ENVIRONMENTAL
PROTECTION AGENCY FOR
SPECIAL AREAS

# ANATOLIAN SWEET GUM TREE
# (LIQUIDAMBAR ORIENTALIS Miller)

**Authors**

**Prof.Dr.Osman Ketenoğu and Assoc.Prof.Dr.Latif Kurt**

Univ. of Ankara, Faculty of Science, Dept. of Biology, Staff of Ecology and Environmental Biology Subdivision, Tandoğan/Ankara



Print:
**Pozitif Matbaa – +90 312 397 00 31**
Çamlıca Mah. 12. Sk. No: 10/16 Yenimahalle / Ankara / Turkey

# PREFACE

Environmental Protection Agency for Special Areas undertakes the task and responsibility of setting up the areas in which the nature and biological diversity can breath and diminishing the negative effects on the nature in order to provide continuity of life and biological diversity.

Support and cooperation of organizations, institutions and individuals are the most important factors in performing this task and responsibility.

I believe that the book is going to provide a significant contribution to expand the "Sweet Gum Conservation Action Plan" which we initiated in Köyceğiz-Ðalyan, the special protected area intending to protect Anatolian Sweet Gum, the eigenvalue of our country and one of the important plant gene resource, to national scale and turn it into "National Sweet Gum Conservation Action Plan".

**Ş. Önder KIRAÇ**

President of Environmental Protection Agency
for Special Areas

# FOREWORD

The discovery of fire is the first intervention of humanity to the nature. The hunters of the Paleolithic age by using fire in the way they desire have created a destroying effect at the natural environment they existed. Especially the use of fire haphazardly during hunting, forms the beginning of the destruction of plant communities at various places of the world. At the Paleolithic age, the flora at the African continent and Central Europe has been very much destroyed as a result of these fires.

These systematic destructions and changes at the flora have resulted in product loss in the biotobe and the biological capacity of ecosystems has decreased.

While food being the most important limiting factor for the human populations living as hunters and collectors before the awareness of agriculture, together with the invention of agriculture, the limiting role of food has disappeared and the population in the world has begun to increase gradually.

With the expansion of agricultural areas, ecosystems have begun to replace and first meadows and then agricultural fields took place of the climax forest biomes.

Creation of new agricultural ecosystems, beginning to apply mono culture techniques for the food requirement improved the cattle breeding. It caused forests to be converted to meadows by being burned for cattle breeding.

The hunters of the Paleolithic age, as they met their needs at small areas (for example 20 $km^2$ areas), were forming small but frequent communities. The ones who survive with agricultural activities at the Neolithic Age have begun to spread into larger areas (a few hectares). On the other side, the product of wheat, with the construction of silos in time, has provided to pass into settled population organization from nomadic life. As a result of continuous irrigation of agricultural lands, the structure of soil has been destroyed practically and excessive pasturage has decreased the efficiency of ecosystems.

The beging of agriculture in Mesopotamia North of Syria, South Palestine and East of Iran which are accepted as the cradle of civilization, and cattle breeding, especially sheep farming date back to 10.000 years ago. These areas which were covered by forests in the past are replaced with sand deserts today. But 8000 years ago, at these places, the heyday of Neolithic agriculture has been lived.

While the intervention of agricultural communities to the nature could still be deemed as limited, the industrial revolution in the $19^{th}$ century has brought together population increase.

When we look at the demographic past of the population in the world, we see that after the industrial revolution, the population has multiplied in very small periods of time.

| INCREASE | YEARS | TIME |
|---|---|---|
| 125.000–1 milliard | since1850 | estimated $10^6$ year |
| 1–2 milliard | 1850–1925 | 75 year |
| 2–3 milliard | 1925–1960 | 35 year |
| 3-4 milliard | 1960–1975 | 15 year |
| 4-5 milliard | 1975–1985 | 10 year |
| 5-6 milliard | 1990–2000 | 10 year |

As a natural result of all these developments which is tried to be summarized, the pressure on ecosystems has quickly increased and our planet has begun to give signals of danger.

As a matter of fact, M. Gorbatchev, in one of his words has said "In the 21st Century the most important threat awaiting ahead of nations will be ecological disasters more than being military" and unfortunately, he was not faulted in this view of him.

Starting from the 18th Century, the increasing usage of fossil fuels has resulted an increase in the $CO_2$ concentration from 280 ppm which was the normal level in the atmosphere to 340 ppm. This stuation has resulted, with an increase in green house effect, in global worming. According to the measurements of observations over last 100 years, the world's average temperature has increased by 0.6 °C. As long as the usage of fossil fuels continues, the increase at the temperature will go on and the dismays in the matter that the world will be a non-livable planet on a global scale will keep on increasing every day.

It is impossible for the species to adopt these rapid environmental changes. Because species were naturally selected through billions of years during the evoluation processes. Sudden changes that occur in the environment which are expressed in hundred years are threatening living species and animals come face to face with a global extinction process.

As a matter of fact, many species have gone extinct and many of them are faced with the threat of extinction. Especially extinction in the mammalian species that have similar ecological desires with to humans expresses the bells of danger also for the human race.

Humanity which began to hear the bells of danger started to search for routes of solution and "environment" has begun to be one of the preferential articles of agenda of nations, from the beginning of 1970's.

At the 80'ies, the environmental problems have become to be the focus of interest of the world's public opinion and environmental consciousness at societies has begun to be developed.

In order to review the environmental and development relations and without consuming the resources that the future will need, to start studies providing development and progress to be supported, in year 1983, by the United Nations "World Environment and Development Commission" has been established. The commission of which Norway Prime Minister G.H. Brundtland is doing its presidency has published the report named as "Our Common Future", in 1987.

The opinions and recommendations at this report echoed extensively in the world and in our country. In the Brundlandt's report, generally abolishment of poverty, equality in the redistribution of the benefit obtained from natural resources, population control and development of environmental technologies has been directly associated with the sustainable development principle. In the Brundtland's Report, sustainable development has been defined as "the development which meets today's necessities without compromising from the ability to meet the necessities of the future generations."

Sustainable development concept is one which has environmental, economical and cultural dimensions and this concept is used together with the concept such as "sustainable growth" and "ecological sustainability" every one of these dimensions, covers very important headlines such as social requirements, biological diversity, production, cultural inheritance take place. .

In 1992, United Nations General Council, for the purpose of changing the present tendencies in the world and to form a balanced and continuous life style, made a call for a conference "World Summit" has been realized in Rio de Janeiro on June 1992. The most important results of this summitare: Biological Diversity Contract, Climate Change Contract and Agenda 21. Turkey has signed Biological Diversity Contract at this summit.

