



Hedera helix L. and damages in Tlos Ancient City

Zuhale Elinç^{1*}, Taner Korkut², Latif Gürkan Kaya³

¹ Akdeniz University, Faculty of Fine Arts, Interior and Environmental Design Dep., Antalya, 07059, Turkey

² Akdeniz University, Faculty of Letters, Archaeology Dep., Antalya, 07059, Turkey

³ Mehmet Akif Ersoy University, Faculty of Engineering-Architecture, Architecture Dep., Burdur, 15030, Turkey

Abstract

There are various plant types in Tlos Ancient City of Fethiye district in the Province of Mugla, a city where different residential ruins of Lycia Civilization starting from Classical Age until Byzantine Period. Tlos is an important city in West-Lycia and is situated right on the control point of Lycia Way. *Hedera helix* L. is one of the plants living in this area, which attracts the attention as it mostly harms the ancient ruins. One of the most important reasons why *Hedera helix* L. is growing commonly in this region is the perfect ecological circumstances for the growth of this plant of the location where this ancient city is situated in. Additionally the fact that the ruins of the city are left on their fate, is another perfect circumstance for the *Hedera helix* L. to grow. Climbing or creeping stems of *Hedera helix* L. stick easily to the objects it touches and encircle them. Due to this characteristic, the walls of the ancient city are covered by this plant. Nevertheless, *Hedera helix* L. does not only harm the ancient constructions and natural rocks but also woody plants. The harm caused by dried out or cut *Hedera helix* L. are more than the harm caused by them when they were untouched. The subject of this study is to prove the shape and level of the harm caused by *Hedera helix* L. on ancient ruins of Tlos. At the same time, this study will underline the fighting methods against *Hedera helix* L. by comparing similar studies in other countries. Knowledge collected after this study will offer an insight into the excavation and restoration studies undertaken in all Mediterranean countries.

Keywords: *Hedera helix* L., Tlos Ancient City, Plant damage, Turkey

Copyright © 2013 by the Author(s) – Published by ISDS LLC, Japan
International Society for Development and Sustainability (ISDS)

Cite this paper as: Elinç, Z.K., Korkut, T. and Kaya, L.G. (2013), "*Hedera helix* L. and damages in Tlos Ancient City", *International Journal of Development and Sustainability*, Vol. 2 No. 1, pp. 333-346.

1. Introduction

Aim of the study is to determine the results of the studies regarding the spread and removal of the plant over and from Tlos Ancient City, which has favorable ecological conditions for the habitat of the plant *Hedera helix* L. No other research has taken place on this subject concerning this issue. This is the first study which has taken place under the project of TUBITAK (The Scientific and Technological Research Council of Turkey).

Three criteria are taken into account for the spread of the plant over the structures and these are as follows:

- a) Direction,
- b) Age of the structure and
- c) Material of the structure.

2. Literature review

There are many wall flora-related researches in the world, which have been carried out in various countries. Segal (1969) and Brandes (1992a; 1992b) comparatively studied wall flora and vegetation in various parts of Europe (especially central, west and south parts). A great number of researchers analyzed the plant communities of the wall flora in the countries in Mediterranean and mild temperate zones. However, there are very few studies about this subject in Turkey. These few studies are the ones carried out on the historical structures in Izmir (Gemici, 1995), Kayseri (Aksoy and Çelik, 2000), European Side of Istanbul (Yeşilot, 2000), Edirne (Yarçı and Özçelik, 2002), Antakya and its environs (Karahan et al., 2012) Antalya and its vicinity (Sert, 2007; Sert et al., 2008). Also some of the researchers carried out important studies regarding the spread pattern of the flora over the structures and the damage to the structures caused by the flora Mishra et al. (1995) find out in their study that the higher plants generally grow in the cracks, cavities and crevices already present on the monument or in areas where other types of plant growths already exist. Lisci et al. (1993) ranked the damage caused by the plants from + (minor) to ++++ (major) in their study, which was performed on the plants over the historical structures. In their study, Lisci and Pacini (1993) prepared a sketch showing the wall parts (over, inside etc.) in which the plants grow in the historical structures. They stated that although *Hedera helix* L. plant was very aesthetic, it caused various damages and the degree of its damage was ++++ (major), English Heritage (2010) studied all positive and negative effects of the plant *Hedera helix* L. on the historical structures in their seminar report titled "Ivy on walls". They revealed that the plant, despite its damages on the historical structure, had benefits both for the structure and ecology. Northern Ireland Environment Agency (2009) have discussed the points to take into account while removing the plant *Hedera helix* L. from the historical structures, in their Protecting historic monuments guidance booklet.

