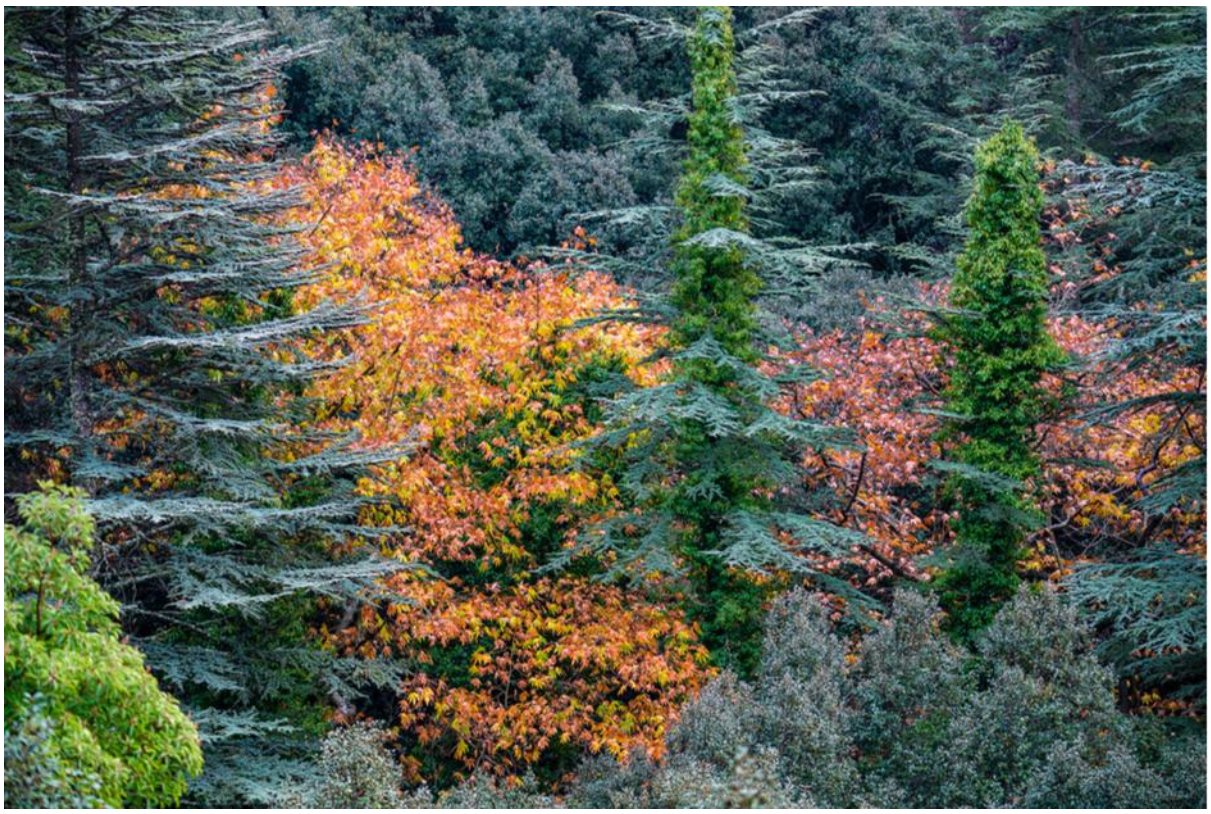
Studying the major dendroflora across southern Cyprus as well as understanding the key roles these forests serve for their habitats as well as for local Cypriot communities.



Harry Baldwin

26/10/23-06/11/23

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*Front image: Cedrus brevifolia at Cedar Valley. Source: Yelisleev, (2023).

With thanks

The applicant would like to express his huge thanks to firstly all the sponsors that made this trip a reality; Merlin Trust, Royal Horticultural Society and Hardy Plant Society. There were many individuals and groups that contributed to the research and planning of this trip including; Tony Kirkham, International Oak Society, Beatrice Chasse, James MacEwan, Andreas Paradisis, Dr. Ralph Hands, Dr. Charalambous Christodolou, Leon Charalambous and amongst many others. Without the kind support of these individuals this trip could not have taken place.

Aims and Objectives

1. To identify all 5 taxa of *Quercus* spp. including all major trees and shrubs across southern Cyprus, note the range of habitats they are grown in, the importance they play within their habitat, how local Cypriot communities rely and manage woodlands and the importance of these species within their ecosystem.
2. By identifying major trees and shrubs in the field, the applicant is to note down key edaphic, topographical, climatic factors to better understand cultivation practices.
3. To recognise what key plant communities are associated with major tree species in order to enhance gardens, education and knowledge.
4. To visit Troodos Botanical Garden, Episkopi Environmental Centre and experts in the field to build contacts and further applicants knowledge in Cypriot trees and shrubs. In addition, these visits will allow the applicant to compare findings from the field to cultivated specimens in botanic gardens, understand conservation efforts and understand how collections are managed.

Map of Places Visited

Plate 1: Map of places visited in Cyprus. Source: Google Maps. (2023).

Introduction

Cyprus, positioned as the third-largest island in the Mediterranean, lies in the eastern Mediterranean Sea, approximately 60 km to the south of the Turkish coast and 100 km west of Syria. Spanning an area of around 9,251 km², the island boasts a varied topography. Starting from sea level along the coastal belt, the terrain gradually ascends to the steep, rocky summits of diabase and serpentine within the Troodos range, culminating in the highest peak, Olympos, reaching 1,952 m. The prevailing climate mirrors the typical arid Mediterranean conditions, characterised by a brief, cool, and wet winter, succeeded by a dry, hot summer. Winter temperatures in the Troodos range can plummet to -10°C, leading to an average of 10 weeks of snowfall above 1,400 m. Rainfall ranges from a modest 300 mm/year on the central plain to an abundant 1,100 mm on the upper slopes of Mount Olympos

Historically, Cyprus boasted extensive forest cover, but today, much of these woodlands have vanished. The Troodos and Kyrenia ranges still retain remnants, accounting for 18% of the island's overall vegetation. This woodland increases to 31% in regions surpassing 1,000 meters, occasionally giving way to tall, shrubby maquis formations (4-6 meters tall) featuring *Arbutus andrachne*, *Pistacia terebinthus*, *Olea europaea*, *Styrax officinalis*, and *Quercus coccifera*. Alternatively, in some areas, it is predominantly replaced by sub-shrubby garigue (vegetation less than 3 meters tall), encompassing Cistus spp., *Lithodora hispidula*, and *Genista sphacelata*.

Cyprus boasts a remarkably diverse flora, due to the varied edaphic and topographic characteristics of the island. Among the 1,750 species in its flora, 128 are exclusively endemic to Cyprus, including well-known species like the Cyprus cedar (*Cedrus brevifolia*) and the golden oak of Cyprus, *Quercus alnifolia*. The eco-region's plant endemism rate stands at around 7% (WWF, 2007). Unfortunately, the impact of human activities over the past 1,000 years has been devastating for the woodlands, leaving only small surviving forest habitats. The presence of old-growth black pine forest (*Pinus brutia*) is now confined to the rocky summits of high mountains. The *Cedrus brevifolia* forest, covering only a few hundred hectares, owes its existence to Winston Churchill. In 1907, during his tenure as Under Secretary of State for Cyprus, Churchill initiated a reforestation program to replace the historic forests that centuries of logging had depleted for smelting fuel, causing extensive systematic erosion (Barton, 2002).