For a sustainable life;

The apprehension of the importance of Biological Diversity has become an obligation for the continuation of life sustaining systems in the biosphere and necessary precautions to be taken for it to be protected.

As a passage between North and South and East and West, Turkey is a country which joins three different biogeographycal regions with transition forms, namely; Euro-Siberian, Irano-Turanien and Mediterranean. Because of its position Turkey is a country with valuable biological resources and biodiversity which can only be seen in a few regions of the world. In order to have better conditions for the country, either economical or sociological, these resources needs to be determined, protected and wisely utilized.

Efforts of all the citizens to transfer his awareness to the other levels of society about the significance and value of biodiversity will help a step forward progress to establish a better future.

We believe that, as people knows "Liquidambar oriantalis" better, which is the pearl of Mediterranean and a heritage on these soils of Anatolia before existing of humanity since 60 million years, they will stop "the tears of Liquidambar".

**Forest Eng. (MSc). Yaşar Dostbil**

President of Agricultural Devolopment Foundation

**Prof.Dr.Osman Ketenoğlu and Assoc.Prof.Dr.Latif Kurt**

Univ. of Ankara, Faculty of Science, Dept. of Biology, Staff of Ecology and Environmental Biology Subdivision

# ACKNOWLEDGEMENT

We gratefully acknowledge to Mr. Ş. Önder KIRAÇ, the President of the Agency, Mr. Ahmet ÖZYANIK, Vice President of the Agency, Mr. Mehmet MENENGİÇ, Head of Departments of Environmental Protection & Research, Mr. Ümit TURAN, the Protection Branch Manager, and Mss. Aynur HATİPOĞLU, the Project Coordinator, Mss. Muhsine MISIRLIOĞLU, Chemistry Engineer, Mr. Murat KARAHAN, Agriculture Engineer, Mr. İRFAN REİS, Forest Engineer (MSc), Mr. Mesut AVCI, Director of the Muğla SPA, Mr. Bekir ERDOĞAN, Vice-Director of the Muğla SPA for their supports to the studies.

# CONTENTS

# INTRODUCTION

Turkey is one of the richest country of the temperate zone in terms of biological diversity with 12,000 flowering plant species (including infraspecific taxa), 163 mammals, 456 birds, 24 amphibians, 105 reptiles and 180 freshwater fish species. Biological diversity is a reflection of climatic, edaphic, topographic etc. diversities, especially ecosystem diversity.

It is possible to summarize the primary reasons of Turkey's biological diversity as follows:

**1. Climatic Diversity:** Turkey is harboring three different climate types such as Mediterranean, Continental and Oceanic climate such that, this climatic diversity leads to biological diversity.

**2. Soil (Edaphic) and Topographical Structure Diversity:** Turkey harbors different soil groups where geological and geomorphologic varieties are frequently seen and different topographical structures. Altitudinal differences till 5000 m from the sea level is another reason of biological diversity.

**3. Phytogeographic diversity:** Turkey is at the meeting part of 3 different phytogeographical region (Europe–Siberia, Irano–Turanien and Mediterranean) included in the Holarctic Kingdom. Besides having specific climatic and edaphic factors, the transition zones between these 3 regions and the local areas having different phytogeographical property in a region show interesting characteristics that can be observed frequently in Turkey. The similarity between Mediterranean and Irano–Turanien regions are more than that of between Euro–Siberian region.

**4. Existing at Migration Routes:** Turkey, it is located at the connection point of Europe, Asia and Africa continents and on the migration routes of living beings. Another and important reason of our biological diversity is being on these migration routes.

**5. Habitat Differences:** Different habitat types such as forest, steppe, maquis, sand dune, rocks, sea, lake and river leads to increase in biological diversity.

Turkish flora, with over than 3000 endemic species, is one of the important countries of the temperate region in terms of endemism. The second richest country of Europe in respect to endemism is Greece and the number of endemic taxa is about 800 – 1000.

## THREATENED PLANT TAXA

RED DATA BOOK which covers the classification of the plants of our country according to international threat categories has been published in 1989, and then revised in 2000, the threat categories endangered conditions of plants have been rearranged according to the categories of IUCN which is published in year 1994 (Ekim et al. 2000).

According to this work; it is indicated that

- 13 plant taxa have extincted (12 of them are endemic),
- there will be a decrease at the rate of 20% in the population of 1457 species (688 is endemic taxa) in 10 years,
- 843 taxa (774 is endemic) is under very high level of risk,
- 181 taxa (171 is endemic) is under the danger of extinction in a very short time at the nature,
- 1586 taxa is under low danger,
- For 514 taxa however, there is not sufficient data and these should be collected these plants.

The growth place of 6 species of our country is not known and therefore they are placed in the category of unevaluated species (Ekim et al. 2000).