There are some studies (i.e. Segal, 1969; Darlington, 1981) about wall vegetation and their growing direction. According to Segal (1969), direction of the wall has great importance for wall vegetation. Although wall vegetation has been grown well on the north, east and west, the growing has been poor on the south.

3. Materials

3.1. Tlos antic city

3.1.1. History

Tlos Ancient City (Fig. 1), which is located on the western slopes of Akdaglar, is an important city in western Lycia settlement. According to the ancient sources, the city, which is distinguished with its defensible mountainous terrain and location reaching over Xanthos Valley, is accepted to have been established by the hero Tloos. Even the city is believed to be named after Tloos. Since the name of the city is referred to as Tlawa in Lycian language and the city is the same with "Dalawa Country" emphasized in Hittite manuscripts, the existence history of the city dates back to 15th century B.C. The fact that history of the city, which was formed in the light of the epigraphic data, began during the earlier periods is supported by various ceramics, hand tools, jeweler, divine figurines and grave foundlings which belong to Prehistoric Ages and were discovered during the on-going archeological excavations that began in Tlos in 2005. These findings are dated as of late Neolithic Age and are considered as the earliest archeological findings discovered in Lycia Region until now. Similar to other Lycian cities, Tlos Ancient City was under the impression of Persians for a long time and experienced a bright Classical Age in the 5th and 4th centuries B.C. The fact that Tlos was one of the six cities to have 3 rights to vote in Lycian Union shows the power of the city in terms of military and economy in Lycian Region during the Hellenistic Age. The importance of the city also continued during and after the Roman Age. The monumental structures which reach our day from the Roman and Byzantine Periods are the significant proofs of the importance of the city (Tloskazilari, 2012).

