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Seven years of arboreal pollen monitoring in the İğneada waterlogged forests (NW Turkey)

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Abstract

This study was carried out in the İğneada Waterlogged Forests (Kırklareli) located downhill of Istranca mountains at 20 km distance to Bulgaria border line and had a shore to Black Sea. These forests have different vegetation types such as waterlogged forest, peat, bog and sand dunes plant communities, sand zone and wetlands. The main arboreal species of these forests are *Acer campestre, Acer trautvetteri, Alnus glutinosa, Carpinus betulus, Carpinus orientalis, Fraxinus angustifolia, Fraxinus ornus, Juglans regia, Quercus cerris, Quercus frainetto, Quercus petraea, Quercus robur, Ulmus leavis* and *Ulmus minor*. Pollen monitoring results were obtained from six different sampling sites in the waterlogged forests around Mert and Saka Lake. The purpose of this study is to determine the modern pollen distribution of these forests and to create a basic calibration scheme for the fossil pollen studies. For this purpose, seven years of modern pollen distribution was monitored between September 2009 and 2016 using Tauber pollen traps which were placed at 6 different points in this study area. These traps were changed once a year in the field and transferred to the Palynology Laboratory of Istanbul University-Cerrahpaşa. The protocol of European Pollen Monitoring Programme (EPMP) was followed in the laboratory methodology. The majority of the pollen influx obtained from the Tauber pollen traps in the İğneada Waterlogged forests belongs to *Fraxinus* and *Carpinus* from 2009 to 2016. As a result of this study, the annual arboreal pollen influxes of *Fraxinus, Carpinus, Quercus, Acer, Corylus, Ulmus, Hedera helix* and *Alnus* was higher respectively in the years of 2009-2016. Seven-year pollen influx data of these pollen traps reflects the current vegetation.
Keywords: European Pollen Monitoring Programme, Tauber pollen trap, İğneada.

Özet

Bu çalışma, Bulgaristan sınırına 20 km uzaklıkta Istranca Dağları'nın aşağı yamaçlarında bulunan ve Karadeniz'e kıyısı olan İğneada Longoz Ormanları'nda gerçekleştirilmiştir. Bu ormanlar; subasar orman, turba, bataklık ve kumul bitki toplulukları, kumsal ve sulak alanlar gibi farklı vejetasyon tiplerine sahiptir. Bu ormanların önemli odunsu taksonları *Acer campestre, Acer trautvetteri, Alnus glutinosa, Carpinus betulus, Carpinus orientalis, Fraxinus angustifolia, Fraxinus ornus, Juglans regia, Quercus cerris, Quercus frainetto, Quercus petraea, Quercus robur, Ulmus leavis* ve *Ulmus minor*'dür. Polen izleme sonuçları, Mert ve Saka gölü etrafında bulunan subasar ormanlarının içindeki altı farklı örnek alanından elde edilmiştir. Bu çalışmanın amacı, bu ormanların güncel polen dağılımını belirlemek ve fosil polen çalışmaları için temel bir kalibrasyon şeması oluşturmaktır. Bu amaçla, çalışma alanında 6 farklı noktaya yerleştirilen Tauber polen tuzakları kullanılarak Eylül 2009 ve 2016 yılları arasında yedi yıllık güncel polen birikimi izlenmiştir. Bu tuzaklar yılda bir kez arazide değiştirildikten sonra İstanbul Üniversitesi-Cerrahpaşa Palinoloji Laboratuvarı'na getirilmiştir. Laboratuvar metodolojisinde Avrupa Polen İzleme Programı (European Pollen Monitoring Programme: EPMP) protokolü takip edilmiştir. İğneada Longoz Ormanlarındaki tuzaklardan 2009-2016 yılları arasında elde edilen polen yoğunluğunun çoğunluğu *Fraxinus* ve *Carpinus*'a aittir. Bu çalışmanın sonucu olarak, 2009-2016 yılları arasındaki yıllık odunsu bitki polen yoğunluğu sırasıyla *Fraxinus, Carpinus, Quercus, Acer, Corylus, Ulmus, Hedera helix* ve *Alnus*'ta fazla çıkmıştır. Polen tuzaklarına ait 7 yıllık polen yoğunluğu verileri güncel vejetasyonu yansıtmaktadır.
Anahtar kelimeler: Avrupa Polen İzleme Programı, Tauber polen tuzağı, İğneada.