Figure 1: Map of Cyprus. Christodoulou et al. (*2002*)

Avakas Gorge:

Plate 2: Avakas Gorge path. Source: Baldwin, H. (2023).

Avakas Gorge is to believed to have been created after the area's emergence from the sea millions of years ago. The long-lasting action of the river 'Eggs' followed the sloping and diffuse limestone geological background of the area, composed of chalk, marls, limestone, granular limestones and bentonite clays.

Before entering the Gorge, the hills either side were steeped with *Juniperus phoenicea* clinging to the cliff edges. It is known to be a wide species across the Mediterranean and can live to up to 1500 years. There did not seem to be any individuals that were at an excessive size, this likely due to historic forest clearance and natural fires. It is known that the wood has been highly prised for furniture building which might be the main reason for the lack of mature individuals. Despite this, it was good to see a range of co-horts, ranging from small saplings to large individuals. I am told by Andreas Parsdisis (Curator of Troodos Botanical Garden) that juniper forests are now under full protection from felling, but as far as fire is concerned, they do not regenerate satisfactorily after such an event. He stated that after a forest fire, planting of juniper is necessary to ensure its regeneration and perpetuation (Paradisis, 2023). It must naturally be dispersed by mammals and birds that are attracted to the bright red berry. During my visit the fruits were not ripe and must mature during the months of December bringing an important food source for the local habitat.

On the lower slopes and flat ground, small shrubby vegetation consisted of: *Rubus sanctus* (a miniature leaved form resembling *Rubus fruitcosus*, *Sarcopoterium spinosum* (thorny burnet) and *Dittrichia vicosa*.

Plate 3: Juniperus phoenicea. Source: Baldwin, H. (2023).

Plate4: Sarcopoterium spinsosum. Source: Baldwin, H. (2023).

One of the most common small trees that was noted growing amongst the maquis vegetation was *Pistacia terebinthus* and *P. lentiscus*. Interestingly both species grew in close vicinity of each other but were easily distinguished by their rachis. Pistacia lentiscus has a winged rachis whereas *P. terebinthus* was absent. *P. lentiscus* is related to *P. terebinthus*, with which it hybridizes frequently when in contact. It was noted later in my trip that *P. terebinthus* is more abundant in the mountains and inland and the *P. lentiscus* is usually found more frequently in areas where the mediterranean influence of the sea moderates the climate. It is known that when both species grow together they can readily hybridise but upon trying to distinguish it was difficult to ascertain with any certainty.

Plate 5: Pistacia terebinthus. Source: Baldwin, H. (2023)..

Plate 6: Pistacia lentiscus. Source: Baldwin, H. (2023).

Other shrubs and trees included: *Rhamnus lycioides*, *Ceratonia siliqua*, *Cupressus sempervirens* var. *horizontalis*, *Platanus orientalis*, *Olea europaea* and *Styrax officinalis*. An ancient stump of an olive was present with a small piece of interpretation stating the age of the olive was 800 years old. Although just a decaying stump, small whispy growth was present which shows the resilience *Olea*.

Upon entering the Avakas Gorge, the flora almost completely changed. The gorge stood at 45 m in height and up to 150 m in places. Where little light and substrate was present, ferns clung to the limestone walls and at times where conditions allowed, *Nirium* sp., *Platanus orientalis* and *Ficus* sp. were also present.

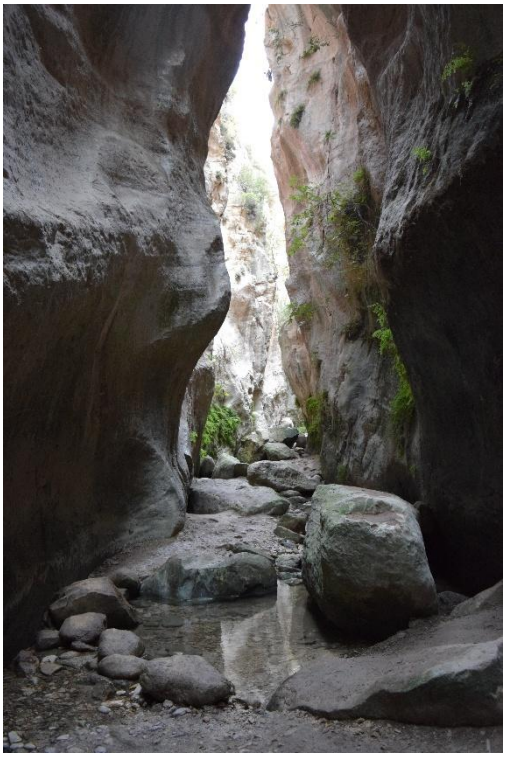


Plate 7: Avakas Gorge. Source: Baldwin, H. (2023).

The most exciting find within the Gorge was *Centaurea akamantis*, an endemic perennial to Cyprus with only two small populations found within the Akamas peninsular. It clung to the steep limestone walls with glaucous hanging but erect stems. Luckily the applicant was able to appreciate it in flower, it produces attractive, purple-pink flowers with a spiky, globe-like shape. The flowers were solitary and terminating each stem.

It is known that this species has been categorised CR (Critically Endangered) according to IUCN Red List Criteria B1ab(iii)+2ab(iii) which an estimated EOO of 7 km2 and an AOO of approximately 1 km2 (IUCN, 2023). Although it is known that the number of mature individuals has increased since a new subpopulation was discovered in 2012, the habitat is known to be declining as a result of grazing. The applicant was told that grazing is not permitted in these areas and penalties are imposed by the Department of Forests. Overgrazing in turn enhances local soil erosion processes. The applicant counted only 12 individuals, although it has been noted by researches that the total population size is 800 individuals undertaken in 2013. The subpopulations are isolated from each other and if one of them disappears it is unlikely that its habitat will be colonised by seeds coming from the other subpopulations.

Plate 8: Centaurea akamantis. Source: Baldwin, H. (2023).

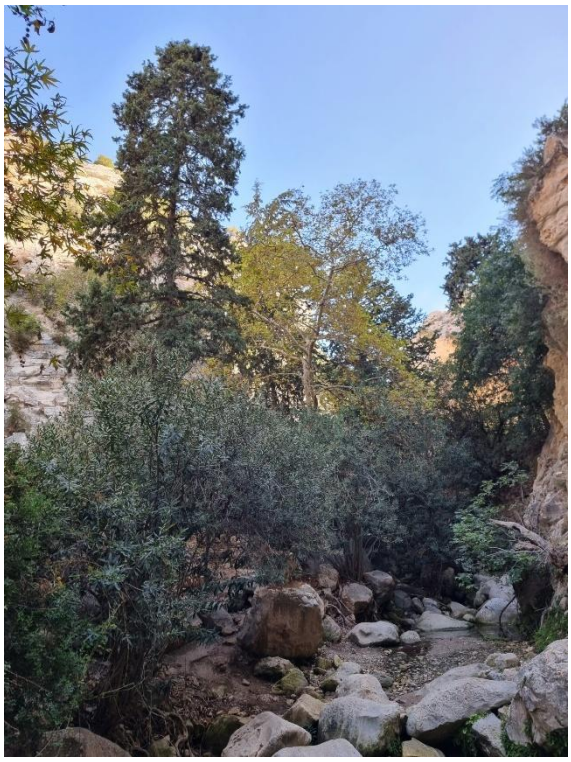


Plate 9:Cupressus sempervirens var. horizontalis and Platanus orientalis. Source: Baldwin, H. (2023).

