This anacardiaceous genus presently occurs in South America mainly, but it was also reported from the Tertiary flora of Florissant beds in Colorado (MacGinitie, 1955). Considering the concurrent distribution of several other anacardiaceous genera such as Cotinus, Pistocia and Rhus in the Old and New Worlds today, it is reasonable to assume that Astronium had a more extensive distribution in the Tertiary period (cf. Li, 1971; Raven & Axelrod, 1974).

Presently, Güvem is situated in the transition from montane forests to the true steppes of Central Anatolia, which are characterized by small xeric trees and shrubs scattered in a semiarid land where most species of the epoch are extinct. The closest relict areas where many Pliocene taxa survive today are along the river valleys of the Colchis region extending from western Transcaucasia (cf. Tumajanov, 1971) to Trabzon and Ayancık on the Black-Sea coast of Asia Minor (cf. Handel-Mazzetti, 1909; Krause 1932; Kasaplıgil, 1947).

CONCLUDING REMARKS

I. The age of the Güvem Flora is estimated as Pliocene (possibly 5-6 million years old) when compared and correlated with the floras of Sofia (in Bulgaria), (Stojanoff & Stefanoff, 1929), Valea Neagra (in Romania) (Givulescu, 1962), and Kodor River (near Sukhumi in Georgia) (Kolakovski, 1964).

2. Accurate age determination is needed by using potassium-argon dating through the volcanic rocks such as andesite, rhyolite and quartz latite which are common at the Güvem locality, and I have samples of them. A team work with a cooperating geologist who is familiar with the geologic occurrence of the area is highly desirable.

3. Although some taxa are extinct, many broad-leaved woody members of the flora are strikingly similar to the extant species of the Colchis flora. That is why in many instances, the specific epithets of several recent taxa are followed by the term «fossilis» to designate the Pliocene taxa in this preliminary report before the final nomenclature of any particular fossil taxon is decided. The dicotyledonous fossil species manifest remarkable affinities to those in Miocene floras of the United States, Central Europe and the Far East.

4. Apparently, the mutation rate and the pace of evolution have been rather a slow process in the Colchis flora, while the evolutionary changes took place at a higher rate in the mediterranean flora where the increasing aridity played an important selective role (cf. Axelrod, 1972).

5. The disjunct distribution of several taxa deserve investigation in the light of plate tectonics and continental drift. Recently, many publications appeared about the age-old Wegenerian hypothesis. As evidenced by the ophiolite belts, the Alpine-Himalayan mountain system extending through Asia Minor took place by the collision of the continents during the Mesozoic era and continued to rise through the Tertiary period. No doubt, altitudinal changes, geographic barriers and the climatic diversities had great selective pressures upon the life forms. Nevertheless, some of the widely distributed arcto-tertiary elements progressively advanced throughout the Tertiary period in the humid temperate zones of the northern hemisphere and survived relatively unchanged in the disjunct Tertiary relict areas such as in China, Caucasus and Mexico.

6. The locality of this Pliocene flora needs immediate protection as a natural monument before the best fossil remains face the danger of depletion. The Natural History Museum in Ankara has an excellent nucleus of fossil collections from Güvem and can function as the primary depository for all collections in various institutions including the collections made by this author.

7. Likewise, a living Tertiary relict forest in Hatila Valley in Artvin (northeastern Asia Minor) should be preserved as a national park. Forest utilization in this valley started in 1964 upon completion of a new road through this virgin forest. It would be most instructive to the present investigator to revisit the Hatila Valley near Artvin to observe and record the effects of forest utilization and human pressure upon this Tertiary refuge.

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F I G U R E S

Fig 2 - Güvem, Beşkonak village, Çambaşı graveyard with an old, undisturbed specimen of black pine (Pinus nigro var. *pallasiana)* within the fence. Lacustrine sediments consisting of diatomaceous earth and volcanic ash were exposed during road construction (foreground).'Nearly white or beige-colored sediments at this site are excavated for commercial uses such as inertfillers for aspirin, chalk manufacture, toothpaste, oil filters, insulation, etc.

Fig. 3 - Güvem, Kadıoğlu village with Isıkdağ (2015 m) in the background to the right. Note the absence of vegetable gardens and orchards around the houses where the soil consists of exposed lacustrine deposits.