## A Relict Species Under Threatened:

## Liquidambar orientalis Mill.

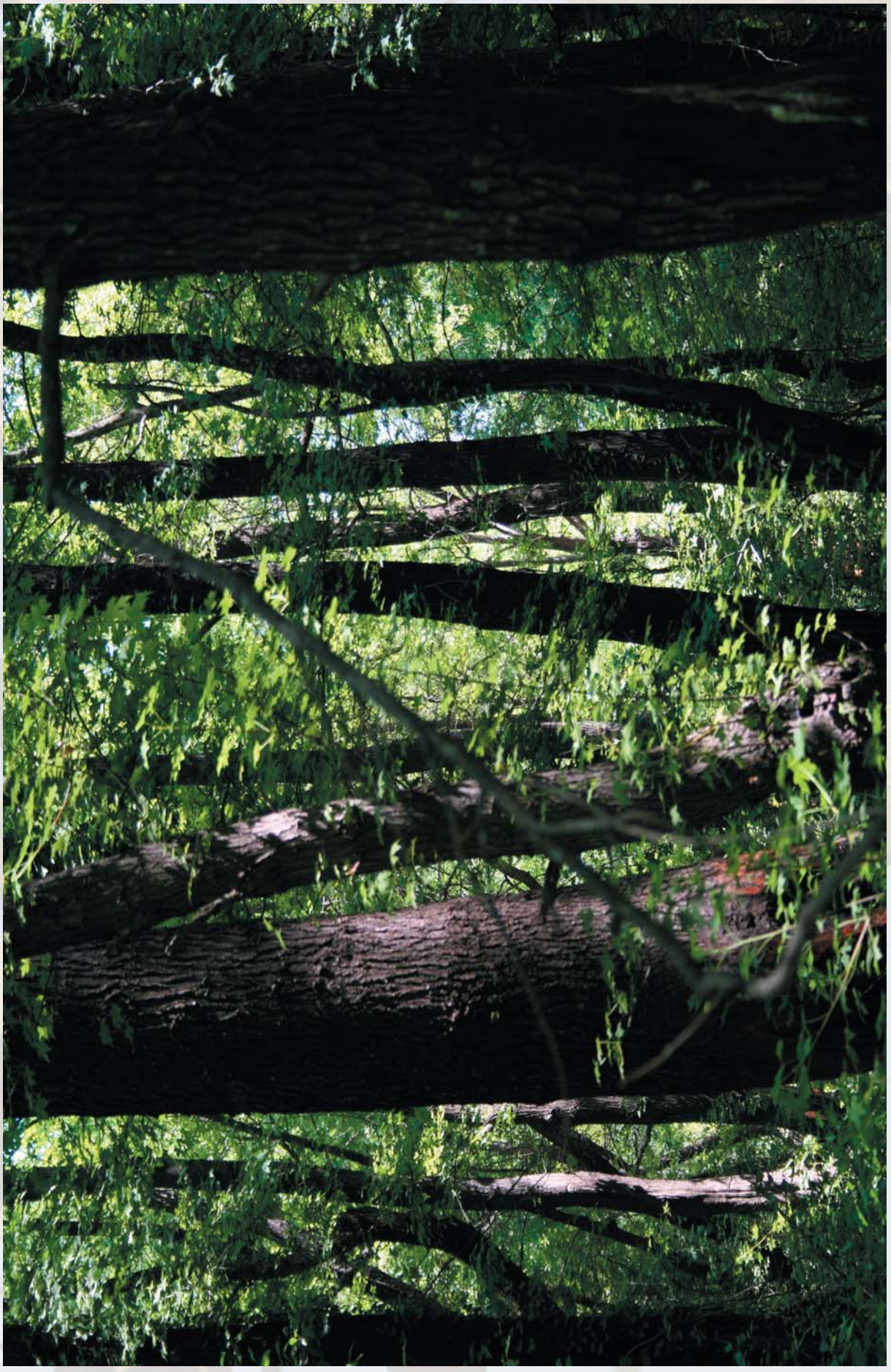
While widespread over wide areas in the Tertiary period 60 million years ago, Liquidambar orientalis Mill. has become a relict endemic species as its distribution area has become narrow gradually. Today the species distributes only in Southern-West Anatolia throughout the world.

Bringing together the Latin word "Liquidus" due to its balsam content which is not normally included in its body but generated as a result of a trauma and arabic word "Amber" due to its aromatic balsam, the Latin genus name "Liquidambar" was given. There are 4 species of Sweet gum in the world. The species epithet "orientalis" meaning eastern swallow gum was given to the sweet gum species that distributing in Southern West Anatolia. It is also known as "Anatolian Sweet gum" as it distributes only in Anatolia. There are two subspecies of sweet gum within Turkish flora. They are Liquidambar orientalis subsp. orientalis and Liquidambar orientalis subsp. integriloba.

**Liquidambar orientalis Miller:**

A deciduous, crown tree which is a member of Hamamelidaceae family and can reach the height about 15–25 m. Its leaves has a thin and long petioles and the blade have 3–5 and sometimes 7 lobes. Lobes have sharp–toothed margin.

The flower; many flowers without petals are all clustered at the top of a long pedicel. Flowers unisexual. The male flowers are in terminal and cluster shaped. The female flowers are lateral in leaf axils. Ovary has two septa. The fruit is a septicide capsule.



**Inflorescence and Fruiting Periods**

Infloresence period of sweet gum starts at the second part of February, namely at February 15 and reach its maximum bloom between February 10 and 20. Strobilas start to grow at April 15 and ripen at the end of May. Dispersal of seeds starts at the end of August and at the beginning of September and proceeds to the end of October.

## Distrubution of Sweet Gum Forests in the World

Liquidambar species has distributed in the warm and hot regions of the world.

According to the studies of Arnold (1974), it was known that the genus was widespread especially at Miocene (tertiary). At the tertiary period, pallynological studies showed that Liquidambar had a distribution area over Japan, Asia (Russia), Central Europe, North America (Oregon, Idaho and Colorado) and Turkey. Nevertheless, glaciations in the Quaternary period resulted in the decrease of the survives area of this species as other species. Today this genus distribution in certain parts of the world.

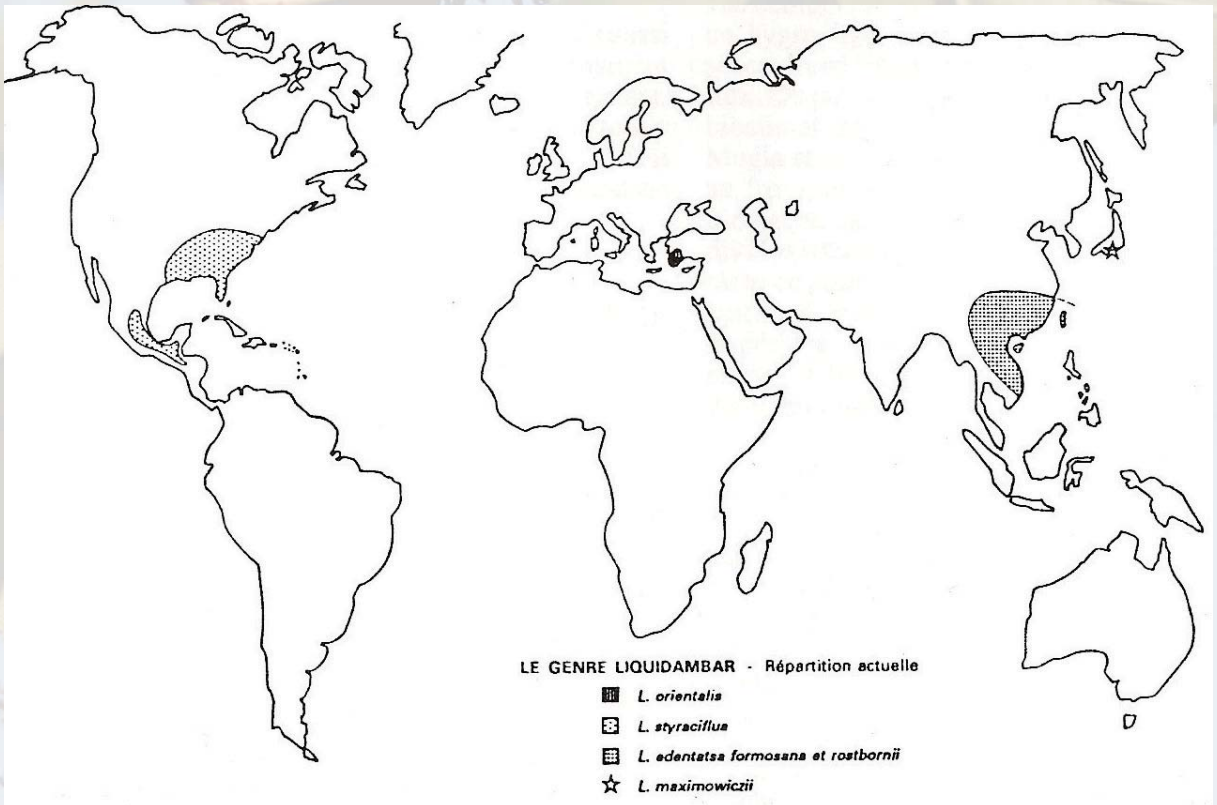
Furthermore ZEILLER (1900) stated that the fossils of similar forms of Liquidambar stericiflua spreading in America today were discovered in the middle and upper Cretaceous period. Also, the fossil leaf of Liquidambar orientalis were discovered within peat beds in Kızılcahamam, Ankara (KASAPLIGIL).