Introduction

Monitoring the modern pollen influx for many years is very important in order to determine the paleovegetation and climate of Quaternary based on the fossil pollen studies. There is little knowledge about the distribution and sedimentation processes of the modern pollen grains and how they represent the current vegetation at the regional and local scale. In accordance with this purpose, European Pollen Monitoring Programme (EPMP) was established in 1996 and modern pollen-monitoring stations have been created in many European countries during the last 23 years. Pollen influx data has been obtained by monitoring the pollen accumulation at varying vegetation points by using Tauber pollen traps properly according to the protocol of EPMP (Hicks et al., 1996; Hicks, 2001; Van der Knaap et al., 2001; Pidek, 2004; Tonkov et al., 2001; Atanassova, 2007; Filipova-Marinova et al., 2007; Giesecke et al., 2010; Tonkov et al., 2016).

The modern palynological studies conducted in Turkey are mostly about pollen allergy, pollen analysis in the atmosphere and airborne pollen concentration. In these studies; Hirst Spore, Burkard and Lanzoni style traps were used at a certain height and a lot of pollen calendars belong to many provinces of Turkey were created with this method (Aytuğ et al., 1974; İnce and Pehlivan, 1990; Pehlivan and Bütev, 1994; İnceoğlu et al., 1994; Kaya and Aras, 2004; Bıçakçı, 2006; Öneş et al., 2008; Erkan et al., 2011; Bıçakçı and Tosunoğlu, 2019).

Among these studies, the first pollen monitoring study in Turkey was conducted as a doctorate thesis in the context of EPMP, which aims to find out the relationship between meteorological parameters and monthly pollen influx in Belgrad Forest and İğneada Longoz Forest between 2007 and 2009 (Karlıoğlu, 2011; Karlıoğlu and Akkemik 2012, Karlıoğlu et al. 2014, Karlıoğlu et al. 2015). EPMP studies have been continued in different regions of Turkey in accordance with this protocol (Şenkul et al. 2018a, Şenkul et al. 2018b; Şenkul et al. 2018c; Karlıoğlu Kılıç et al., 2019; Şenkul and Karlıoğlu Kılıç, 2019).

The aim of this study is to investigate the seven years of arboreal pollen monitoring in the different sample areas of İğneada Waterlogged Forests in accordance with the EPMPP. This study will be a basic calibration scheme in order to better interpret the quantitative reconstructions of previous fossil pollen diagrams.

Material and Methods

Study Site

İğneada Waterlogged (Longoz) Forests belong to Kırklareli-Demirköy province locates downhill of Istranca mountains at 20 km distance to Bulgaria border line and has shore to Black Sea. According to Davis' (1965-1985) grid system locates in A1 (E) square. The altitudinal profile of İğneada waterlogged forests is between 0-20 m (Fig.1). These forests have different vegetation types such as waterlogged forest, peat, bog and sand dunes plant communities and sandy meadows at river side banks, sand zone and wetlands. They are accepted as one of the 122 Important Plant Areas of Turkey (Özhatay et al 2005). The dominant arboreal plant species in the area are *Acer campestre* L. (Common Maple), *Alnus glutinosa* (L.) Gaertn. (Common Alder), *Fraxinus angustifolia* Vahl. (Narrow-leafed Ash), *Quercus cerris* L. (Turkish Oak), *Quercus frainetto* Ten. (Hungarian Oak), *Quercus robur* L. (Pedunculate Oak), *Quercus petraea* (Mattuschka) Liebl. (Sessile Oak), *Fagus orientalis* Lipsky. (Oriental Beech), *Carpinus betulus* L. (Common Hornbeam), *Carpinus orientalis* (Hornbeam), *Ulmus minor* Miller (Common Elm) and *Ulmus leavis* Pall. (European White Elm). *Fraxinus angustifolia* is the most widespread tree species in the İğneada Waterlogged Forests. Another tree species, which has a wide spread like ash, is common maple. There is a rich ecological diversity in this forest, which has a total area of approximately 1600 ha (Kavgacı, 2007; Karlıoğlu, 2011).