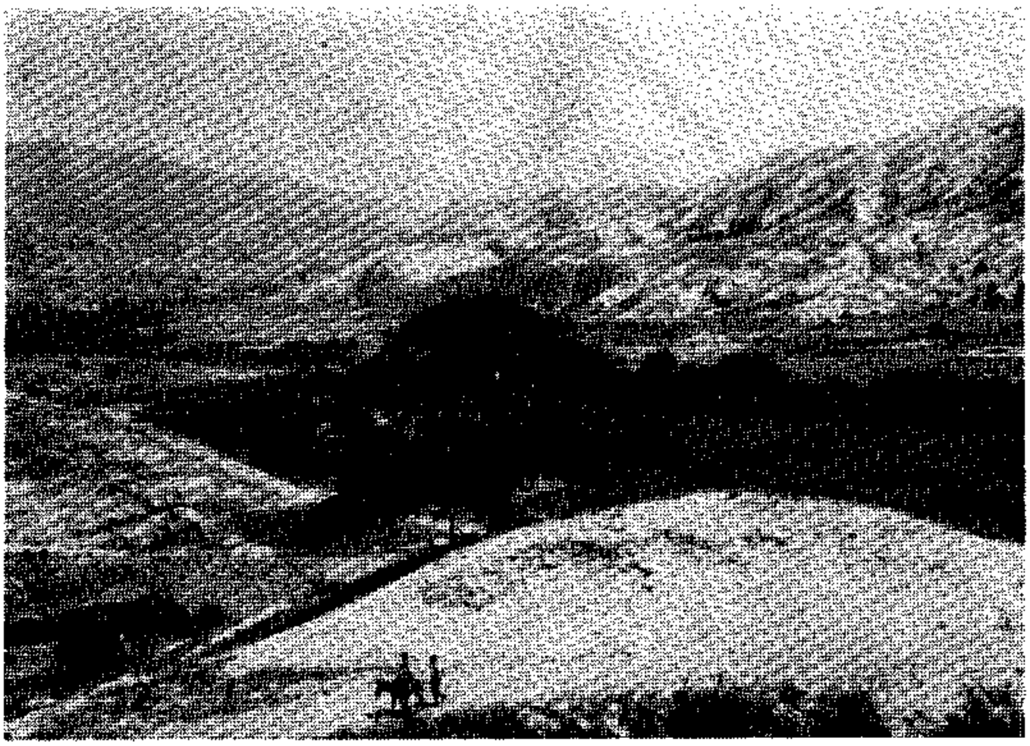


Fig. 4 - Güvem, Beşkonak gorge as seen from the «Sabun Kayası» looking towards the north. The gallery forest of willows and poplars meandering along the Beşkonak stream in the middle, eroded slopes exposing the lava in the foreground and the lacustrine deposits ir. the background. Most probably, this gorge represents the southern end of the ancient fresh-water lake of the Pliocene epoch.

Fig. 5 - General view of the Tertiary lake basin in Güvem. The gallery forest of willows, Lombardy poplars and Russian olives along the creek intersecting the cultivated land established upon the alluvial deposits of recent origin. Kızılcahamam - Çerkeş road seen at the extreme right was the first site of my fossil collections in 1968.

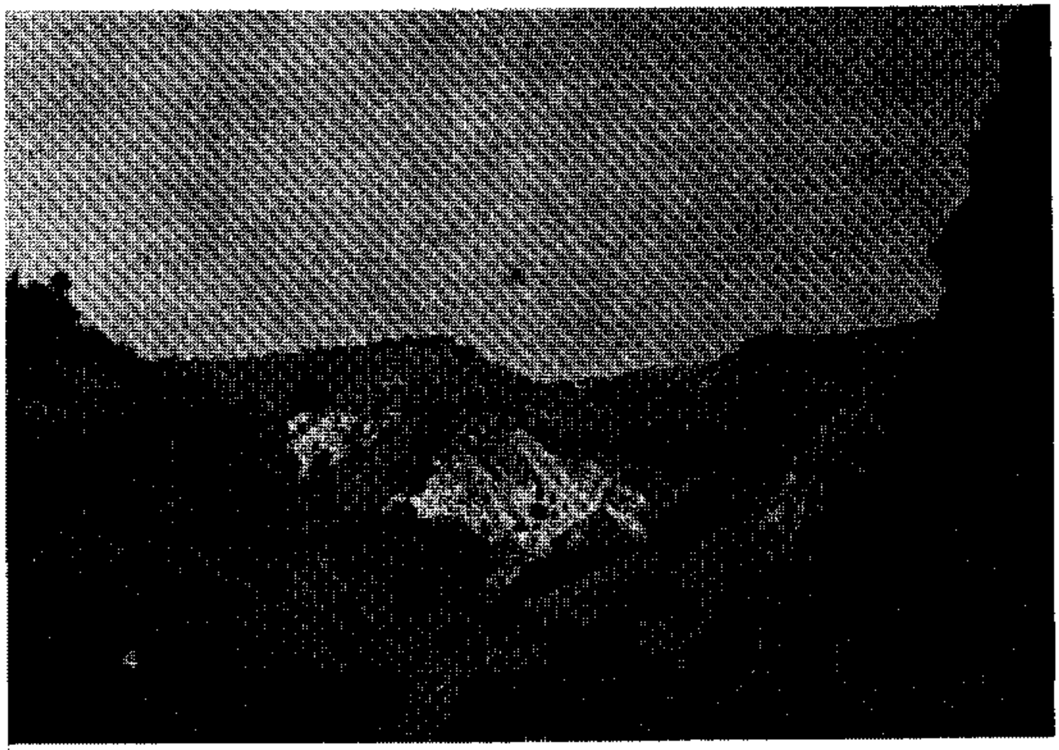


Fig. 6 - Exposed lacustrine sediments of the Tertiary lake bottom about 2 km south of Kadıoğlu village. The lacustrine sediments bear a sparse vegetation of herbaceous perennials rather than trees and shrubs. The powdery soil surface is exposed extensively due to erosion. Note the deep secondatsy gullies to the right, running perpendicularly to the primary gully forming a sh3rp zigzag between the two major slopes in the middle.

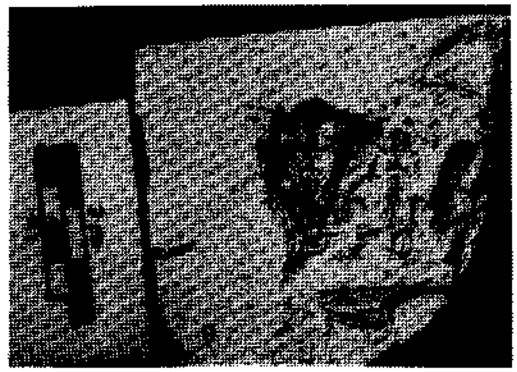
Fig. 7 - Sabunkaya at the Beşkonak gorge, aiong the main rosd from Güvem to Çerkeş. Basalt columns with remarkably regular cryscal forms and smooth, shiny surfaces of soapy appearance are responsible for the local Turkish name Sabunkaya meaning «soap rocks.» Strangely enough, the same name is applied to serpentine rocks with similar, superficial appearance in various localities.