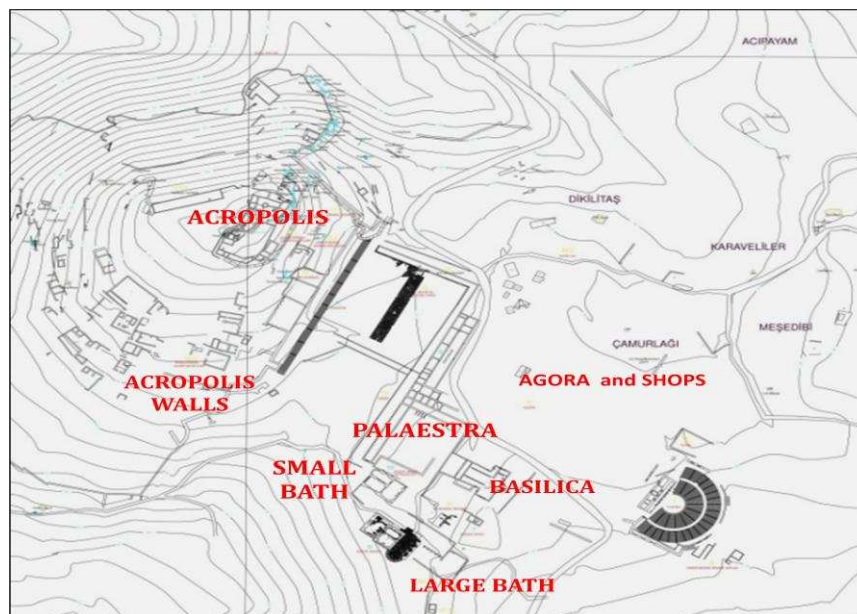


Figure 1. The Map of Tlos

3.1.2. Large bath

The structure, which is called as Large Bath due to its dimensions (45 m x 28 m), was built on the slope in the south of Kronos Temple, at a location dominating Xanthos Valley. Large bath, which is made up of three adjoining areas connected to one another with two doorpasses, displays the figure of a typical Lycian Bath due to its architectural features. The place located in the east direction of the bath and used as entrance area is *frigidarium* and this place is organized in north-south direction. Entered through a monumental door in the north direction, *frigidarium* oversees Esen Valley through the apsidal structure with seven-arched window arrangement in the south. Through two doors in the middle of the western wall of *frigidarium* section, a passage to *tepidarium* is enabled. Unlike *frigidarium*, *tepidarium* section is organized in an east-west direction and lightened in the south with the windows. As distinct from the *frigidarium*, the place is heated with a different system—underfloor and wall heating. For underfloor heating hypokaos system was used. As to the wall heating, the hot air circulating inside the gaps formed in the backs of the earthenware plates fixed on the walls with earthenware nails was used. In the far west side of the bath, exists the *caldarium* section. As in the *tepidarium* section, *caldarium* section is also organized in east-west direction and lightened in the south and west directions with the windows. *Tepidarium* and *caldarium* sections are also connected to one another with two different doors. Different heating systems seen in the *tepidarium* section—underfloor and wall heating— are used in the *Caldarium* section, too. There are also channels of hot air circulation under the floor, which connect two places to one another (Tloskazilari, 2012).

3.1.3. Small bath and palaestra

The structure having been called as small bath due to its dimensions (36 m x 30 m) is located in the north of Large Bath and similarly made up of three master areas. However it is not possible to see the Lycian type adjoining sequence observed in Large Bath. The two places in the west side of the bath lie in the east-west direction. The place in the east side is located in north-south direction. Entrance to the place in the east direction is through an arched door which opens into the middle of the eastern wall and is surrounded by alcoves both on the right and left sides. The passage to palaestra is through another arched opening in the western wall of the place. At the place in the east, no heating system was observed. Therefore it is thought that this place was used as *frigidarium*. The function of the place coming after the *frigidarium* is a matter of debate. However, since a passage to the second place in the western direction is enabled through the opening in the middle of the northern wall of this place, it is more probable to think that this place is a *tepidarium* section. The mentioned place is smaller when compared to the other sections of the bath and there are underfloor and wall heating systems formed with similar techniques. The western wall of this place is demolished. However following from the ground level, it can be understood that it was organized in an apsidal way. There is no opening to allow passage from this place to the palaestra but there is another door which enables direct passage from the *frigidarium* in the east to this place. Considering these, it is highly possible that this place is *caldarium* (Tloskazilari, 2012).

3.1.4. Basilica

“City Basilica”, which was constructed in the dimensions of 44 m x 33 m x 20 m during the Early Byzantine Period, reminds the cross-formed basilicas of the age in architectural terms. East-West oriented structure has three naves and its apsis faces east. Main entrances of the structure are in the west direction. The main entrance in the middle is larger than the side entrances. While the doors in the north and south directions open into the naves, the door in the centre enables the passage into the middle nave. Doorframes of the doors in the north and south directions still remain standing but headstalls of the doors have fallen right on the threshold. The headstall and doorframes of the door opening into the central area are demolished towards the threshold and narthex. While the Basilica is lightened with 8 windows in total on the northern and southern walls, it is lightened with 2 windows on the eastern wall. The 3-window abscissa built in the middle of the eastern wall is formed as a polygon. The walls, most of which still remain standing, were formed using rubble stone. However, it is observed that plain, embossed and unscripted blocks, which were collected materials, were also used from place to place. Also 14 bases in two rows, which divide the central area into three naves, are also made up of collected materials. Pedestals are located over these stands. The gaps between the stands were closed by laying up bricks and collected blocks. However openings enabling the passage into the central area were also allowed. For example, there are two opposing passages with a width of 87 cm, at the entrance of the basilica. The partially protected plaster pieces on the inner walls of the structure show that the wall of the structure was covered with plaster. Even it is partial, the painting made on the said plasters using red-black colors reached our day. The floor of the basilica is covered with mosaics prepared with *Opus Tessera* technique (Tloskazilari, 2012).

3.1.5. Agora and shops

The plain area in the west of the theatre is thought to be Agora. The external walls of two-storey shops in the east end of the stadium area extend through this plain area, which is thought as Agora. The recently opened asphalt road has cut the connection between Agora and the shops. However the doors enabling exit from the interiors of the shop structures into the Agora have reached our day in a solid way. Of these shops, while the entrances of those facing the stadium area were enabled through the posted gallery which lay in the north-south direction and was used as a street, the second floors opened into the Agora located at the upper terrace. Also at the beginning point for palaestra, which is located in the south, stands a long and monumental door allowing exit into the Agora in the allowing exit into the Agora in the east (Tloskazilari, 2012).