Today 4 species of sweet gum exists throughout the world.

Among them ;

- Liquidambar formosana Hance; south and south–west China and Taiwan
- L.styraciflua L.; North America and the areas close to Atlantic Ocean and the east of China.
- L.macrophylla Oerst.; in the middle of North America.
- L.orientalis Mill.; South–West Anatolia.

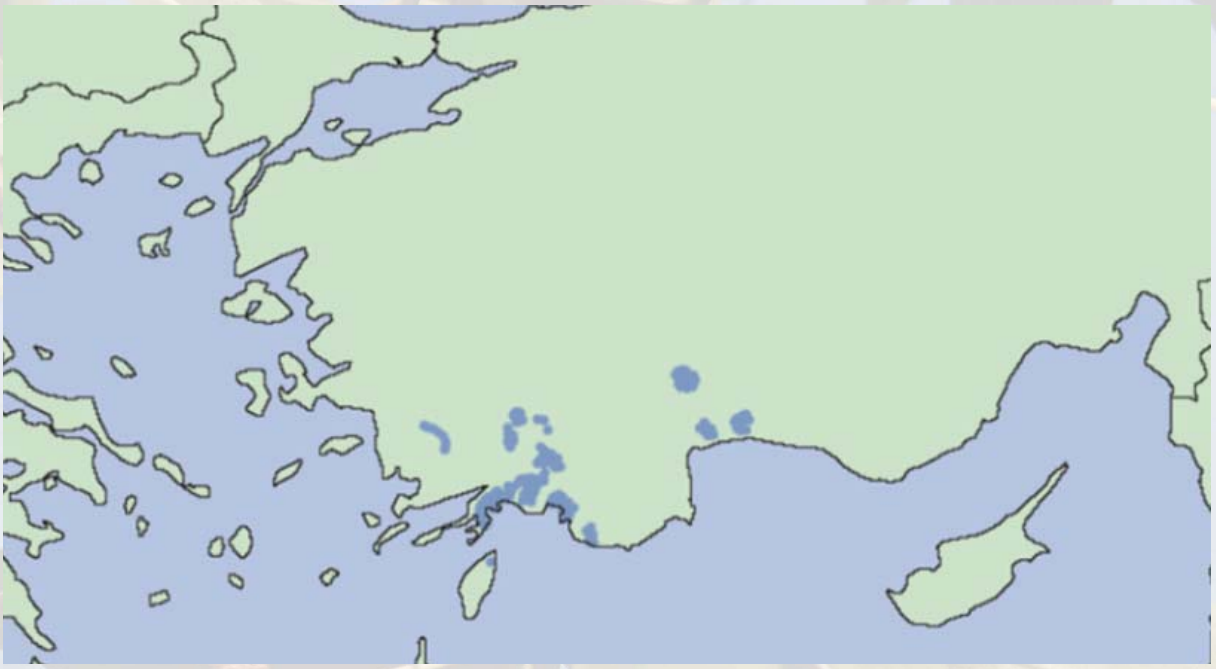
These species are located at more or less the same latitudes, but their distribution areas are interrupted.



**Distribution area of Sweet Gum in Turkey**

The widest Sweet gum distribution occurs in the region of Muğla, particularly at the coastal zones around Marmaris, Dalaman, Köyceğiz and Fethiye where hot and temperate Mediterranean climate is observed. Also, the species can be seen in terrestrial parts as small patches, for example instance Denizli–Acıpayam–Gölcük Village, Antalya-Sütçüler–Çandır and Turgut Stream pouring into Namnam stream in the region of Muğla.

Sweet gum exists in following regions in our country.



Muğla: at Gökova-Kocapınar, Köyceğiz and Turgut Village

Marmaris: Gelibolu, Gökbük, Hisarönü region, Arputça, Bördübend and Değirmenyanı, around Soğuksu, Günnücek forest, Central Area Karasu, Adaağzı and Göllü location, Çetibelli-Taşhan Bridge, Kocaalan, Kuzcadere and Söğütkent regions.

Datça: Around the Emecik village and Aksaz region.

Yatağan: Along Gökbel–Çine stream.

Milas: Selimiye, Kandak village.

Aydın: Emirdoğan village–Çine stream, İncekemer.

Köyceğiz: Central area, the series of Yuvarlak stream, Nasuhdede village, the series of Günlük, Büyük Kalaağaç, Hamit Village, Köyceğiz Lake, Ortaca District, Okçular, Sarısu Kavakarası location.

Dalaman: Kocdüven, the range of Tersokan, Akçataş location, Bahtiyar region, the series of Dalaman brook, Değirmen Stream, Gutça location, The range of Aladağ mountains , Domaçe Streams– Akçaalan location, the region of Ağla, the range of Kargıcık, Sazak and Okluk location, the range of Alioğlu, Kocapınar ve Toparlar location, the vicinity of Döğüşbelen

Fethiye: Güneydağı region–Kargı, Yanıklar, Kirsecik and cental location, Kızıldere–Göcek region, Series of Dikmentepe –Karanlık stream, Inlice and Küçük Kargı location.

Denizli: Karacaören region –Günlük Strait, Gavurpazar and Çakmak stream location, Köprübaşı region, Günlük Stream location and Günlüklü district, Acıpayam Region, the Series of Gölcük , Alcı Region Akdere location.

Burdur–Bucak: Melli Region, The Series of Cobanpınar, Sarı Stream Çobanpınar village, Kızkığılca District.