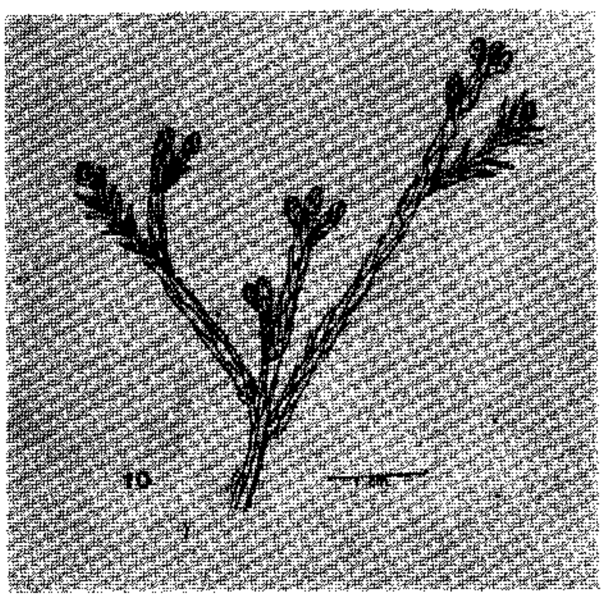
Fig. 8 - Glyptostrobus europoeus (Brongn.) Heer is the most dominant species of this ancient conifer-oak forest. Note the scale-like and linear dimorphic leaves attached to various shoot segments. This deciduous member of the redwood family is closely allied with the genus Taxcdium presently distributed in the southeastern United States and Mexico.

Fig. 9 - Glyptostrobus europoeus (Brongn.) Heer. Pyriform, ovulate cones at mature stage. Note the characteristic, crenate margins of the ovuliferous scales overlapping each other. The ovuliferous scales of Glyptostrobus are persistent while *Taxcdium* has deciduous cone scales.

Fig. 10- Extant species of G/yptostrobus line*atus* (Poiret) Druce (Syn.: G. pensilis K. Koch, G. heterophyllus Endl., *Taxodium* japonicum *heterophyllum* Brongn.) is a native of China where it exists only under man's cultivation in rice paddies. Our living specimen in the Botanical Garden of Mills College is six years old and has produced several ovuliferous cones already. So far it has not produced any pollen cones. Note the spiral arrangement of the scale-like and linear leaves as well as the abundance of the vegetative buds terminal to the branchlets. (Drawing by Barbara Noah).

Fig. I I - *Sequoia langsdorfii* Brongn. (M.T.A. Natural History Museum, no. 75-707) is another redwood represented by several vegetative branchlets with distichous, linear leaves. It is remarkably similar to leaves and branchlets of the extant species *S. sempervirens* Endl. distributed along the coastal zones of California and southern Oregon. Further excavation in the fossil deposits may yield the seed cones of S. *langsdorfii.*





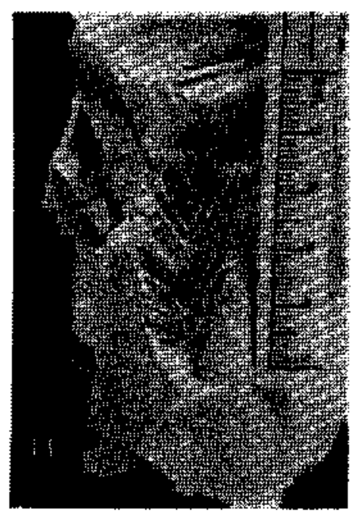
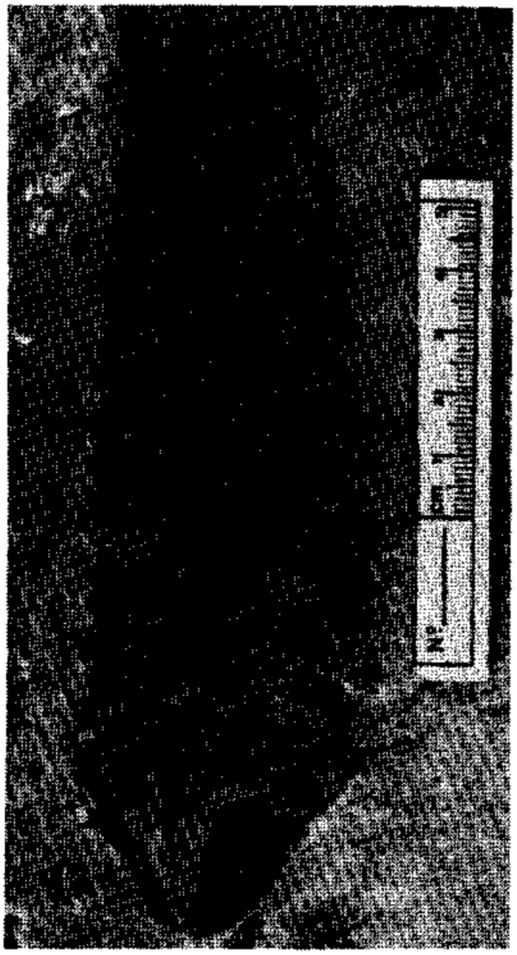