Plate 10: View from Akamas Peninsular. Source: Baldwin, H. (2023).

The applicant drove to the coast of Akamas Peninsular to gain an understanding of coastal habitats and the flora of the area. The main vegetation along the coastline mostly dominated by the carob tree, *Ceratonia siliqua* and *Olea europaea*. The hike began up a steep slope over looking the Mediterranean ocean. There was little substrate with outcrops of rock, most of which was colonised by *Pinus brutia* and *Juniperus phoenicea*. The main shrubby coloniser was *Noaea mucronata* (thorny saltwort) taking on the attribute of gorse, with attractive blue foliage and sharp spines, but had attractive small pink flowers. One juniper (as seen in attached image) was covered *Ephedra foeminea* in full fruit

Plate 11: Ephedra foeminea. Source: Baldwin, H. (2023).

The slope was open to the elements of the hot sun, salt breeze and at times strong seasonal rainfall. It was clear that the plants present were adapted to cope with these conditions. No doubt in the spring, the area would be cloaked in wildflowers, but as the applicant was visiting in mid-autumn where there was little groundwater present, most herbaceous perennials were absent. Although some flowering bulbs were present.

Asphodelus ramosus was present in its thousands across the whole hike with incredibly large bulbs measuring on occasion over 10cm in diameter. These were found from sea level at the sandy dunes to 1825 m. It was noted by the applicant that it colonised abandoned land, open pine

woodland and roadsides. In smaller crevices *Muscari autumnalis* was present with delicate small blue flowers which was only present on occasion. A surprising find was *Narcissus obsoletus* found growing on the edge of *Juniperus* and *Pinus brutia* woodland. it seemed to be only present in a few locations on the edge of footpaths in full sun. Upon closer inspection, it was interesting to note that ants were pollinating the tiny flowers.

Plate 12: Narcissus obsoletus. Source: Baldwin, H. (2023).

Once reached the top of the plateau, other than *Pinus brutia* and *Juniperus phoenicea*, the ground was mainly colonised by both *Cistus creticus* and *C. salviifolius.* Both not in flower and were generally small in stature. The exciting find was the endemic *Phlomis cypria* subsp. *occidentalis* only found on the Akamas Peninsula. It has been evaluated by the IUCN as Vulnerable as its distribution and populations are fragmented (IUCN, 2023). Upon speaking to Andreas Paradisis at Troodos Botanical Garden, it is likely the reduction of its population is down to previous grazing which is now abolished on the peninsular (Paradisis, A, 2023). The main specimen found was guarded to help prevent grazing or visitors getting close causing compaction. Further hiking revealed a few other individuals but was not seen again on the trip.

Plate 13:Quercus infectoria subsp. veneris. Source: Baldwin, H. (2023).

At the end of the hike, the applicant was greeted by one of the largest aleppo oaks on the island, *Quercus infectoria* subsp. *veneris*. This was the only specimen seen in the area, it might be that more specimens are present but were not apparent on the hike. This particular specimen measured 6 m in circumference and is thought to be over 500 years old. It took on the appearance of *Q. robur* in some respects, although smaller in stature, its habit was broad with rough deep bark but its leaves and fruits were rather different. It has large leaves which were lobed similarly to the English oak but were much larger and its cupule and nut were too much bigger. It was clear by looking at the growth rate on the stems, only 3 cm of growth took place on average each year, suggesting its dry, hot climate with seasonal rainfall prevents too much seasonal growth. It was noted that when visiting Troodos Botanical Garden, recent hot summers have prevented small seedlings from establishing, which might be the reason why no other trees were noted in this area.

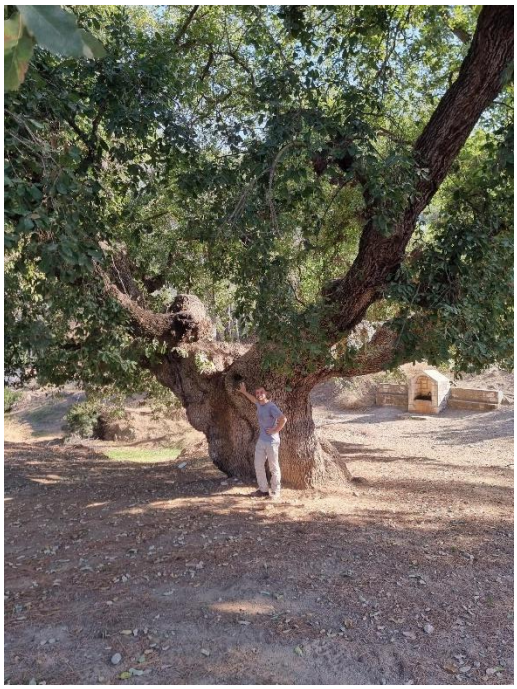


Plate 14: Applicant with Q. infectoria subsp. veneris.

Plate 15: Foliage of Quercus infectoria subsp. veneris. Source: Baldwin, H. (2023).

Plate 16:Foliage of Quercus infectoria subsp. veneris. Source: Baldwin, H. (2023).

Quercus alnifolia, the golden oak.

Quercus alnifolia

Plate 17: Quercus alnifolia. Source: Baldwin, H. (2023).

Quercus alnifolia was one of the key trees that the applicant wished to study whilst in Cyprus. The reason for this began whilst undertaking a student position at The Sir Harold Hillier Gardens in 2013. The Sir Harold Hillier Gardens had the TROBI Champion specimen by height in Britain and was told by Allen Coombes this specimen is unusual in the fact it had made a standard tree rather than a multi-stem. Since then, the applicant has been wishing to see this tree in its native habitat and understand the crucial role it plays within the forests of Cyprus.

Plate 18: Quercus alnifolia. Source: Baldwin, H. (2023).

Quercus alnifolia is also known as the golden oak of Cyprus. It is an evergreen shrub to a small tree, up to 10 x 5 m, bark grey, smooth when young and vertically fissured with age; young twigs at first densely grey tomentose; leaves thick and leathery, slightly convex, ovate, oblong, obovate or suborbicular, dark shiny green and glabrous above, below densely golden brown or greenish

tomentose (rarely silvery grey); acorn narrowly obovate or subcylindrical, cupule enclosing one sixth to one quarter of the acorn, covered with strongly recurved, linear scales.

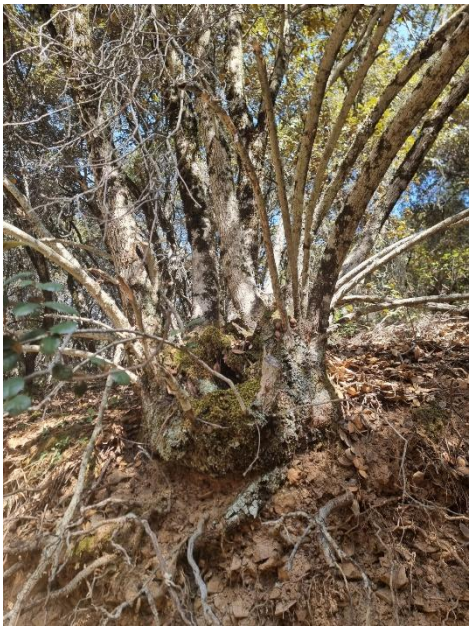


Plate 19: Quercus alnifolia coppice. Source: Baldwin, H. (2023).