Antalya: Kaş, Kalkan Region, the area 2 km west from Kınık Ruins, Serik Pınarözü region, Pınarözü stream, Gediz–Bozburun Mountain, Sinni Brook, Söğütlü Plateou.

Isparta: Sütçüler–Çandır sub–district, Kızılı Village, along Aksu stream, Karacaören Dam construction area.

Additionally, the study of RECHINGER named " Flora of Aegean" stated that sweet gum has also distributed in Rodos islands. The expansion of the tree toward Rodos island is so normal since the island is located against to Köyceğiz and Fethiye.

While the total sweet gum forest area was 6300 hectares in our country in 1940s, today only about 1350 hectares sweet gum forest was left. According to the forestry amenagement report, normal high forest cover is about 980 hectares and the degraded scrubs is about 320 hectares of the existing sweet gum population. The sweet gum forest between Bucak–Çandır Karacaören Dam where there is no sweet gum production, covers only 8.5 hectares, that's quite small.

It can be observed that in the period of 68 years from 1940 to 2008 the area of sweet gum forest has decreased more than 6 times.

Consequently, the amount of sweet gum balsam provided from these forests also decreased in parallel with this reduction. For instance, while the amount was 181.279 kg in 1950, it decreased to 18.000 kg in 1980 and less than 1000 kg in 1990.

According to these results, the sweet gum balsam production decreased by 99% from 1950 to 1990.

Nevertheless, we learned that many importing companies in European countries, as well as Russia bought so much sweet gum balsam which is enough for ten years. (H. C. BAŞER 1991).

## The Ecological Requirements of the Sweet Gum Tree

We can specify the ecological requirements of Liquidambar orientalis as follows:

**Climatic requirements:**

Sweet gum prefers hot and warm type of Mediterranean climates. In Turkey, it can be seen only at the locations where the minimum average temperature (m) of the coldest month is +3°C at least. Therefore sweet gum is so sensitive to frost. Sweet gum mostly distributes at coastal regions that have minimum average temperature value (m) of 6–10°C (m) value.

**Water Requirements:**

Annual precipitation of the area in which sweet gum distributes is quite high. For instance the annual precipitation is 1203 mm in Marmaris, 1209 mm in Muğla, 1122 mm in Köyceğiz, 1086 mm in Dalaman and 934 mm in Fethiye. But the drought period in summer is about 3 to 6 months without any precipitation for a long time. The presence of sweet gum depend on the ground water and the streams where it can get water at drought period.


**Land and Soil Requirements:**

The hydromorphic alluvial areas with ground water in warm Mediterranean climate are most suitable areas for the location of sweet gum. The land slope is one of the primary factors determining abundance of sweet gum forest. Because, sweet

gum can expand along the stream in a strip if the land slope is excessive. However the forest can expand over the area where water can distribute.

Thus, sweet gums which can be seen to a certain degree in the vicinity of Antalya–Sütçüler, Acıpayam Gölcük Village, Muğla Turgut Village, can expand only along the stream banks in a narrow line.

Consequently, we can say that all of these factors are effective on the development of sweet gum.

Both Water–Temperature and Alluvial lowland play essential role on the tree's development. When one of these factors is absent, the development of sweet gum is ceased. Yet, temperature and water are the primary factors. Land slope is a factor which restricts wider expansion, hence the forest development.

**Altitude Factor:**

Sweet gum develops at coastal zones and can extend up to 900 m. at warm and southern slopes in case of finding suitable land structure. Except for the coastal communities others develop on the southern slopes of approximately 850 m around Turgut Village in the region of Muğla. Also, they are found at about 250–300 m around the Karacaören Dam in the region of Isparta–Sütçüler (Çandır).

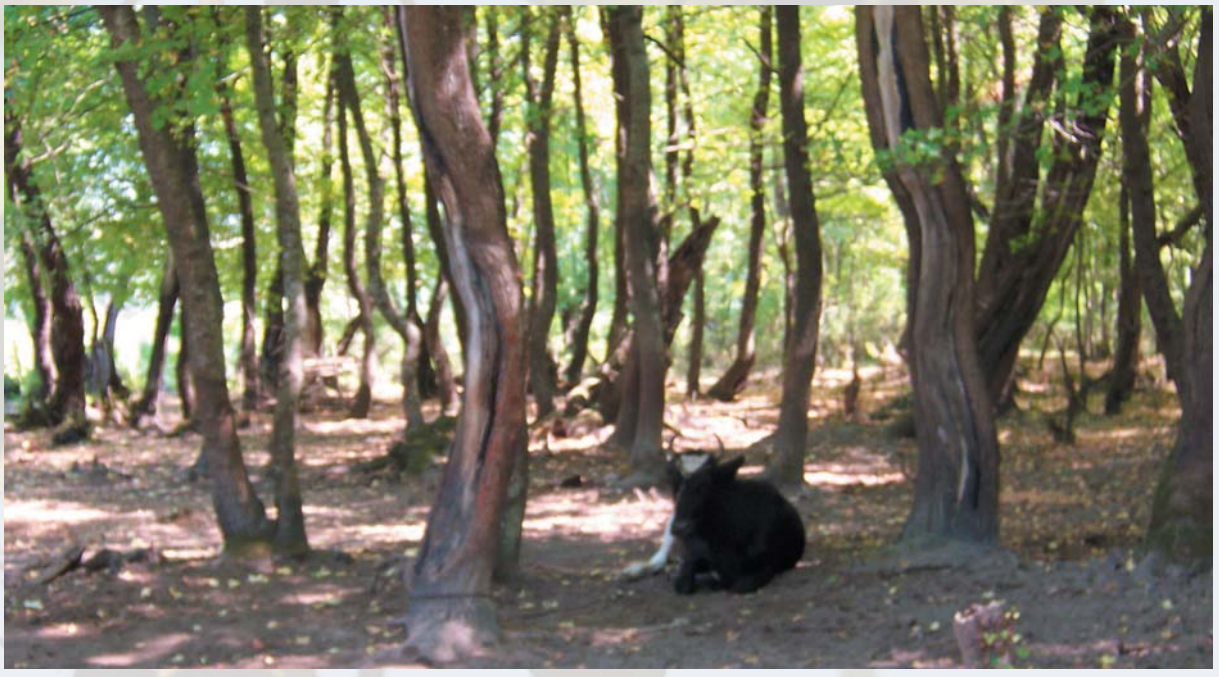
The sweet gums located in Acıpayam–Gölcük Village–Değirmendere can reach up to 600–700 m. But at the above mentioned regions because of the excessive slope sweet gum trees only present at stream banks and the floristic composition of these populations is poor and herbaceous plants can't grow at these regions. Only the trees such as Platanus orientalis, Nerium oleander ve Alnus orientalis ssp. pubescens can grow at the regions.