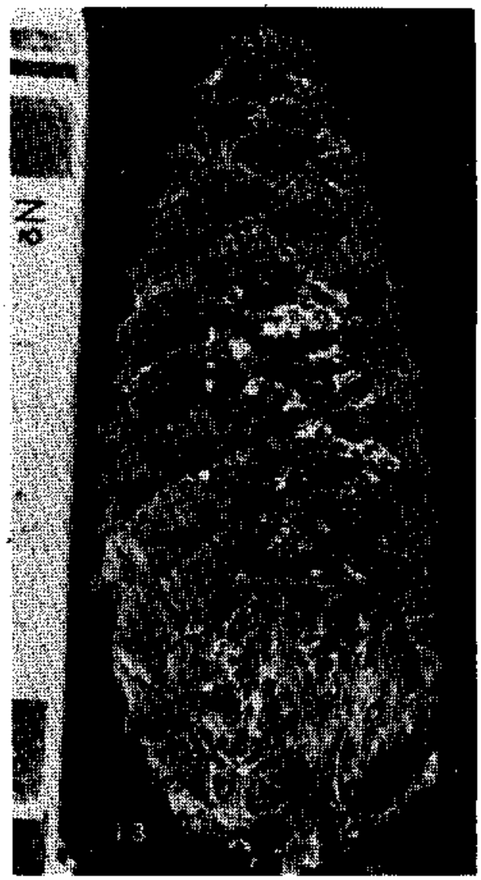
Fig. 12- *Pinus canariensis* Smith *fossilis* (M.T.A. 75/698). A beautifully preserved impression of the megasporangiate strobilus. Note the supra median umboes of the apophyses and the pyramidal spurs of theseed scales terminating into a dull apex. This three-needle pine is extinct in Asia Minor. I do not have any fossil specimen with the needles attached to a cone-bearing branch, but I do have an impression of three needles which may belong to chis particular species. Morphological characteristics of the individual ovuliferous scales are evident at the base of the cons.

Fig. 13 - *Pinus canariensis* Smith. The cone of the extant species obtained from a cultivated specimen in Berkeley, California. This pine is a subtropical species distributed in Hierro, Gomera and Canary Islands. Its nearest relative is *P. roxburgii* Sarg. (Syn.: P. *longifolia)* of the Himalayan region from Bhutan to W. Pakistan. According to Wulff (1943) and Mirov (1967) afossil pine similar to *P. canariensis* was found near Malaga, Spain.

Fig. 14-Ephedro aff. *major* Host. (Semra Başaran, no. 2) is represented by several stem impressions as well as by pollen grains in the subtratcum. The vegetative branch of the extant species to the left was collected by M. Koyuncu from the vicinity of Çubuk Dam in Ankara at an altitude of ca. 900 m.

Fig. 15- Pinus aff. morrisonicc/o Hayata (M.T.A., no. 75/687) is an haploxylon pine with five needles (Syn.: P. *uyematsu* Hay., P. *formosana* Hay., P. *parvnona* Sieb. & Zucc.). This fossil pine has a remote relationship to P. *palaetyentaphylla* Tarai & Onoe whose cones and needles are much shorter. The extant species of P. morrisonicG/o is a native of Hainan Islands and Form. sa.





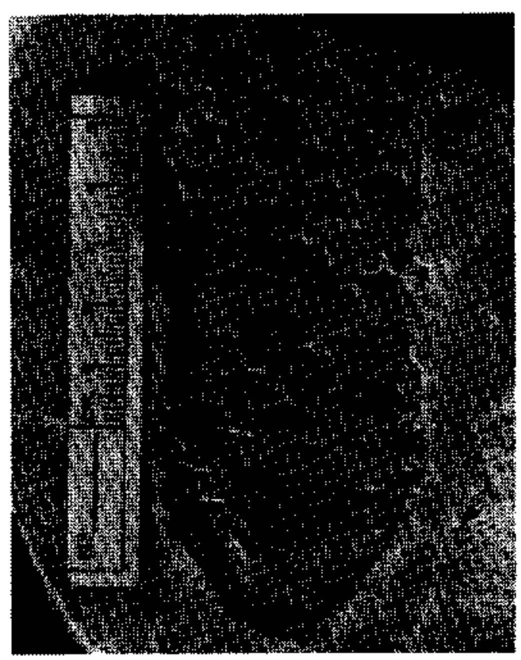
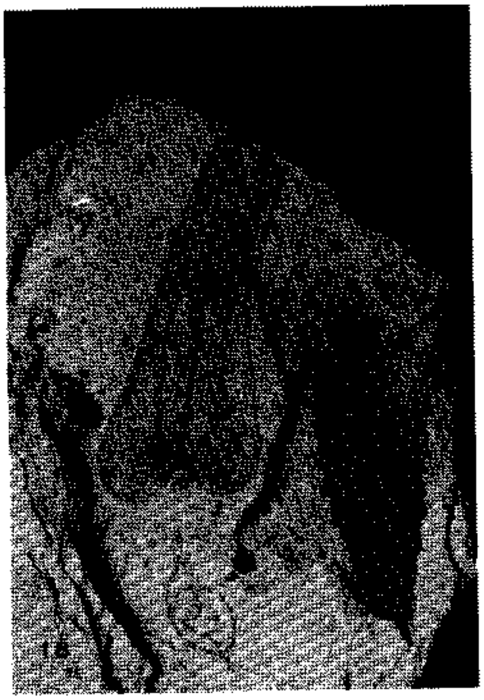