Quercus alnifolia is endemic to Cyprus and the applicant noted how abundant this species was within the Troodos Mountains from 300 – 1800 m. It only occurs on the ultra-basic rock formations where it is the dominant understory species within dry habitats and often associated with *Pinus brutia*. The applicant did not have time to visit exceptionally large specimens but it is known in a few locations where the species attains heights of up to 10 m which is exceptional. It is generally a multi-stem shrub and was never noted to have a single stem. It is clear that *Q. alnifolia* has a high ecological value, since it thrives on stony and rocky mountainsides, preventing erosion. It coppices well from the base and thus reinstates itself after fires. The acorns form an important diet for the mountain fauna, the hardwood is suitable for the construction of hand tools and various small artifacts. According to Paradisis, A. (2023) at the Troodos Botanical Garden, the wood was once used as a fuel species to make charcoal.

The habitat type according to Paradisis, A (2023) is "scrub and low forest vegetation of *Quercus alnifolia'* is a priority of Annex 1, Directive 92/43EEC. Therefore, large tracts of forests have been suggested to be included in the Natura 2000 network in order to protect the endemic forests of *Q. alnifolia*. The Red List of Oaks (Oldfield and Eastwood, 2007), lists *Q. alnifolia* as Vulnerable stating that habitat degradation, fire and grazing is the species main threats.

Plate 20: Underside of Quercus alnifolia. Source: Baldwin, H. (2023).

Plate 21: Fruits of Quercus alnifolia. Source: Baldwin, H. (2023).

Plate 22: Quercus alnifolia. Source: Baldwin, H. (2023).

Drummond, who visited Cyprus in 1754, was the first English text that references *Q. alnifolia* "a kind of alder, the leaves of which shine like a green orange; the backs of them, when young, are yellow, but as they grow old, they turn brown" Drummond, A. (1756). The Austrian Botanist, Theofor Kotschy collected this oak at the end of October 1840 "with ripe acorns, on the eastern slopes of Mount Olympos" (Kotschy, 1862). He sent collected material to his colleague Joseph Alois Poech in Vienna, who formally described *Q. alnifolia* in 1842 as well as a number of plants collected by Kotschy. According to Bean who wrote in the Bulletin of Miscellaneous information, (1920), stated that "the tree is apparently not uncommon in Cyprus, for Kotschy states that the acorns were collected by the monks of the Greek monasteries, dried, and used for mixing with the winter fodder of their domestic animals. Kotschy (1862) states that the species may be hardy in southern Europe as it is covered more than a month with snow in its natural habitat. Bean states in the Bulletin of Miscellaneous information (1920), that is hardy but began as a plant in the Temperate House and now grows in the Arboretum in the open air. According to Bean, the original plant raised at Kew from acorns were sent by Sir Robert Biddulph, High Commissioner for Cyprus from 1879-1886. Since then, and to the knowledge of the applicant, this is a hardy species to Britain but needs a position of hot sun and a free draining aspect.

Quercus alnifolia var. argentea

The applicant had read that in 2005, Ralph Hand described a new variety of *Quercus alnifolia.* They observed a number of populations as small groups of plants with flattish leaves with slightly revolute margins and a silvery-tomentose lower surface. The authors consider this constant variation as remarkable enough to support the creation of a varietal level taxon: var. *argentea*. According to Uzunova, *et al*. (1997) the indumentum of the leaves consists of colourless, stellate and glandular hairs. There seems to be no clear qualitative different in the relation of both hair types in leaves of the same age in the two

Plate 23: Quercus alnifolia var. argentea. Source: Baldwin, H. (2023).

varieties. The different colouration of leaves older than one year is possibly caused by a deviating colour of the glandular hairs – young leaves of both varieties are almost indistinguishable. From the applicants perspective, there is no difference between both varieties other than the indumentum colour.

The applicant planned to visit Moummouros in Stravos tis Psokas valley as it from his research on Google Earth and other maps, the area seemed possible to visit by car. Although when arrived it was a long, steep bumpy track. The applicant persisted almost all the way down the valley but barely saw any *Quercus alnifolia* and certainly not the newly described silver form. After many hours of searching, he drove back up onto the main road of in the Troodos Mountains and continued his drive. After a few minutes of driving, to his amazement he saw a flash of silver through the car window and noticed this could be *Q. alnifolia* var. *argentea*. Upon pulling over and investigating, it was clear this was the newly described silver form of *Q. alnifolia*. The silvery indumentum was visually different from the type and glistened in the sun. Throughout the rest of his trip in the Troodos, the applicant on occasion came across *Q. alnifolia* var. *argentea* on many occasions which shows that this is present across the mountains. It often grew next to or in close vicinity of the type but seemed as though no introgression was present. It was clear however, that looking at many specimens, the silvery underside did vary considerably from light brown, slightly silver to strong grey. With little literature to go on, the applicant was extremely happy to find this taxon.

Plate 24: Quercus alnifolia. Source: Baldwin, H. (2023).

Plate 25: Quercus alnifolia acorn. Source: Baldwin, H. (2023).

Plate 26: Lichen covering stems of Quercus alnifolia. Source: Baldwin, H. (2023).

It was also interesting to note that when the applicant visited a dark ravine within the Troodos, he came across *Quercus alnifolia* with no indumentum at all (as seen in Plate 24). This was unusual to the applicant as every individual seen across the whole trip in addition to his research, he had not seen or heard of this being apparent. It is clear that the indumentum is likely used (as seen with other plants) to help prevent moisture loss. Elevation and climatic influences did not seem to affect where both the type and the silver form was found, indicating that the colour might just be genetic. This may suggest *Q. alnifolia* found within deep shade and with a constant supply of water does not therefore need indumentum. It seemed peculiar to the applicant that this is not found in literature and is not described within the type's description.

Plate 27: Quercus alnifolia var. argentea (left) and Q. alnifolia var. alnifolia (right). Source: Baldwin, H. (2023).

Quercus coccifera subsp. calliprinos

The kermes oak, also native to Turkey, Syria, and Israel, is widespread in Cyprus, spanning elevations from 100 to 1300 meters in maquis and pine forests, where it forms small stands of shrubs. While there are a few giant kermes oaks in Cyprus, the applicant, despite lacking time to visit the particularly large specimens, observed numerous sizable trees in their natural habitat. Andreas Paradisis informed the applicant about the historical utilization of this species for fuel and the use of its acorns as pig fodder.

Quercus coccifera subsp. *calliprinos* serves as the host for the carmine scale insect, *Coccus ilicis*, with larvae appearing as red berries on twigs and leaves. The extraction of a red dye from these insects in the past led to the species being named *Coccus coccineus*, emphasizing the association with red berries.

Similar to other species within the genus *Quercus*, the taxonomy of *Q. coccifera* remains contentious, with several authors rejecting the proposed subspecies. The name *Q. coccifera* has different meanings. Usually, it's used for small plants in the Mediterranean, while *Q. calliprinos* or *Q. coccifera* subsp. *calliprinos* is for larger ones in the eastern Mediterranean. In southern Portugal, tree-like forms were called *Q. coccifera* subsp. *rivasmartinezii*, and they're found in other Mediterranean areas too. Pending a comprehensive revision of the species complex, it appears worthwhile to consider accepting and distinguishing the proposed name subsp. *calliprinos*, particularly noting its eastern, more tree-like form within *Q. coccifera* (applicants view).

Plate 28: (Left) Quercus coccifera subsp. calliprinos and (right) Quercus coccifera subsp. calliprinos. Source: Wespelaar webpage, 2023)

Kampos Village – Quercus x campitica

Plate 29: Kampos Village. Source: Baldwin, H. (2023).