**Current Situation of Sweet Gum Forests**

Vast part of sweet gum forest in the region of Muğla, where sweet gum has its widest distribution, are destroyed in various ways since the closeness of the area to the settlements.

Some of the most important reasons of the destruction are; the primary and most critical reason is the destruction of sweet gum communities because of the belief that the sweet gum balsam lost its economical importance after the usage of synthetically fixatives and the area of sweet gum populations turned into citrus and other agricultural gardens.

For this purpose, by using drainage channels the ground water level was decreased intentionally and let the sweet gum trees die. This activity is carried consciously and publicly.



The trees encounter the danger of extinction, as a result of loss of soil wetness as the water (drainage channels) directed to sweet gum communities was taken away from the environment for any reason and this poses the most important threat for sweet gum forests. In this case, the youth can not develop well.

The floristic structure spoils completely with the reduction of groundwater level and understory flora destroys. Thus, the ecosystem of sweet gum reaches a point of no return and extinction phase starts.

## Production Patterns and Improvement Studies of the Sweet gum:

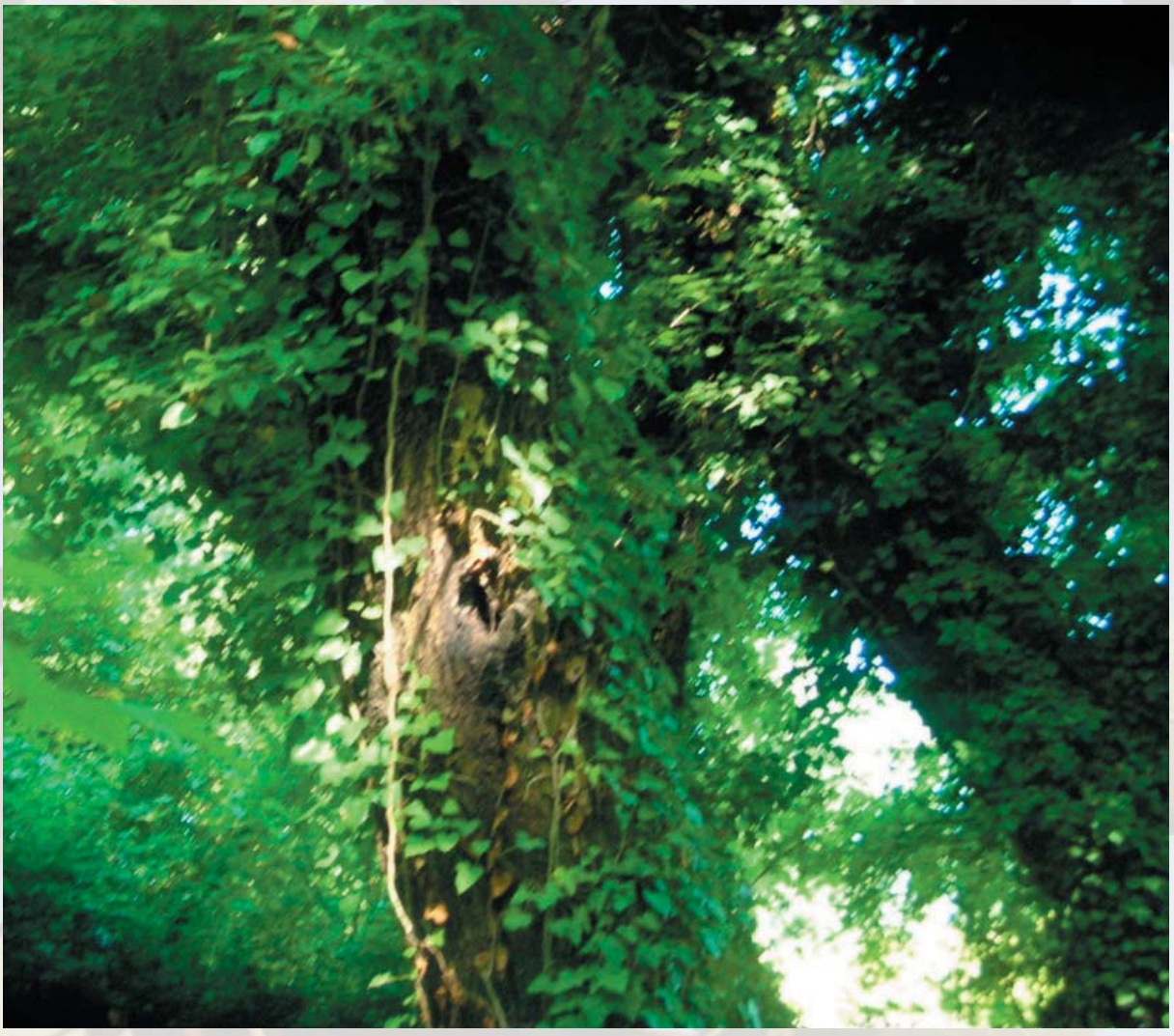
According to explanations of M.I.ACAR (1988), the maximum production rate of sweet gum balsam supplied from the population of the sweet gum grown by using rooted steels (40 %). However, any direct relation between sweet gum balsam production and genetic constitution is not understood from these explanations. As genetic performance is under the control of both environmental conditions and internal factors (genes and other molecules), they may not perform under new conditions (inner and outer), even the gene/s coding the balsam production is transferred to the new individuals. Thus the ratio of 40% displays the plant density. Researches on the production of sweet gum balsam, a pathological secretion at a genetic and molecular level and karyotype analysis are required in order to reach a precise conclusion. Only by this way it could be possible to find which individual has balsam content and play an essential role in improvement studies.

Sweet gum forestation was carried out in Forestry Operation Directorates of Köyceğiz, Dalaman, Marmaris and Fethiye subjected to Muğla Regional Directorate of Forestry. Beyond these forestation areas, the sweet gum forest comprising of high genetic quality trees are separated as seed stand under the control of Forest Trees and Seeds Improvement Research Directorate in Fethiye-Gökçek. An 30, 0 Ha area was separated as biogenetic reserve in order to protect the biologic and genetic characteristics of the sweet gum in Köyceğiz. Also in Sütçüler trees have trunk with good shape are also under conservation because at this region there is no sweet gum balsam production.

According to our observations, one of the most suitable and simple condition for growing sweet gum is to plante numerous individuals at the age of 0–1or 0–2obtained from the root bud.