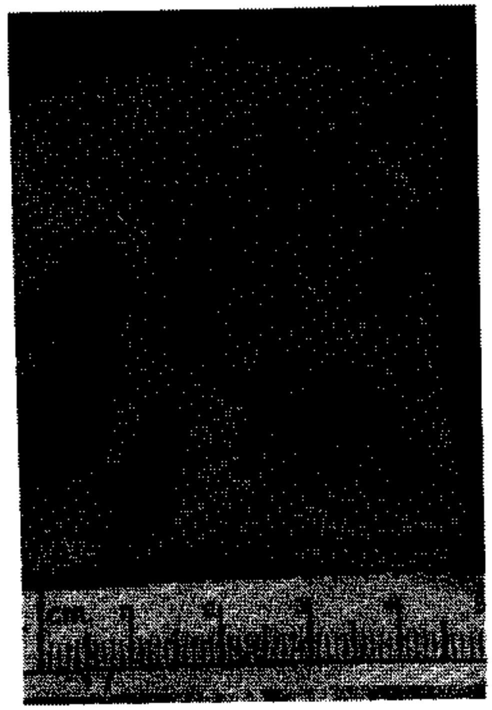
Fig. 16- Smilax aspera *L. fossilis* (Semra Başaran, no. 22) showing the basal lobes and actinodromous venation (to the left) and Quercus *kubinyi Cz.* (S. Başaran, no. 24) a common, extinct species of this forest (specimen to the right). The extant species of *Smilax aspera L.* is distributed from southern Europe to India.

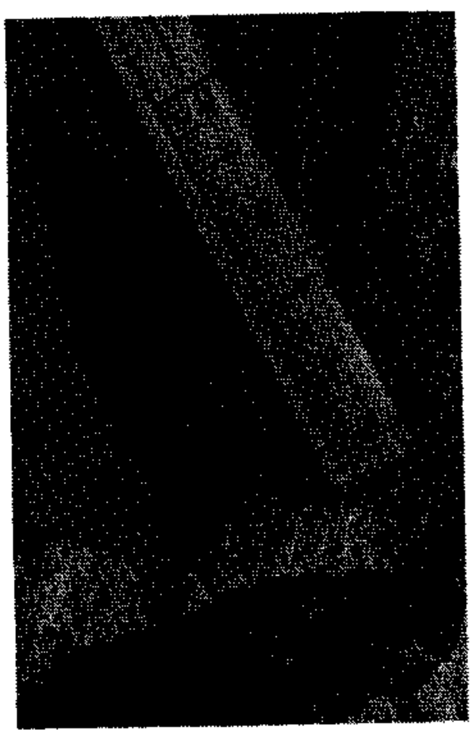
Fig. 17- A portion of a leaf of Cercis (M.T.A., no. 75/708) showing the actinodromous venation and cordate leaf base with a stout petiole (to the right) and two incomplete leaf segments of Zelkovo.

Fig. 18- Ilex *gradlis* Kolakovski has affinity to Ilex *serrata* Thunb. var. *sieboldii* from Japan. The venation pattern is brachidodromous and the secondary veins form prominent arches along the margins of the leaf blade.

Fig. 19- Persea *indica* Spreng. *fossilis* is remarkably similar to the extant species distributed from the Canary Islands to Madeira and to the Azores. The venation pattern is brachidodromous which is quite common in Lauraceae.







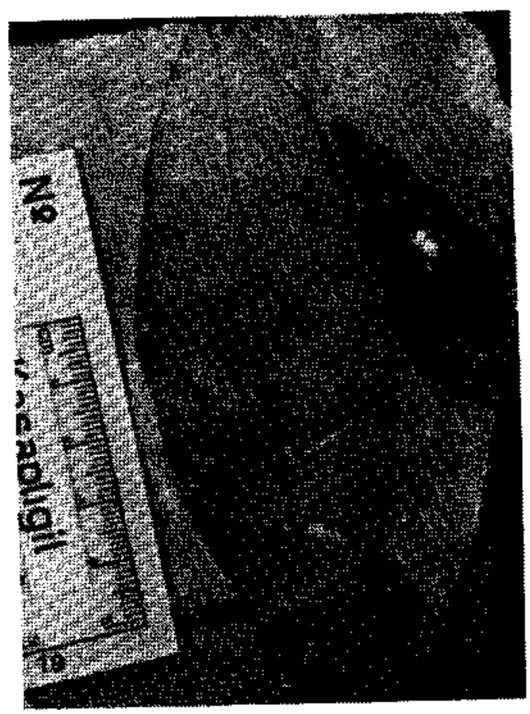
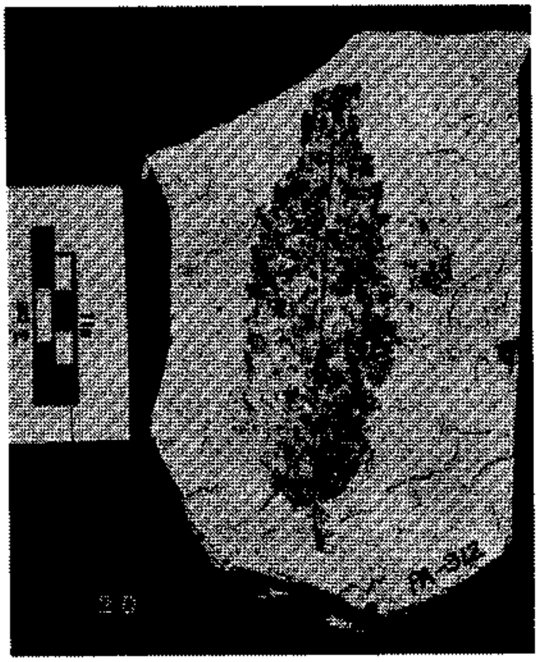
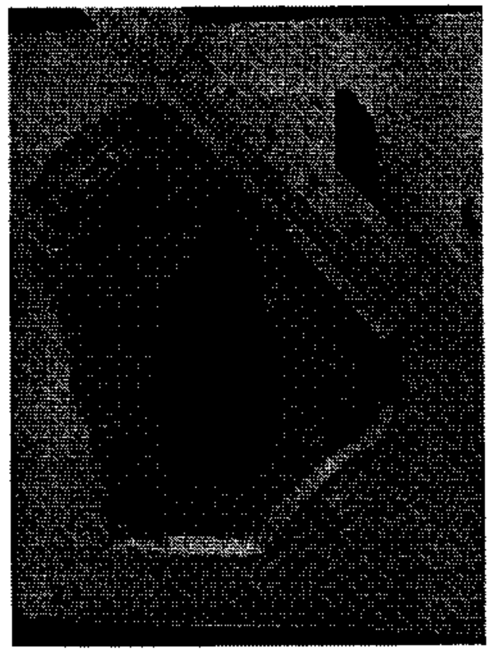
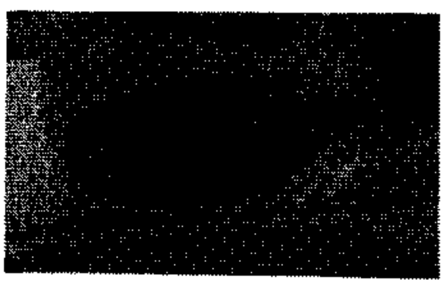