The applicant visited a small village within the Troodos Mountains where there has been recorded sightings of a recently described oak hybrid. *Quercus xcampitica* is a hybrid between two evergreen Cypriot oaks; *Q. alnifolia* and *Q. coccifera* subsp. *calliprinos*. *Quercus. alnifolia* grows on igneous formations of the Troodos mountain range at an altitude between 500 and 1800m. *Quercus. coccifera* subsp. *calliprinos* grows from sea level to 1400m. At several places around the Troodos mountain range, the two taxa form mixed populations. Despite being described in 2005, it has been long known by the local inhabitants that this population bear characters of both taxa. In 1997 they adopted the vernacular name "Lakopernia", 'Lakia' referring the vernacular name of Q. alnifolia and 'Pernia' to *Q. coccifera subsp. calliprinos* and in 1999 it was confirmed that they are hybrids (Hand, 2006).

Plate 30: Quercus coccifera subsp. calliprinos (left), Q. alnifolia (middle) and Q. xcampitica (right). Source: Baldwin, H. (2023).

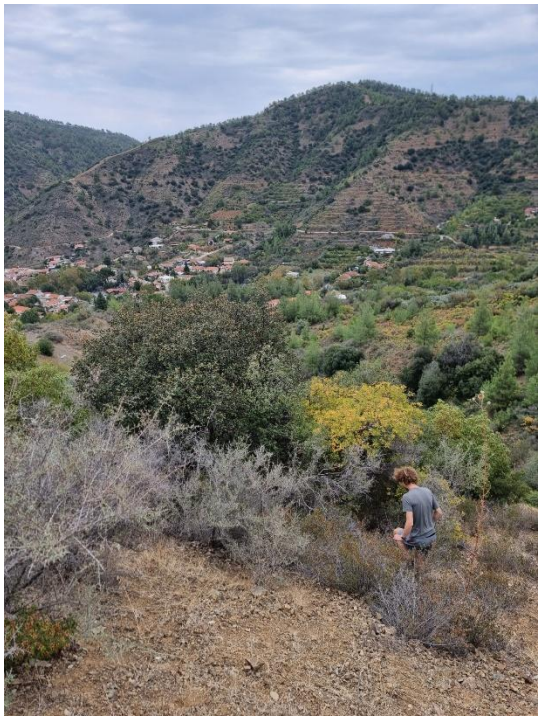


Plate 31: Q. xcampitica. Source: Baldwin, H. (2023).

The applicant was able to locate the exact area with thanks to correspondence with Dr. Charalambous Christodolou near a water tank high above the village at 767 m. On the hike up the location, no hybrids were noted, but once reached the water tank there were a number of individuals. In this location, it seems the hybrid was closer to *Quercus alnifolia*, in its dark shining-green leaves above and the rather dense indumentum below, whereas, closer to *Q. coccifera* subsp. *calliprinos* in the acute, spinose apex, shallowly cordate base and the spinose dentate margins. Yet what was interesting, the applicant had found a further 8 populations (to his knowledge not recorded) following the contour of the mountain and all showed a huge amount of variation. Some individuals showed a much more lanceolate leaf shape with deep dentations with varying degrees of indumentum, some with dark orange and others glaucous or an ivory white. Others exhibited a much larger affinity towards *Q. coccifera* subsp. *calliprinos* as they had minute but entire leaf margins with large acorns with a small, tight cupule preventing the acorn from dropping. The latter I presume are backcrossed with *Q. coccifera* subsp. *calliprinos* with perhaps multiple generations. In addition, upon speaking to Dr. Charalambous Christodolou, he mentioned that when visiting on 5th May 2005, *Q. coccifera* subsp. *calliprinos* was in full flower on 20th May and *Q. alnifolia* was at its end. This suggests that *Q. alnifolia* is the pollen parent and *Q. coccifera* subsp. *calliprinos* is the fruit bearer. Although some individuals looked much more similar to *Q. coccifera* subsp. *calliprinos*, but could potentially be backcrossed with *Q. coccifera* subsp. *calliprinos*

Plate 32: Q. xcampitica. Source: Baldwin, H. (2023).

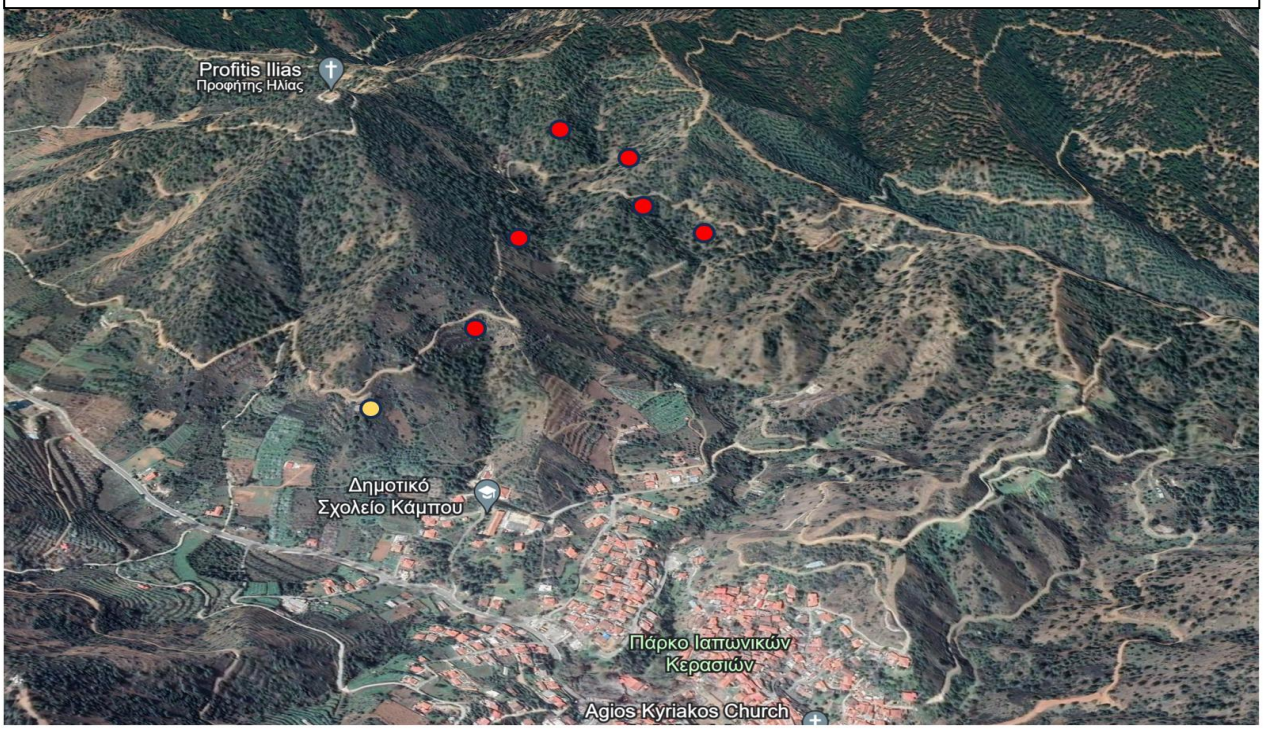
Table 1: Diagnostic leaf characters of Q. xcampitica and the two parent taxa observed by author			
Leaves	***Quercus xcampitica***	***Quercus alnifolia***	***Quercus coccifera subsp. calliprinos***
- Upper surface	Dark shining green	Dark shining green	Bright green
- Lower surface	Rather densely silvery to golden yellow-tomentose below in young leaves and densely silvery-tomentose in mature leaves.	Densely golden or brownish-tomentose in var. argentea	Glabrous or thinly stellate-pubescent, or nearly tomentose at first, usually becoming glabrous with age
- Apex	Acute, spinose	Rounded or shortly acute	Acute, spinose
- base	Distinctly or shallowly cordate	Rounded or broadly cuneate	Rounded or often shallowly cordate
- Margins	Spinose dentate with usually upwards-directed pungent teeth	Conspicuously or obscurely serrate, or sometimes entire or almost entire	Marginal teeth upwards-directed, or when coppiced growth markedly spinose

Plate 33: Q. xcampitica scan. Source: Baldwin, H. (2023).