## Floristic Characteristics of the Sweet Gum Forests

As sweet gum forests grow in wetland areas, their flora is mostly composed of plants like wet and shadow conditions. Most of them are herbaceous species. The species belonging to the families Juncaceae and Cyperaceae are dominant. Equisetum telmateia widely distributes in the region of Marmaris-Çetibeli–Karacasöğüt Village. Some climbing plant species such as Smilax aspera, Hedera helix, Peribloa graeca, Rubus sanctus have distributed under almost every sweet gum forest.



On the other hand, the wide distribution of Laurus nobilis in the forest of Marmaris Günlücek is also interesting. The most widespread herbaceous species are; Oenanthe pimpinelloides, Poa trivialis and Brachipodum sylvaticum.

The trees and shrubs are not abundant. Alnus orientalis ssp. pubescens, Platanus orientalis and Vitex agnus–castuscan be seen in some sweet gum communities.

The number of the endemic species is quite few and these are; Iris xanthospuria, Juncus sparganifolius, Silene lycaonica, Carex divulsa ssp. coriogyne.

## The Production Phases of Sweet Gum Oil

The bark is made thinner by grinding, late in March in order to obtain sweet gum oil. This application is called as "redden" process. The trees are left at this situation for a month. It is started to make wounds on the tree with the tool called spoon at the end of May.

These wounds, named as vein, are opened in such a way to reach into the cambium and into abit wood.

The wounds are renewed a week later and this application is called as " Making Wound" .

2 weaks later, the sweet gum oil accumulated in these veins are collected with spoon and this process is called as " Balsam Collecting or Exudation Phase"

Then the main process of sweet gum oil collection begins (Post Exudation Phase). This phase continues from the middle of July to the end of October.

The oil, accumulated on the wounds are removed along with by scrapping with a spoon in every 15 days.

So, the oil, wood bark, cambium and wood layers collectedare in case of chips. They are collected in bag tied around waist.

Oil residuals leaking from wounds and becoming harden, having the dark color

due to oxidation are again collected with spoon at the end of October. This process is called as "Blackbark Phase"

The shavings consisting of wood bark, cambium and fresh wood are boiled for a period between 0,5 and 1,5 hours in water in copper boilers.

The shavings boiled are taken from the boiler via spoons, compressed via presses and sweet gum oil is degreased and collected in concrete pools.

It is very important not to give harm to the health of sweet gum in order to provide the sweet gum oil production's sustainability. Therefore this procedure should be carried out by trained people.

This part remaining at the end of the process of pressing and containing oil even a little amount is named as "Frankincense"

Today, there are too few people who know the method of obtaining balsam from sweet gums in the region. Among these old men, some of them live in Ula and one or two live in Kızılkaya Village.

A great shortage would be felt in case of the death of these people. Hence, education programs with guidance of these men should be organized and people who will employ in production of sweet gum production should be trained. People attained to the training programs can be awarded a certificate and the certificate obligation can be imposed to employees of the sweet gum oil production.

Diameter of the tree, length, width, depth and number of the wound opened is very important in sweet gum production. The production period, starting and ending time of the production, the production techniques are all effective factors on the production quality.

During the process of wound opening, 1/3 of the tree diameter and 2/5 of the trunk surface should not be exceeded. Ideal trunk diameter is 160 cm. The attention should be paid attention that the wound length does not exceed 50 cm and the width does not exceed 5 cm. The wound number can be various depending on diameter and it is suitable to open 3 wounds for 25 cm diameter. One more wound can be opened for every 5 cm diameter increase.

Sweet gum oil is also supplied from L.styraciflua L. (American Sweet gum) however, different production techniques are applied.

Sweet gum oil (Styrax Liquidus) is brownish yellow colored and has unique explicit odorous and gives bitterish flavor when it is fresh. It consists of cinnamic acid, cytracin, cytrol, cytron, storesinol and styrogenin. It gives off cinnamon odour when it is heated due to the cinnamic acid it contains.

Sweet gum oil has dense honey-like consistency and is at 1,091–1,1Ɓ gr/cm specific weight.

To summed up the production phases of Sweet gum oil;

| | |
|---|---|
| Redden Phase | End of March / Beginning of April |
| Opening Wound | Beginning of May |
| Collecting Balsam or Wall Phase | Beginning of June |
| Post Wall Phase | July –October |
| Collecting Balsam (Blackbark Phase) | September –October |

The most fertile production months are September and October and continue to the end of November. Additionally, according to the information obtained from Foresters, the first rainfall and dewfall in autumn help the increase in the production.

The production in 1950 which was 181.279 kg, decreased to 18.000 kg in 1980 and below 1000 kg in 1990. Balsam production decreased at the rate of 99% between 1950 and 1990.

The Sweet Gum Production by Years:

| Year | Production (kg) |
|---|---|
| 1950 | 181.279 |
| 1980 | 18.000 |
| 1990 | 1000 |
| 2000 | ––––––– |
| 2001 | ––––––– |
| 2002 | 2000 |
| 2003 | 1702 |
| 2004 | 1000 |
| 2005 | –––––– |
| 2006 | 127 |
| 2007 | 187 |

**Area of Usage of the Sweet Gum Oil**

Liquidambar orientalis is an economical tree, although it has a narrow distribution area.

Sweet gum balsam is supplied from the tree's trunk. The balsam is names as Styrax liquidis, Styrax cradus, Styrax resin and sweet gum oil in Pharmacognosy (Pamukçuoğlu 1964).

Balsam is a pathological product obtained from the leakage due to the wound made with various methods. The product collected, is pressed afterwards and separated from the foreign materials. The residual sediment is used as fumigant.

Balsam is a semi-liquid, brown colored, adhesive, opaque and aromatic substance.

Sweet gum oil which is produced by means of opening wounds on the bark of sweet gum consists of such materials as cinnamic acid, styracin, Styrol and Storesinol.

It is used particularly in perfumery industry as fixator, then in soap making, in varnishes, in tobacco flavoring, in some medical applications; it is also used externally as antiseptic and parasiticide for skin disorders such as scabies and fungal illnesses and used internally for upper respiratory illnesses such as asthma and bronchitis. Moreover, frankincense (Cortex Thymiamitis) remaining after sweet gum oil is produced is used as incense and blister in mosques and church (Pamukçuoğlu 1964).

The production of sweet gum has been occurred for thousands of years. Phoenicians played a significant role in its commerce throughout the historical period. Old Egyptians used sweet gum oil in mummification.

## Market Value of Sweet Gum Oil

Average market price of sweet gum oil is 25 YTL./0.4 Kg, and average market price of the frankincense is 5 YTL/Kg.


As can be seen from the production capacity, the production of sweet gum oil differentiates depending on the years and has been decreasing gradually in recent years. The most important reason of this is the usage of synthetital sweet gum in France which is the main consumes of sweet gum oil.