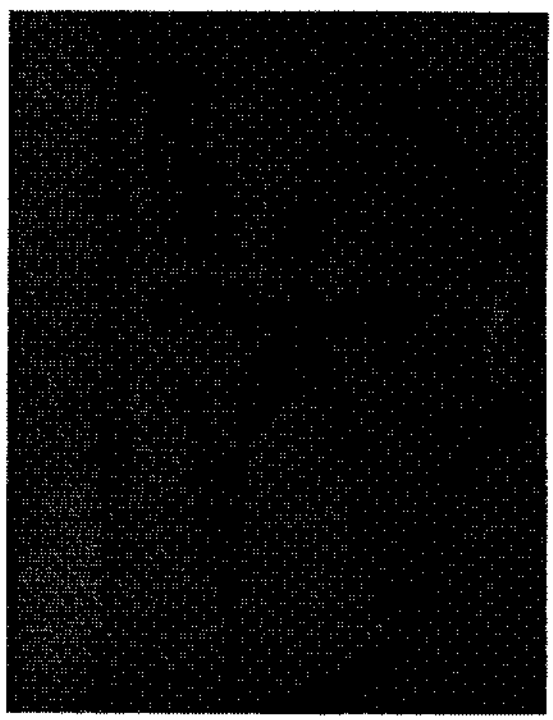
Fig. 20-23 - *Zelkova ungeri* Ettingshausen nas close affinity to Z. *carpinifolia* (Pall.) Dippe! (of northeastern Turkey, Transcaucasia, Karabağ, Talysh and the Caspian coast of Iran) as well as to Z. serrata (Thunb.) Makino (of China, Japan and Korea). Note the leaf variation in size and shapes. However, all of them are readily identifiable by craspedodromous venation and prominent serration with acuminate tips and convex basal side of the teeth.

Fig. 24 - *Myrica banksiafolia* Unger is represented by a lanceolate leaf (to the left) tapering gradually towards the petiole. Note that the upper half of the lamina is sharply serrate while the lower half of the blade has entire margins. This is an extinct species which has affinity to *Myrica lignitum* (Ung.) Sap., another fossil species reported by Kolakovski (1964) from the Kodor River flora. Presently the center of evolution of the genus *Myrica* is in Africa. The flower to the right belongs to *Astronium truncatum* (Lesquereux) MacGinitie and is a member of the Sumach family. Like *Myrica,* this genus also is extinct in Turkey.









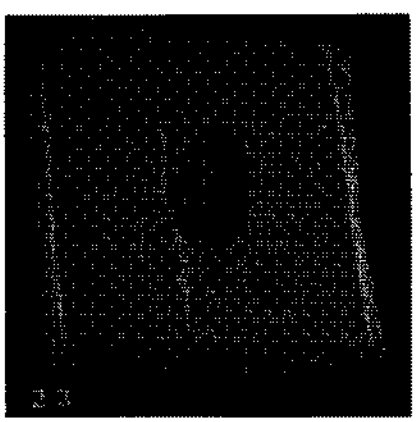
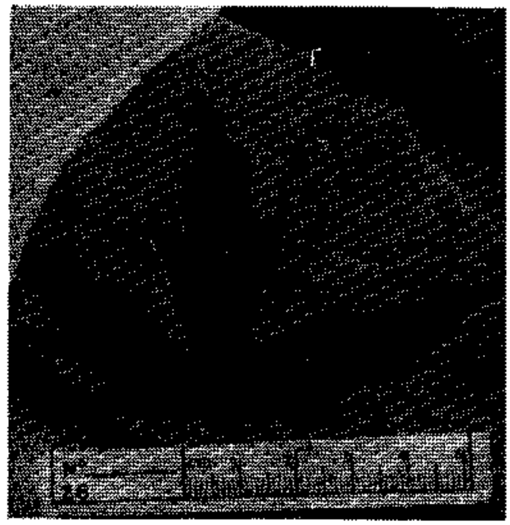