What was interesting to note, that according to the description notes, only one individual is found at this location and the applicant believes he found three distinct hybrids with possibly several backcrossed individuals. In the additional 8 populations found, other distinct F1 (F>1) hybrids were discovered amongst varying and potentially backcrossed hybrids. It was also noted by the applicant that *Q. coccifera* subsp. *calliprinos* does show wide phenoptypic variability, which may reflect a greater genetic variability than *Q. alnifolia,* which has reduced morphological variability, possibly attributed to its narrower ecological range.

Recent studies on genetic differentiation and hyrbidisation between *Quercus coccifera* subsp. *calliprinos* and *Q. alnifolia* in Cyprus (Neophytou, 2010) show that the two species are both morphologically and genetically distinct, with very limited chloroplast DNA introgression. Evidence for interspecific pollination was rare. Specifically, no interspecific pollination was detected in *Q. alnifolia*, but rare pollination of *Q. coccifera* subsp. *calliprinos* by *Q. alnifolia* could be inferred. This coincides with comments made to the author from Charalambous Christodoulou (2023). Reproductive barriers may be the reason for the limited genetic introgression between both species.

Sites of Quercus xcampitica at Kampos Village, Troodos Mountains.



Additional populations found

Original described location

Valley of the Cedars – Cedrus brevifolia

Plate 34: Valley of the Cedars. Source: Unknow, (2023).

Cedrus brevifolia has witnessed the islands history through time. The presence of the cedar in Cyprus has been traced through to predate human inhabitation of the island to the second half of the Miocene period to about 7 million years ago. *C. brevifolia* is just 1 of 4 species found on earth. They are all descended from a common ancestor which existed on the shores of the Tethys seas - the mass of water that connected two great oceans on the earth at that time. The other species of *Cedrus* found worldwide are: *C. libani* (Lebanon, Turkey), *C. atlantica* (Morocco) and C. deodara (Himalayas). The isolation of Cyprus in combination with its environmental conditions has led to its unique characteristics. Other than its shorter needles, it has a higher endurance to hotter drier conditions unlike other known species of the genus.

Plate 35: Kykkos Monastery featuring C. brevifolia.

The first reference is by Theophrastus an author who lived in the 4th century BC. The Roman Pliny the Elder also noted that cedar wood as the main material used to construct the battle ships of Demetrious the Conqueror who described the Cedar Valley in his journal during a visit to Kykkos Monastery in 1753. In St Nicholas Church (as visited by the applicant, Plate 35) which is located in Chakistra dates from the 16th century;

it was noted many sacred icons were made from cedar wood and despite their age seem to be in very good condition. This is due to the woods durability and its resistance to rotting due to the resin it contains which also gives it a distinctive aroma. The cedar wood was highly esteemed throughout history for its properties and its excellent timber qualities. Now a protective species, it is no longer sold as timber. However, the applicant was told by the Department of Forests, that in special circumstances small amounts of dead wood are sent to local timber yards for furniture making and construction beams for religious icons. From visiting Kykkos Monastery, it was clear how important the cedar has been for religious purposes as well as building materials. The image above celebrates the cedar in the paintings and shows how important it must have been.

It typically has a conical shaped crown, but mature and over mature trees are distinguished by flattened crown with horizontal branching. The colour of the foliage is characteristic of the cedar, ranging from light green to grey or blue. Its flowering period is from September to October when it forms both male and female flowers. The seed cones reach full maturity after 18 months and is shaped like a barrel, measuring 8 x 5 cm. Wind is necessary for pollination and fertilisation and facilities seed dispersal since cedar seeds have winged appendages allowing them to travel large distances away from the mother tree.

Plate 36: Cedrus brevifolia cones. Source: Baldwin, H. (2023).

Changes in climate through the centuries, human pressure and over exploitation of natural resources, have all contributed to the shrinking of the cedar forests; which in the past, was more widely spread across the island. The presence of *Cedrus brevifolia* on these rocky mountain slopes creates suitable conditions for other important flora and fauna to live alongside. It seems as though they act as an umbrella to host other species within its habitat. The Department of Forests have recognised the enormous ecological importance and has now been classified under a special conservation convention. The species has ben included in the Red Listed Data Book of Cyprus and has been based on the Criteria set out by the International Union for Conservation of Nature which they have characterised as Vulnerable. A huge area of the cedars were burnt in 1974 when the Turkish invaded Cyprus. Now the area has been replanted with thanks to the Department of Forests.

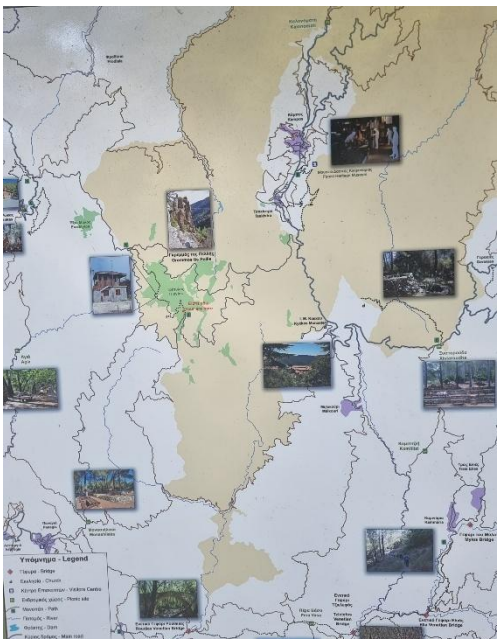


Plate 37: Distribution of Cedrus brevifolia. Source: Baldwin, H. (2023).

This distribution is fragmented in Paphos Forest as seen in the attached image. Some small populations are found on the mountain tops at 1362 m and others at low altitudes of 900 m. Some in deep soil, others clinging to the sides of rock faces. Those that have rooted in rock and streams

prove the adaptability of the species. It seems now it is negatively affected by abiotic factors such as climatic change, soil erosion, competition with other woody species, insect infestations, forest fires as well as fragmentation of its habitat due to natural processes or human intervention. Recognising the pressures and threats, the Department of Forests submitted a project proposal through the Life programme to ensure further conservation is undertaken.

It was noted that some trees removed had direct competition on young cedars. *Quercus alnifolia* is often coppiced as well as the removal of small *Pinus brutia* in order to allow light and more access to water. The applicant was told that for the first time, its habitat is now being expanded out of its current range. Two thousand seven hundred cedar seedlings were planted alongside other companion species within its habitat. In order to ensure the survival of these seedlings, an irrigation system was installed for a three year period. It was not possible to install irrigation in all remote locations, so the Department of Forests developed other practices such as autonomous irrigation ponds and small water tanks.