Another reason is the illegal sweet gum oil production. When demand for sweet gum oil and thus sale price escalates, the illegal production increases in following year and the illegal sweet gum oil put on the market meet the requirement of the market as much as the illegal production. As a result of this, the price reduces and the supplier of sweet gum oil is faced with unduly competition.

**The Studies on The Conservation of Sweet Gum Forests;**

The widest and highest quality population of sweet gum forests distributes within the town borders of Muğla. The best sweet gum forests in this region are located within the boundaries of Specially Protected Environment Area of Köyceğiz-Ðalyan.

"Determination of Biological Diversity and Management Plan in the Köyceğiz–Dalyan SPA" was conducted by Environmental Protection Agency for Special Areas between 2005–2008.A series of activities were specified in the scope of the project. "Conservation Action Plan" towards the sweet gum forests distributing in Köyceğiz–Dalyan SPA was actualized in line with these activities.

## CONCLUSION:

While widespread over wide areas in the Tertiary period 60 million years ago, Liquidambar orientalis Mill. has become a relict endemic species due to the fact that its distribution area has become narrow gradually and today the species distributes only in South-West Anatolia throughout the world.

Greater part of the sweet gum forests are destroyed in various ways due to its close proximity to settlements in Muğla where it distributes mostly.

Some of the most important reasons of the destruction are; firstly and most critically, the destruction of sweet gum communities for usage of area as citrus plantation and agricultural use on suspicion that the sweet gum has lost its economical value after the production of fixatives.

For that reason, with the drainage channels the ground water level is decreased intentionally and sweet gums are left dead. This action is carried out consciously and publicly.

The trees encounter the danger of extinction, because of loss of water in soil (drainage channels). In this case, even the youth can not develop.

While the total sweet gum forest area was 6300 hectares in our country in 1940s, today about 1350 hectares sweet gum left only. According to the forestry amanagement report, normal high forest cover 980 hectares and the degraded scrub covers 320 hectares of the existing sweet gum population. The sweet gum forest between Bucak-Çandır Karacaören Dam where there is no sweet gum production is only covers 8.5 hectares, that's quite small.

The area of sweet gum forests have decreased 6 times during the period of 68 years from 1940 to 2008.

Consequently, the amount of sweet gum balsam provided from these forests also decreased in parallel with this reduction. For instance, while the amount was 181.279 kg in 1950, it decreased to 18.000 kg in 1980 and less than 1000 kg in 1990.

Expantion of the "Sweet Gum Concervation Action Plan" initiated in Köyceğiz–Dalyan, the special protected area (SPA) intending to protect Sweet Gum forest, faces extinction, to a National scale is an absolute requirement for the future of Sweet Gums.

## BIBLIOGRAPHY


1. Acar, I., 1988-Sığla ağaçlarında köklü çelik kullanımının gerek ve önemi. Ormancılık Araştırma enstitüsü Dergisi cilt 34, sayı 2 no: 68.
2. Akman, Y. 1990. İklim ve Biyoiklim. Palme Yayınları, 319 s, Ankara.
3. Akman, Y. 1993. Biyocoğrafya. Palme Yayınları, 379 s, Ankara.
4. Akman, Y., 1982-Climats et Bioclimats mediterranneans en Turquie. Ecologia mediterranea 8 (1/2).
5. Akman, Y., Daget, PH. 1971-Quelques aspects synoptiques des climats de la Turquie. Bull. Sc. Lang. Georg. Tome 5, Fasc. 3. France.
6. Atay, I., 1985-Sığla ağacının önemi ve silvi kültürel özellikeleri. Ist.Orm.Fak.Derg. Seri B, cilt 35 sayı 1.
7. Berkel. A., 1955-Sığla ağacı odununun makroskobik özellikleri ve anatomik strüktürü Hakkında araştırmalar. Ist.Üni.Orm.Fak.Derg. Seri A, cilt V, sayı I ve II.
8. Bonin, G., 1978-Contribution a la connaissance de la vegatation des montagnes de l'Apenin Centro–meridional enasa pour le grade de docteur. es. Sci.
9. Braun-Blanquet, J. 1951– Les groupements vegetaux de la France mediterranneenne centre National de la Rechenere Sci.
10. Davis, P.H. 1965–1985. Flora of Turkey and the East Aegean Islands. Volume 1–9, University Press., Edinburgh.
11. Davis, P.H., Mill, R.R. and Tan, K. 1988. Flora of Turkey and the East Aegean Islands (Supplement). Volume 10, Univiversity Press., Edinburgh.
12. Efe, (Göngördü) A., 1987-Liquidambar orientalis'in morfolojik ve palionolojik özellikleri üzerine araştırmalar. Ist.Üni.orm.Fak.Derg. Seri A, Cilt 37, sayı 2 Istanbul.
13. Ekim, T., Koyuncu, M., Vural, M., Duman, H., Aytaç, Z., Adıgüzel, N. 2000. Turkish Red Data Book (Ferns and Feeded Plants). Turkish Association of the Protection of Nature. 1
14. Erik, S., Tarıkahya, B., 2004. Türkiye Florası Üzerine. Kebikeç. 17: 139–163
15. Gruber, M., 1978-La vegetation des pyrenes aricageoises et catalanes occidentales. These pour le grade de decteur. es. Sci.
16. Örtel., E., 1988-Sığla ormanlarımızın durumu. Orm.Arşt.Enst.Derg.cilt 34, sayı 2, no:68, Ankara.
17. Pamukcuoğlu, A., 1964-Memleketimizin Liquidambar orientalis orman sahası. Türk Biyoloji Dergisi. 14(2).
18. Zohary, M., 1973-Geobotanical Faundations of the midle east Vol. I-II. Gustav Fischer ver by Stuttgart.

**ENVIRONMENTAL PROTECTION AGENCY FOR SPECIAL AREAS**

Alparslan Türkeş Caddesi 31. Sokak 10 Nolu Hizmet Binası 06510 Beştepe
YENİMAHALLE/ANKARA

Phone : +90 312 222 12 34

Fax : +90 312 222 26 61

www.ockkb.gov.tr

ockkb@ockkb.gov.tr

This book is published the framework of the contract signed between by Environmental Protection Agency for Special Areas and the economic enterprise of Agricultural Development Foundation

**AGRICULTURAL DEVOLOPMENT FOUNDATION**

Karanfil Sokak No: 34/13
Kızılay / ANKARA

Phone : +90 312 417 15 88

Fax : +90 312 417 15 89

www.tocvak.org

tocvaktakva@gmail.com