3.1.6. Acropolis walls

The plain area between the acropolis elevation, which borders the Tlos City on the west, and the slope, against which the theatre in the east leans, forms the city center. Traces of settlement in this area go back to until prehistoric times. As in all ancient cities during the early Christianity period, there is also a narrowing in this area, too. In this way a new settlement area was formed on the southern slopes of the acropolis elevation and this area was surrounded by the walls made of reused materials. During the Middle Byzantine period, a secondary narrowing occurred in all other ancient cities. A similar narrowing could have occurred in Tlos, too. However this situation did not occur; on the contrary the borders of the city were enlarged going beyond

the pagan settlements. This unusual situation in the ancient times may be connected to the movements of migration in the Lycian Region. Especially a substantial movement of migration was experienced towards west and north during 11th and 12th centuries A.C. (Tloskazilari, 2012).

3.2. *Hedera helix* L.

3.2.1. The characteristics of *Hedera helix* L.

Hedera helix is a climbing plant belonging to *Araliaceae* family. *Hedera helix* L. is also known as common ivy is a woody and evergreen plant type. They can climb on supports or crawl on surface. They can reach up to 30 m height and the root diameter can reach 20 cm. They can climb with help of their adventitious air roots. Young offshoots have star-like hair at the beginning but become hairless afterwards. Leaves are organized spirally, are skinny and have dark green surface. Their soffit are light-yellowish-green; shining and hairless. Sterile offshoots grow up with round ovoid or they grow to the width. They have 3 to 5 lobes. Fertile offshoots have wide or rhombic ovoid and have rarely single lobe. At times they are asymmetric (Doğan, 2012). The plant grows up slowly and has a long life (Stavretovic, 2007). They spread on soil and climb on surfaces where they are situated in, such as trees and walls etc. The surface should be rough enough, so that the microscopic hairy roots could hold on (Dunnet, and Kingsbury, 2004). This is the reason why they have leaves on surfaces and on supports them against to wind (Roderick and Cochrane, 2002).

3.2.2. *Hedera helix* L. in ancient times

Plants, which were an indispensable part of the daily life during the ancient times, were also significant symbols of religious beliefs and rituals. For example the ivy (*Hedera helix* L.) is believed to symbolize the Dionysos (Baus, 1940; Blech, 1982). Therefore the sacred places were embellished with special plants symbolizing the related deities during the religious ceremonies or fests organized throughout the ancient times. Also attendants of these ceremonies and fests carried crowns over their heads made of similar plants to honor the deities. Over time, the plan depictions were begun to be used as decorative patterns in architecture. For example, the ivy pattern was used as a curled branch pattern or in a leaf form in friezes, cornices, doorframes and in many other areas. These kinds of findings were discovered during the excavation in Tlos (Fig. 2).

4. Methodology

4.1. Spreading of *Hedera helix* L. on structures of Tlos Ancient City

In 2005, results of the phonological observation indicated that the spreading of the plant does not show any difference according to the direction, age and structure material at all. In Table 1, the results of this observation are given. Materials such as limestone, conglomerate stone and white marble are used in the structures of Tlos Ancient City. Therefore, no differences are observed in the spreading of the plant due to material difference.



Figure 2. Tlos, Propylon of Large Bath

Table 1. Age and materials of structure in Tlos and deployment of *Hedera helix* L. in which direction of structure.