Plate 38: Water for wildlife. Source: Baldwin, H. (2023).

Plate 39: Bat box. Source: Baldwin, H. (2023).

In order to deal with forest fires, the Department of Forests implemented a series of actions which included forest patrolling from June to September, the installation of forest fire danger signs, permanent closure of forest roads by installing entrance bars, fire breaks, two 9 tonne water tanks and the removal of organic biomass alongside roads. Particular emphasis was placed on the management of the flammable dry biomass within the forest using the natural method of pasturage by wildlife species of the forest such as the mouflon. For this purpose, new watering stations and artificial lakes were installed within the natural boundaries of the habitat in order to attract the areas fauna during the summer months, thus indirectly contributing to the reduction of dry biomass. These small ponds offer coolness in hot days supporting and contributing to the areas biodiversity. Part of the projects conservation actions are the measures which were implemented to regulate the biotic and abiotic factors. Such measures include the control of insects and rodents in order to control the population of insect species which predate on cedar cones. The control of these organisms was through the installation of insect traps through the use of pheromones together with artificial nests. In addition, bat boxes have been installed to be a biological regulator on insects that predate cedar

seeds. Owl boxes have also been installed to help reduce the rodent population which in turn should bring about a positive affect on the life cycle of the cedar.

Plate 40: Gabions built to prevent erosion. Source: Baldwin, H. (2023).

To improve the abiotic environment, the project has also erected a series of anti-erosion measures. Gabions have been installed along streams which passes through Cedar Valley to help regulate the flow of water. In addition, the construction of drystone walls have been established as well as log barriers to help stabilise the soil. It was noted that within these walls it is with no doubt that this creates a microhabitat for small flora and fauna which will boost biodiversity.

Plate 41: Cedrus brevifolia. Source: Baldwin, H. (2023).

Plate 42: Pollen cones on Cedrus brevifolia. Source: Baldwin, H. (2023).

Plate 43: Small needles of Cedrus brevifolia. Source: Baldwin, H. (2023).

Troodos Botanical Garden

Applicant visited Troodos Botanical Garden to meet Andreas Paradisis, the Curator and Manager of the garden. Located in the Troodos National Forest Park within the old boundaries of the now abandoned asbestos mine, makes the location and garden unique. This is a great example of how an unused space can be transformed into an area of education, science, conservation and recreation.

The applicant gained a tour from Andreas Paradisis of the garden, arboretum, seed bank and herbarium. The garden was laid out displaying a range of endemic and ornamental Cypriot plants which has been landscaped and planted to a high standard. They had cleverly designed the space for the visitor to be drawn through a series of paths leading you to interpretation boards displaying conservation efforts and educational displays. Each plant has been labelled botanically, with its latin name, common name and at times with additional information regarding its ecology and conservation efforts.

Plate 44: Plant label interpretation. Source: Baldwin, H. (2023).

All plants excluding the arboretum is irrigated using a drip line which allows the plant displays to not only be healthy, but also aids against drought during the summer months. Andreas Paradisis added that having irrigation aids seed collection for the seed bank as it allows the plant to put on considerable growth (Paradisis, A, 2023). The seeds collected both inside the garden and in the wild, are collected for the National Seed Bank based in Nicosia which is used for conservation. Alongside any seed collections, herbarium specimens are made which are sent to Nicosia as well as keeping some at Troodos Botanical Garden.

Plate 45: Scilla autumnalis. Source: Baldwin, H. (2023).

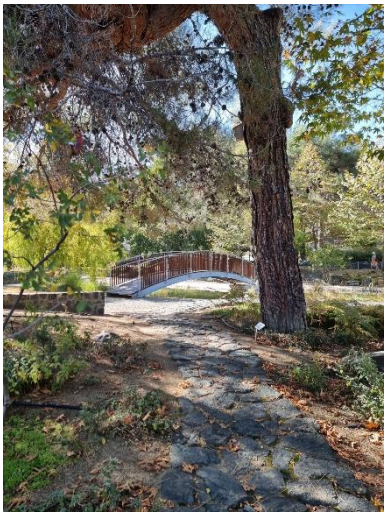


Plate 46: Paths within the garden. Source: Baldwin, H. (2023).

Plate 47: Plant label. Source: Baldwin, H. (2023).

Interview with Andreas Paradisis – Troodos Botanical Garden

What is the role of Troodos Botanical Garden?

The role of the Troodos Botanical Garden is to promote recreation, research, education to all demographics and conservation of all higher plants within southern Cyprus. When the applicant walked through the Botanic Garden, although small, it was nicely designed, taking visitors through an ornamental garden planted with generally only rare species of plants from Cyprus. All were labelled with their botanical names and for some species a QR code was available for further education.

How many staff do you have working in the Botanical Garden?

Andreas is the Curator who is full time and the rest of the staff are part time workers which varies depending on the workload and time of year. At times he may have between 3 and 8 part time workers looking after the garden or undertaking reforestation/conservation projects.

What have been the historical pressures on Cypriot forests?

Andreas stated that due to human occupation, Cyprus at low elevation was heavily forested which contained large numbers of oaks, including *Quercus coccifera* and *Q. infectoria*. However, since early human settlements established on Cyprus about 6000 BC, people have depended on these forests as a source of fuel, building materials, game animals and for grazing of domestic livestock.

During the 19th century, the goat population on Cyprus exceeded that of any other island in the Mediterranean Sea. Overgrazing and intentional setting of fires to produce fresh forage for livestock transformed large areas of forest into degraded shrub (garigue and maquis) vegetation. Land clearance and terracing of hillsides for crop production destroyed virtually all of the island's oak forests. Today, with the exception of *Quercus alnifolia*, oak forests no longer exist in Cyprus, other than a few small groves or individual trees.

When the British took control of Cyprus in 1878, its forests were significantly reduced and what forest remained was severely degraded. One of the first agencies chartered by the British was a Department of Forestry, which began reforesting areas using both native and introduced species. *Eucalyptus cameldulensis*. During the 1950s, following excessive timber harvesting during World War II, the Department of Forestry launched a massive forest recovery effort. During the Turkish Invasion of 1974, large areas in the northern part of Cyprus burned and today most, if not all wildfires are of human origin. Extensive afforestation/reforestation programs continue with the hope to establish further native forests.

What are the current pressures facing Cypriot forests today?

Andreas alluded to pests being one of the major factors affecting native forests today. The two most prolific are pine processionary moth and several species of bark beetle.

Pine processionary caterpillar is regarded as the most damaging pest of pine forests throughout Cyprus and the Mediterranean Region as whole. During outbreaks, needles can be stripped from pines in less than a week. While few trees are killed directly as a result of defoliation, infested trees suffer

from reduced growth and large trees have increased susceptibility to attack by bark beetles. The larvae have irritating hairs, which can cause skin rash and eye irritation on contact. During outbreaks, the entire environment becomes contaminated with microscopic hairs to the extent that campsites and other forest recreation areas become unusable. A variety of preventative and direct control measures are used to combat this insect. Removal and destruction of branches containing egg masses and larval colonies is effective in small areas such as campsites or picnic grounds and has been widely used across Cyprus. Aerial and ground application of chemical and biological insecticides are also widely used.

Bark beetles are another group of insects that are damaging Cypriot forests. Although this group of insects has not been studied extensively in Cyprus, collection records indicate that about 13 species are associated with either *Cedrus*, *Cupressus* or *Pinus* spp.