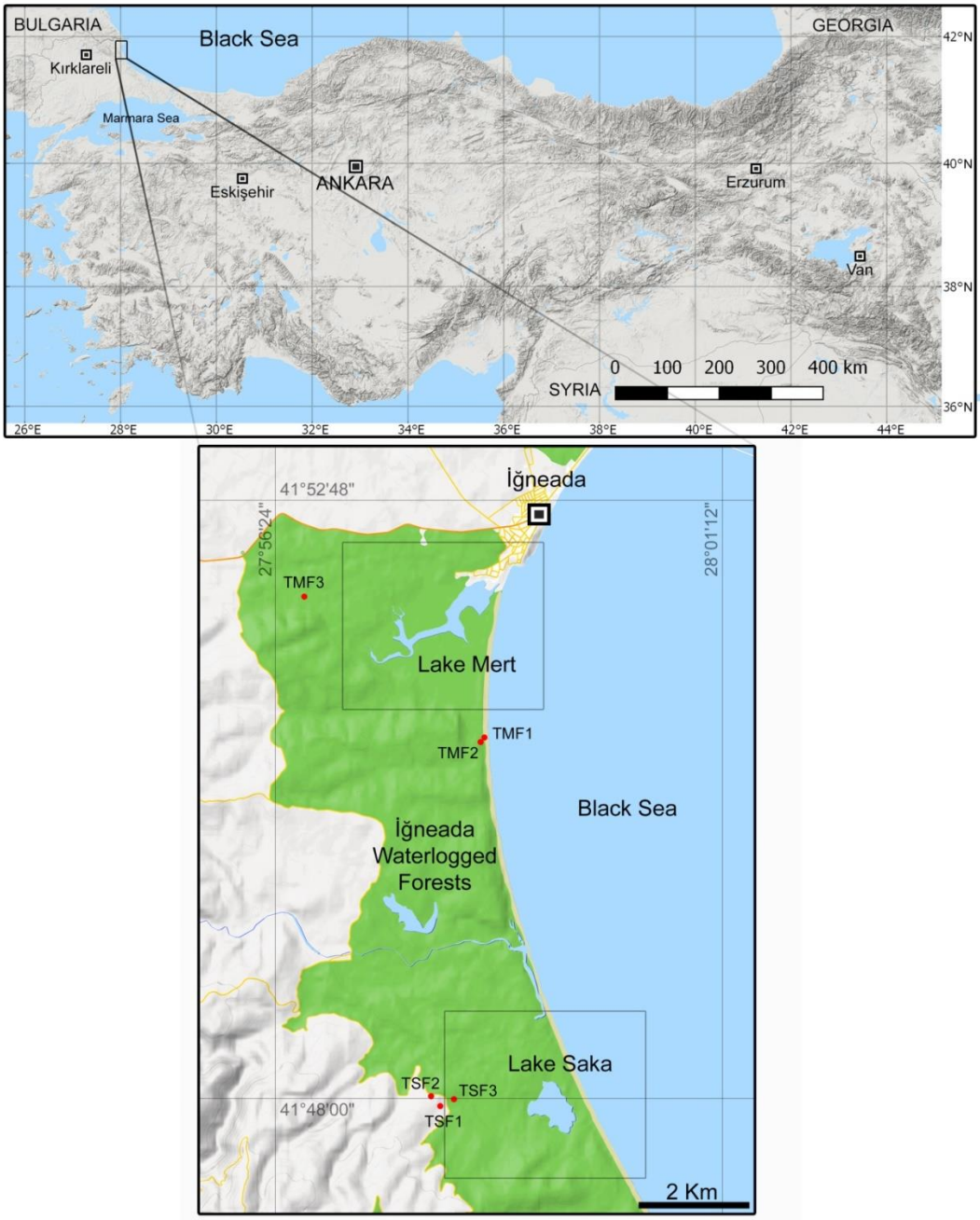

Figure 1. Location map of the study area and position of the Tauber pollen traps in the sample areas ("red circles" show the location of the pollen traps in the field)

Modern Pollen Analysis

Tauber pollen traps were placed in six sample areas (TMF1, TMF2, TMF3, TSF1, TSF2 and TSF3) of İğneada Waterlogged Forests where the vegetation changed in 2007 for the first time and these traps were changed monthly between September 2007 and 2009 as a doctorate thesis (Figure 1). Then, these same traps were changed annually between 2009 and 2016. Each Tauber pollen trap (Tauber, 1974) was brought from the field to the Palynology Laboratory of Istanbul University-Cerrahpaşa. For every 1-year period, the mixture in the each trap was used for the modern pollen analysis according to the protocol of EPMP (Hicks et al., 1996). Every mixture in each trap was filtered by using a sieve of 250 mμ and removed from animal and plant remains (Hicks et al., 1996). Two *Lycopodium* spore tablets (Stockmarr 1971) were added into this mixture,

and this mixture was centrifuged (10 minutes at 3000-3500 rpm) until reaching the sediment. Then 10 ml acetolysis mixture was added to the resulting sediment. After acetolysis process, pollen slides were prepared by adding 2 ml of glycerin. Pollen grains and *Lycopodium* spores were counted by Leica DM 750 light microscope with x40 and x100 immersion objective and x10 ocular. Reference slides and illustrated pollen keys were used for the identification of pollen