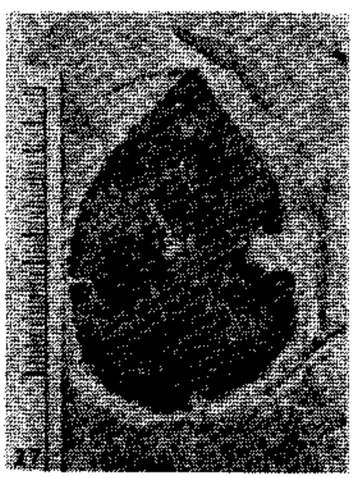
Fig. 25 - Acer *trihbatum* (Sternberg) A. Braun (Kasaplıgil, no. 4513) is an abundant fossil maple of this conifer-hardwood forest. *A. t.* var. *production* Heer which is characterized by an elongated middle lobe is also common in these deposits. This extinct species is related to *A. pennsylvanicum* L. and *A. rubrum* L of eastern North America as well as to the east Himalayan species *A. pectinatum* Wallich (cf. fig. 9 in Banerji 1971).

Fig. 26 - Acer *augustilobum* Heer (cf. Heer, 1859, III, pi. 117, fig. 25 and pi. 118) is somewhat related to the extant species A. *miyabei* Maximovicz from Japan. The lobes are deeply dissected and their number varies from three to five. It is represented by many leaf and samara impressions in the collection.

Fig. 27 - *Cercidiphyllurn crenatum* (Unger) Brown (M.T.A., 75/699) is a widely distributed deciduous tree throughout the Cretaceous and Tertiary periods in the northern hemisphere. It is closely related to the extant species *C. japonicum* Sieb. & Zucc., a native of China and Japan. Note the crenate margins and the actinodromous yenation with seven primary veins arising from the cordate base of the lamina. Hutchinson (1959) considers *Cercidiphyllurn* as a monotypic genus and places it in Cercidiphyllaceae. The generic name refers to the superficial resemblance of the leaves of Cercis.

Fig. 28 - *Magnolia sprengeri* Pamp. with obovate leaf and a long petiole is a deciduous species related to the extant species M. *cyindrica* Wilson, a native of China. Microscopic examination of the specimen reveals comptodromous reticulodromous venation.





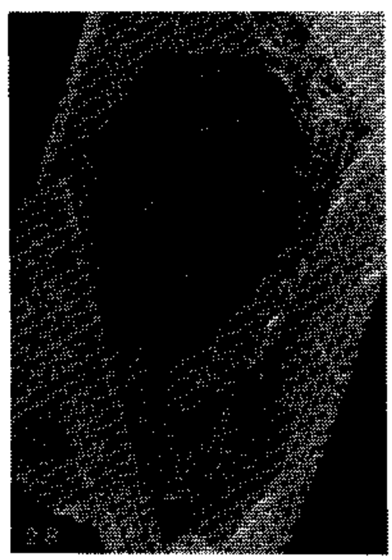


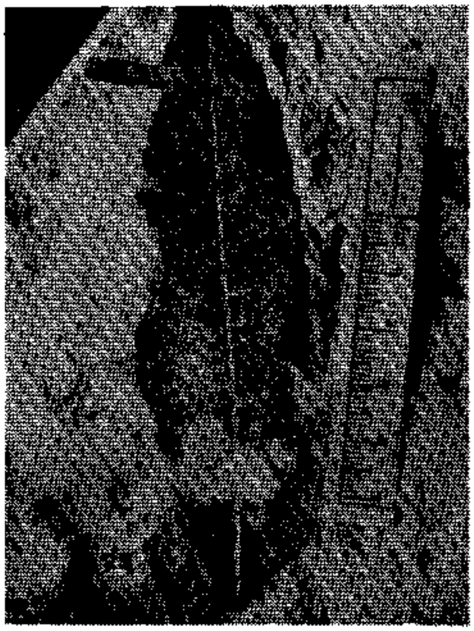
Fig. 29 - Quercus *sosnovskii* Kol. f. *angustifolia* Kolakovski is a variable species with several forms. This particular impression is about the size of a chestnut leaf. The upoer half of the leaf has sharply serrate margins associated with craspedodromous secondary veins, while the lower half of the blade has entire margins accompanied by camptodromous secondaries. This Tertiary oak has affinity to Quercus *glauca* Thunb. of japan.

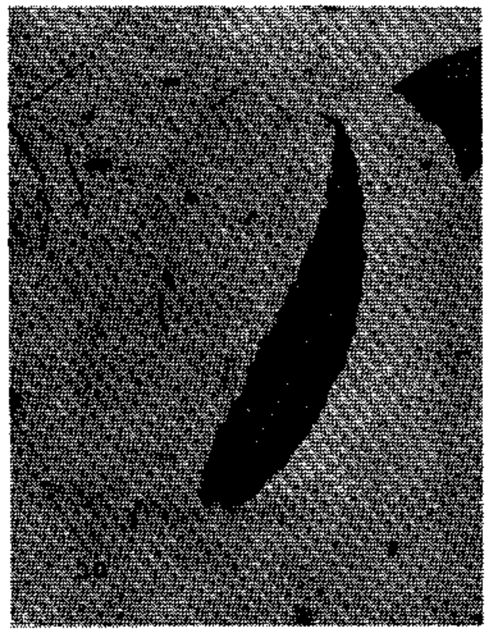
Fig. 30 - Quercus *drymeia* Unger has narrowly lanceolate, asymmetrical leaves. 1/2-3/4 of the upoer blade portion has serrate margins associated with craspedodromous secondaries while l /4-1 /2 of the lower leaf blade has entire or weavy margins associated with reticulodromous (cf. Dilcher, 1974) secondaries. This species was reported widely from Miocene and Pliocene deposits of Central Europe. According to O. Heer, it has afffinities to Q. sartorii Liebm. of Mexico and Q. *castaneifolia* C.A. Mey of Transcaucasia and Iran.