	Direction				Age	Materials
	South	North	East	West		
Acropolis Walls			X	X	5 th AD	Reused materials, limestone, conglomerate stone
Basilica	X	X	X	X	4 th AD	Reused materials, limestone, white marmar
Agora and the Shops	X	X	X	X	Hellenistik Period	Limestone
Small Bath and Palaestra	X	X	X	X	Early Roman Period	Limestone, conglomerate stone
Large Bath	X	X	X	X	Early Roman Period	Limestone, conglomerate stone

Previously, during studies undertaken in Segal (1969) on wall flora, it was observed that the plants were mainly situated in south direction, finally rarely in the north direction of the structure. The spreading of *Hedera helix* L. plant on structures of Tlos Ancient City except Acropolis walls, showed no difference depending on direction. One did not come across with this plant in the north and south direction of Acropolis walls (Table 1). After undertaking observations for 7 years in the working field, it could be defined where the

plant situates itself densely on a structure and also a drawing is prepared accordingly (Fig. 3). As one could also see from the figure, the plant started spreading right from the ground next to the structure, and climbed up the structure (Fig 3.A). This climbing plant spreads in the connections of same or different materials (Fig 3.B and 3.C). Additionally the plant locates itself mainly in the empty spaces (Fig. 3.D) of the structure. On the upper parts of the structure, the plant spreads horizontally (Fig. 3.G). It was observed that, the plant spreads mainly right under the arch (Fig. 3.E, Fig. 4). The plant may totally catch the dislocation of the horizontal and vertical meeting points on the structure (Fig. 3.F).

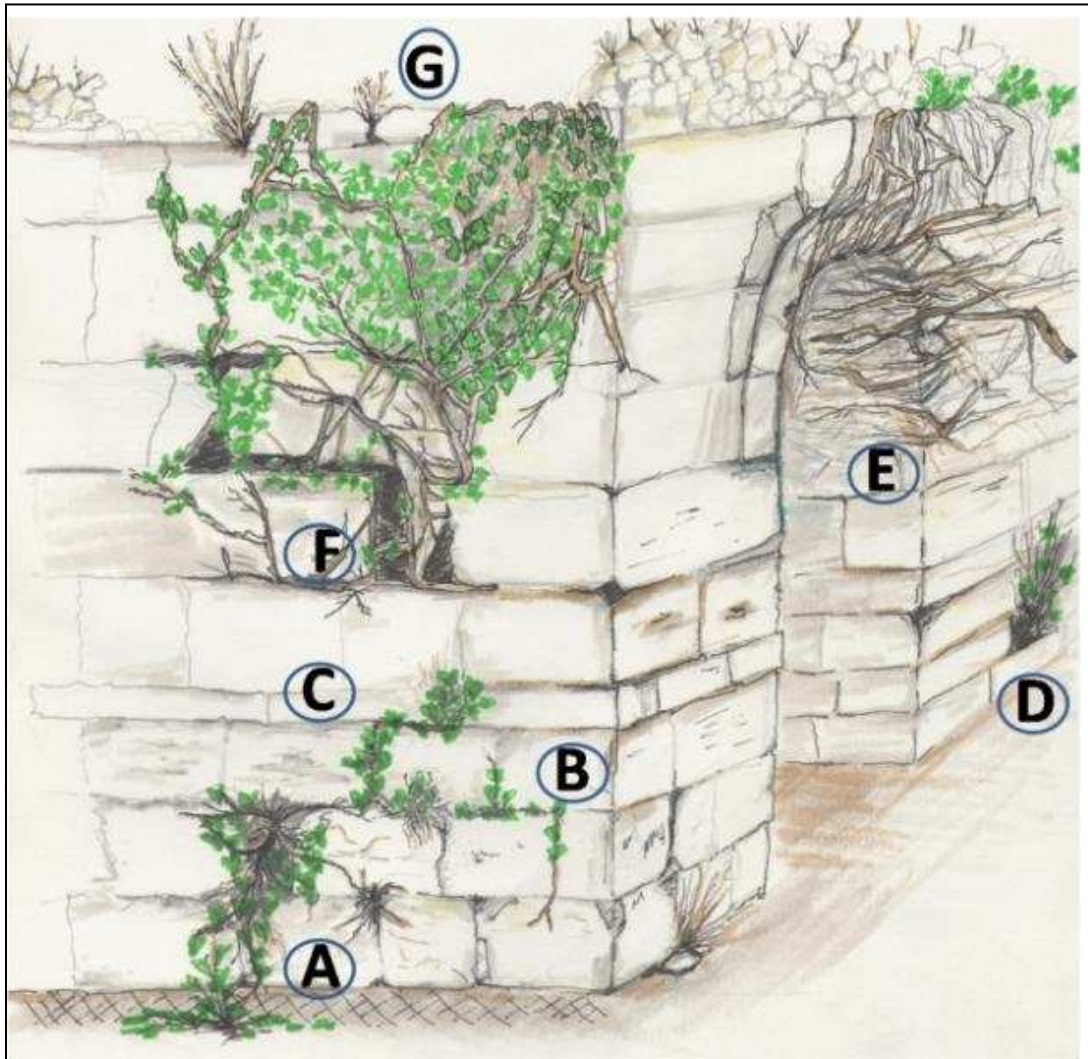


Figure 3. The main microsites for plant growth: A. Climbing from ground;