He also alluded that the amount of snow fall has drastically changed over the last two decades. He stated that 20 years ago in the winter months there would regularly be over 1 meter of snow. Now, the maximum snow that falls does not amasses more than 50 cm in depth. He said this is likely to cause detrimental effect to many habitats as many species rely on a large amount of snow melt in the spring and without it, will likely change the habitat and ecology in various areas across the Troodos. Although he said he has not seen the effects as of yet.

Plate 48:Disused asbestos mine now converted to botanic garden. Source: Baldwin, H. (2023).

Plate 49: Paths within the garden. Source: Baldwin, H. (2023).

Mount Olympus

Plate 50: Pinus nigra subsp. pallasiana. Source: Baldwin, H. (2023).

Plate 51: Juniperus foetidissima. Source: Barret, L. (2023).

The applicant drove and hiked to the highest peak of the Troodos mountains, Mount Olympus (Chionistra). This was an interesting opportunity to understand the change in vegetation in relation to elevation. From 1000 m, the applicant encountered *Arbutus andrachne, Cercis siliquastrum, Quercus alnifolia*, *Pinus brutia*, *Platanus orientalis*; but as soon as the applicant reached 1700 m the vegetation completely changed and became pure stands of *Pinus nigra* subsp*. pallasiana.*

It was interesting to see such large stands of *Pinus nigra* subsp*. pallasiana* as no other tree dominated the area. There was on the odd occasion both old and young *Juniperus foetidissima*, but it was clear *P. nigra* subsp. *pallasiana* formed extensive forests and was the dominant tree species between 1400-1900 m. They are exceptionally long lived, according to the applicants talk with the Troodos Visitor Centre, their age ranges from 500-1000 years old. The applicant saw a cross section of *P. nigra* subsp. *pallasiana* which died in the year 2000 which proved to be over 400 years old, measuring 4.2 m in circumference. Interestingly, all old individuals seen across the trail appeared the same size in age,

Plate 52: Slope of Pinus nigra subsp. pallasiana

which may suggest a mass felling between 400-500 years ago. It has been noted in the applicants research that Cyprus has historically been a hub of ship building and timber exports which may infer this theory. The applicant came across one of the largest black pines in the area which measured over 6 m in circumference suggesting it is over 600 years old.

The applicant asked Andreas Paradisis from Troodos Botanical Garden what is the largest current threats to the black pines. He stated that climate change is having one of the biggest negative impacts on the species. Paradisis, A, (2023) added that up unto 10 years ago, snow would be at a depth of up to 1 m, now the snow reaches barely 50 cm, which means less water is present not only for the black pines but also biodiversity as a whole. Andreas added that any changes in availability of precipitation, affects plant growth and forest cover in particular. Precipitation has decreased (the average precipitation in the last 30-year period is 17% less than in the period 1901-1930) and temperatures are likely to increase (increasing trend of 0.01°C per year). It is expected that by 2030 precipitation will decrease by 10 - 15% and temperature will increase by 1,0 - 1,5°C compared to the normal values of the period 1961- 1990. In Cyprus, the impact of drought is significant for the health of the forest ecosystem.

The applicant had been previously told that *Pinus nigra* subsp. *pallasiana* has also been used for resin extraction in the past. “Pechen” (pitching) is the name given to the process of extracting resin from black pine trees and has been a centuries old technique and occurs in many countries where the distribution of *P. nigra* falls. A cut is made into the bark in spring, which then allows the resin to flow led by wooden slats. The resin is used for varnishes, adhesives glues, medicines, chewing gum and soap. According to Andreas Paradisis at the Troodos Botanical Garden, this is no longer practiced, this might be due as this is invasive damage to a tree and likely causes damage (Paradisis, A 2023). The applicant undertook some research and Van, M *et al*. (2017) undertook a study to determine the effects of the resin extraction process and whether fungal bodies were present in both resin-tapped trees and non-tapped trees. Three hundred and thirty three resin tapped trees and 163 non-tapped trees were investigated. The results indicated that the number of tapping scars on the pines’ trunk surface, resulting from the resin extraction process, explained the decrease of (a) the average annual growth of the pines by 9.2%, (b) the annual growth after the resin extraction process by 11.7%, while the explanatory power increased to 19% in trees that were tapped early in their life. Fungal presence was successfully classified in 91.5% of the resin-tapped trees, whereas those non tapped showed 9.2%

Plate 53: Ski slope degradation. Source: Baldwin, H. (2023).

fungal bodies present. This suggests that the resin tapping process has harmful consequences for the foreseeable future of each individual.

Other threats noted by the applicant was the presence of pine processionary moth. One nest was noted on a mature black pine, the applicant was told it is a big problem in younger plantations as one nest can defoliate an entire tree. The applicant was told that few mature trees are killed directly as a result of defoliation, infested trees suffer from reduced growth and large trees have increased susceptibility to attack by bark beetles, another non-native invasive pest. In addition, it was noted that some areas are used for skiing during the winter months. Large tracts of forest have been removed to allow for ski lifts, yet it might be these tracts are used as fire breaks. Although with added human pressure from this activity, it brings a large amount of tourism to Cyprus which in turn would support and finance many of the conservation activities.

Other than seeing the major tree species of the black pine, it was noted that many *Cedrus brevifolia* have been planted over the last 10 years. It was previously read by the applicant that the Department of Forests are expanding the range of this species outside of its current range to support its conservation. A number of endemic plants were seen by the applicant which included; *Sorbus aria* subsp. *cretica*, *Berberis cretica*, *Rosa chionistrae* and *Nepeta troodii*. Interestingly the applicant also saw *Quercus alnifolia* at 1900 m, which is outside of its elevation range, as they usually are found up to 1800 m. This specimen was small in stature and possessed small leaves, representing its harsh habitat conditions.

Plate 54: Berberis creticus. Source: Baldwin, H. (2023).

Plate 55:Unknown Lamiaceae. Source: Baldwin, H. (2023).

Plate 56: One of the largest Pinus nigra subsp. pallasiana. Source: Baldwin, H. (2023).

Conclusion

The applicant thoroughly enjoyed learning about the dendroflora of Cyprus as well as exploring the importance of Cypriot forests both historically as well as considering their future in a changing climate. Balancing visits alone in the field and with professionals, whilst also visiting and speaking to experts, allowed him to build on his knowledge and experience in this field.

In hindsight, the applicant would have liked to spent more time at Kampos village exploring *Quercus xcampitica* as well as exploring the local area further to understand the potential extent of this new hybrid. In addition, he did not have time to visit the old forests of *Q. infectoria* subsp. *veneris* and visit old individuals located in villages scattered in the Troodos. This is due to additional time spent often at roadsides studying and documenting trees and habitats as well as spending longer at study sites and with professionals. Despite this, the applicant feels really pleased with how much he achieved and documented throughout the entire trip. Although a few small sites were not visited, he feels he managed to spend a great more time studying the important sites associated with the project and helping him achieve all set objectives.

If the applicant were to revisit, he would wish to study extent of fragmented forests of *Quercus. infectoria* subsp. *veneris,* undertake further research online and in the field on the extent of *Q. xcampitica* as well as undertake research into the forests of Northern Cyprus.

Expenses

Flights: £341

Flight luggage: £96

Accommodation 11 nights: £766

Subsistence 11 days: £550

Car rental: £405

Additional expenses including (taxi transfers, car fuel, tolls, additional phone internet etc.): £264

Original proposed costings: £2252.75

Actual spent total: **£2422**

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