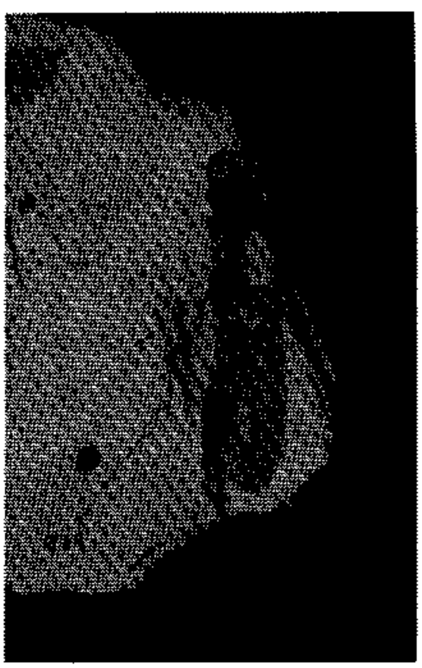
Fig. 31 - Quercus *seyfriedii* A. Braun is characterized by linearly elongated leaves with entire margins and short petiole represented by several impressions. This species is closely allied with the extant species Quercus *phellos* which is a native of the southeastern United States today. A similar oak was reported by Givulescu (1962) from Valea Neagra of Romania.

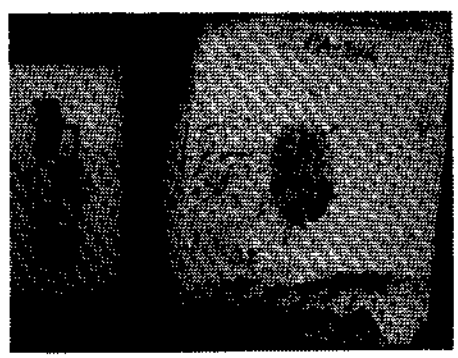
Fig. 32 - Quercus *sclerophyllina* Heer (1856) has close affinity to Q. cocafera L. which is a common, scrubby species of the mediterranean region known as Kermes oak. However, it may have closer relationship to Q. *calliprinos* Webb carefully distinguished from Q. coccifera by M. Zohary (1961). Additional fossil specimens of this fossil oak are required to judge its affinities to the extant taxa.

Fig. 33 - Quercus *coccifera L.* (Kasaplıgil, no. 4625) cleared leaf of the extant species from Turkey showing the semicraspedodromous venation pattern with the secondaries branching nearly at midway between the primary vein and the blade margin. (Contact print 3x, prepared by Margret Mukai.)









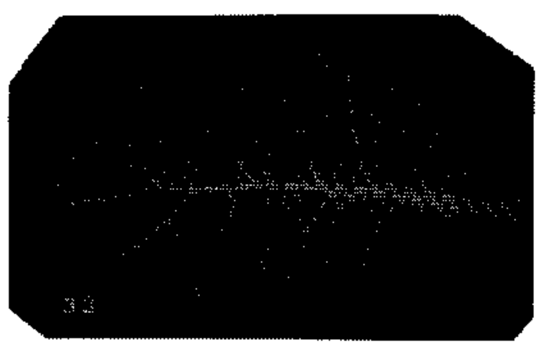


Fig. 34 - Quercus *kubinyi* (Kov.) Czeczott (Semra Başaran, no. 24, Univ. of Ankara, College of Pharmacology) was distributed in Central Europe, Italy and Balkan Peninsula during Mocene and Pliocene. It belongs to the section Aegilops of the genus Quercus as defined by Schwarz (1937).

Fig. 35 - Another fine leaf impression of Quercus *kubinyi* (Kov.) Czecott (U.C. Berkeley, Paleobot.). This Tertiary species has affinities to the following extant species: Q. *libani* Oliv. (Syn.: Q. regia Lindl., Q. *karduchorum* C. Koch), Q. *trojana* Webb. (Syn.: Q. *macedonica* DC.), Q. *macrolepis* Kotschy (Syn.: Q. *vallonea* Kotschy), Q. *brantii* Lindl., all of which belong to the section Aegilops and presently are distributed in Turkey.

Fig. 36-38 - Cleared foliage leaves of Quercus *trojana* Webb. (Kasaplıgil, no. 585) showing the craspedodromous venation type comparable to that of Q. *kubinyi* Czeczott. Note that the upper secondaries diverge under more acute angles than the lower secondaries of the leaf blade. The tertiary veins are almost at a right angle to the secondaries. (The contact prints of the cleared herbarium specimens are prepared by Howard Schorn.)

Fig. 39 - *Carpinus miocenica* Tanai (M.T.A., no. 75/701) has affinity to *C. laxiflora* Blume of Japan and Korea according to S. Ishida (1970).

Fig. 40 - Betulo *luminifera* Winkl. *fossilis* (Syn.: B. *hupehensis* Schneid, B. *wilsoniana* Schneid.) is very similar to the extant species which is a native of Central China, especially of Sechuan and western Hupeh districts.

Fig. 41 - *Populus* tremula L. *fossilis* (Kasaplıgil, no. 4503; S. Başaran.no. 7a, Univ. of Ankara, College of Pharmacology) is very similar to the extant species which is quite common along the edges of the coniferous-mixed forests and in the areas damaged by forest fires in Işıkdağ. The venation type of the leaf is imperfect-actinodromous.