B. At junction of two same materials; C. At junction of two different materials;

D. Cavities, E. Under arch; F. At junction of vertical and horizontal faces;

G. In horizontal surface (Modified from Lisci and Pacini, redrawn by Sariboyaci for Tlos Project, 2012).

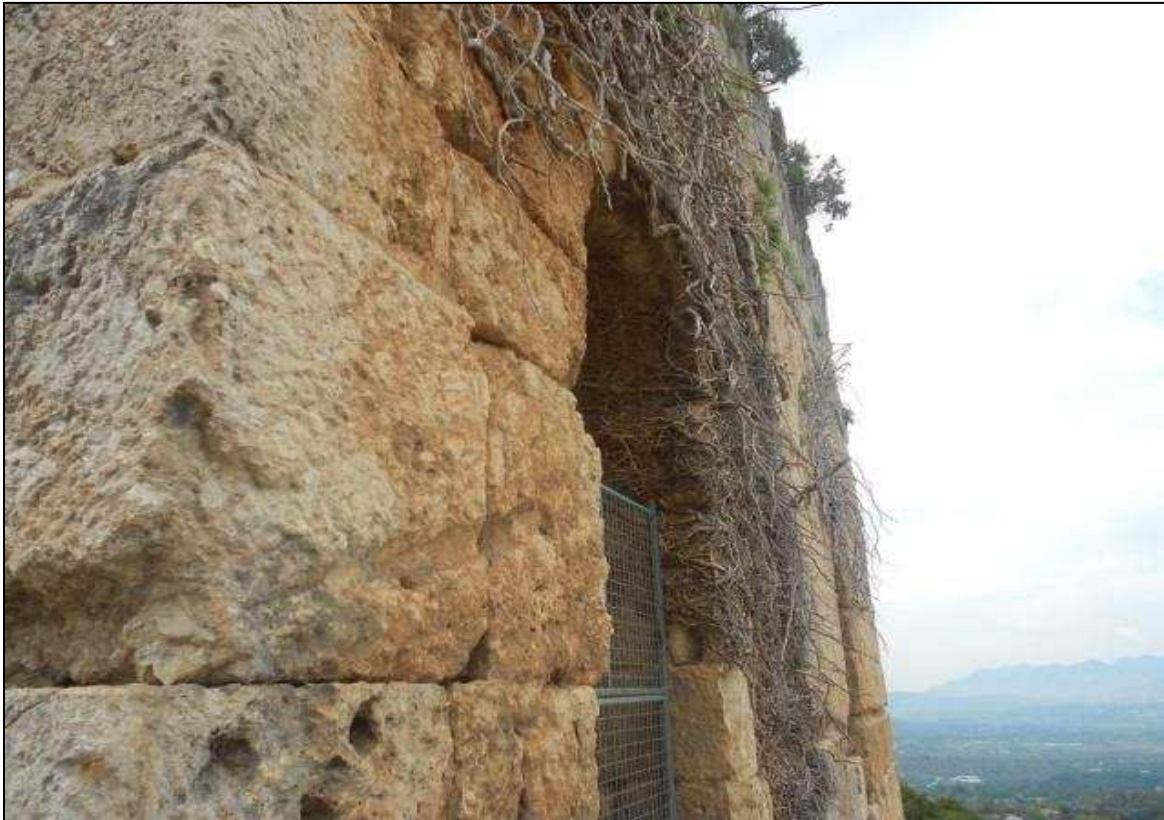


Figure 4. Large Bath in Tlos.

4.2. Struggling with *Hedera helix* L. in Tlos

Since 2005, all studies and their results are kept in records during the depuration of ancient ruins from *Hedera helix* L. in the working area. Since 2005, for these plants in order to be cleaned up from the ancient ruins, certain methods such as mechanical fighting and chemical disinfection are used as well. As these methods remained abortive, fighting with these plants had to be undertaken by removing the water channels from the city center to outskirts.

4.3. Mechanical fighting

It was impossible to remove the plants by hand lifting or by using different instruments as they were holding tightly to the ancients, due to their catching air roots. Therefore, the plants were cut from their pieces close to the soil by pruning or secateurs. The roots of the cut plants are then unearthed (Fig. 5). After this procedure, it was observed that even though the plants dry out in 2 to 3 months, one had to wait 1 to 3 weeks in order to take out the catching roots and hard trunk as they hold really tightly to the ancient structures. It was also observed that, if the roots and trunks were not taken out by human force, they would not pull away the ancient structures.



Figure 5. Large Bath in Tlos

4.4. Using herbicides

Starting from 2005, twice a year, once in spring and once in fall, disinfections using herbicides including Aclonifen were also used. Even though the disinfection was very effective on a large amount of plants, it almost did not have any impacts on *Hedera helix* L.

4.5. Changing the place of water channels

The above mentioned ways of fighting against *Hedera helix* L. remained unsuccessful. In 2007, the ancient city was photographed from the air, in an air balloon (Fig. 6) and it was observed that the ancient city is covered by plants, especially by *Hedera helix* L. The reason for this is that the natural structure of the city is very favorable for the growth of plants and those plants could spread easily. Finally in 2010, the excavation team needed an effective solution for *Hedera helix* L. fighting and they arranged meetings with real professionals. After strict investigations, it could finally be concluded that the water channels running from the city center were the one of the reason for the rapid growth of this plant and also damage for ancient structures.



Figure 6. Tlos Ancient City from the air

The reason why there were water channels in the ancient city is that up to the year of 2005, the ancient city was also used as agriculture area. In the beginning of 2011, water channels were removed totally from the city center to the outskirts. During the investigations undertaken in 2012, it was observed that the amount of living *Hedera helix* L. declined rapidly. Nevertheless, the dried out trunks and catching roots can still be seen on the ancient structures.

5. Results

The cleaning up of Tlos Ancient City took about 7 years, during which certain methods such as mechanical fighting and chemical disinfection were also used. As these methods remained abortive, fighting with these plants had to be undertaken by removing the water channels from the city center to outskirts. This was the most effective way of taking the existing *Hedera helix* L. under control. Nevertheless, newly growing plants right under the cleaned-up walls were also observed. Mechanical cleaning should continue at this stage, before the plant covers up the ruin again. Fighting with this plant actually before starting excavation work every year, became obligatory. Otherwise, all undertaken works in the past years might remain meaningless. Therefore, cleaning up the historical structures from *Hedera helix* L. must definitely take place two to three years before the restoration.

Additionally, removing the plant totally from the structure may cause serious damages, because as the time passes, the plant sticks itself on the plant, with a catching role (Fig. 7).



Figure 7. Small Bath in Tlos

Such places should be determined beforehand and the cleaning personnel should be informed about it. Otherwise structures may be destroyed during cleaning up. It was also observed that during the study, the spreading of the plant does not show any difference according to the direction, age and structure material at all. One could see that the plant started spreading right from the ground next to the structure, and climbed up the structure. The plant situated itself also on empty places on the structure. It was also seen in the work field that, the plant could reach up to the upper parts of the structures and from there they cover the lower sections of the coves totally. Finally, they locate themselves between the materials of the structure and ruin the mortar. This plant, which was embossed on the stones during the Ancient History as a symbol of Dionysus, became a nightmare of the ancient structures, which managed to survive until today.

Acknowledgments

This study was financially supported by the TUBITAK, Project No: 111K227.

References

- Aksoy, A. and Çelik, A. (2000), "Studies on the ecology of plants growing on the historical monuments of Kayseri", in proceedings of the 5th Plant life in South-West and Central Asia International Symposium, Tashkent, Uzbekistan, 2000, Chine ENK, pp. 5-7.
- Baus, K. (1940), *Der Kranz in Antike und Christentum. Eine religionsgeschichtl. Untersuchung mit bes. Berücks. Tertullians*, Bottrop i.W.: Postberg, Bonn.
- Blech, M. (1982), *Studien zum Kranz bei den Griechen (Religionsgeschichtliche Versuche und Vorarbeiten)*, De Gruyter publication, New York.
- Brandes, D. (1992a), "Flora und vegetation von Stadtmauern", *Tuexenia*, Vol.12, pp. 315-319.
- Brandes, D. (1992b), "Asplenietae- Gesellschaften an sekundären Standorten in Mitteleuropa", *Ber. d. Reinh.-Tüxen-Ges.*, Vol. 4, pp. 73-93.
- Darlington, A. (1981), *Ecology of Walls*. Heinemann Educational Press, London, 138 p.
- Doğan, A. (2012), *Hedera helix L.'te yaprak besin elementlerinin değişimi üzerine bir araştırma*, Unpublished MSc Thesis, Ondokuz Mayıs University, the Graduate School of Natural and Applied Sciences, Samsun (in Turkish).
- Dunnet, N. and Kingsbury, N. (2004), *Planting green roofs and living walls*, Timber Press, Portland, OR, 254 p.
- English Heritage (2010), "Ivy on walls", seminar report, available at: <http://www.english-heritage.org.uk/publications/ivy-on-walls> (accessed 20 June 2012).
- Gemici, Y., Seçmen, Ö. and Görk, G. (1995), *In: Urban ecology* (Ed. M. Öztürk), Ege University Press, İzmir, pp. 408-413.
- Karahan, F., Çelik, O., Kayıkcı, S. and Altay, V. (2012), "Eski Antakya evleri (Antakya-Hatay) duvarlarında yayılış gösteren vasküler bitkiler" *Biyoloji Bilimleri Araştırma Dergisi*, Vol. 5 No. 2, pp. 131-134 (in Turkish).
- Lisci, M. and Pacini, E. (1993), Plants growing on the walls of Italian towns 1. sites and distribution, *Phyton* (Horn, Austria), Vol. 33, Fasc. 1, pp. 6-8.
- Lisci, M., Monte, M. and Pacini, E. (2003), "Lichens and higher plants on stone: a review", *International Biodeterioration & Biodegradation*, Vol. 51, pp. 1-17.
- Mishra, A.K., Jain, K.K. and Garg, K.L. (1995), "Role of higher plant in the deterioration of historic buildings", *The Science of the Total Environment*, Vol. 167, pp. 375-392.
- NIEA (2009), "Dealing with vegetation on historic masonry monuments", available at: http://www.doeni.gov.uk/niea/dealing_with_vegetation.pdf (accessed 20 June 2012).
- Roderick, M.L., Cochrane, M.J. (2002), "On the conservative nature of the leaf mass-area relationship", *Annals of Botany, London*, Vol. 89, pp. 537-542.

Segal, S. (1969), *Ecological notes on wall vegetation*, Junk, The Hague, Netherland, pp. 325.

Sert, H.B. (2007), *Biodiversity of black microcolonial fungi isolated from Antalya/Turkey (Side, Perge, Termessos)*, PhD Thesis, University of Natural Resources and Applied Life Sciences, Institute of Applied Microbiology, Austrian Center of Biological Resources and Applied Mycology (ACBR).

Sert, H.B., Elinç, Z.K. and Uçar, A. (2008), "Plants as bio-deterioration agents on historical monuments", paper presented at the 6th World Archaeological Congress, Dublin/Ireland.

Stavretovic, N. (2007), "Biological characteristics of the species *Hedera helix* L. and its use in controlling erosion in shady places", *Archives of Biological Sciences*, Vol. 59 No. 2, pp. 139-143.

Tloskazilari (2012), "Tlos kazıları", available at: <http://www.tloskazilari.com> (accessed 20 June 2012). (in Turkish)

Yarcı, C. and Özçelik, H. (2002), "Wall flora of Edirne (Thrace Region)", *The Herb Journal of Systematic Botany*, Vol. 9, pp. 57-66.

Yeşilot, A. (2000), *İstanbul'da Tarihi Yapılar Üzerinde Yetişerek Bunları Tahrip Eden Bitkiler (The plants that grow up on historical buildings and destroy them in İstanbul)*, Unpublished MSc Thesis, Marmara University, the Graduate School of Natural and Applied Sciences, İstanbul.