grains (Aytuğ, 1967; Aytuğ et al., 1971; Wodehouse, 1935; Erdtman, 1952; 1957; Hyde and Adams, 1958; Faegri and Iversen, 1964; Moore et al., 1991; Hesse et al., 2009; Iwanami et al., 1988). Also, arboreal plants around the traps (0-10.5 m) were identified using the vegetation ring.

Results

Annual pollen influxes (cm²/year) of the arboreal plants around the traps have been determined between 2009 and 2016 in the six sample areas of İğneada Waterlogged Forests (Figure 2; Figure 3). Also, the seven years of arboreal pollen monitoring diagram was drawn in TILIA (Figure 4).

Annual Pollen Influx in the Mert Lake Waterlogged Forest between 2009-2016

The pollen trap in the open area (TMF1) was missing between 2009 and 2010 in the Mert Lake Waterlogged Forest. *Carpinus* and *Fraxinus* have the highest annual pollen influx (cm^2/year) between 2009 and 2011 in TMF3 (in the Forest). The pollen trap in the forest area was missing from 2011 to 2012. Annual pollen influxes of *Fraxinus, Carpinus* and *Quercus* were higher in the forest area (TMF3) between 2011 and 2012. In the years of 2012-2013, the annual pollen influx of *Carpinus, Fraxinus* and *Acer* was higher in all sample areas of Mert Lake Waterlogged Forest. The pollen trap in the open area was missing between 2013 and 2014. Annual pollen influxes of *Carpinus, Fraxinus, Corylus* and *Hedera helix* were higher in the forest and at the forest edge in the years of 2013-2014. The pollen trap in TMF3 was missing from 2014 to 2016. Annual pollen influx was very low from 2014 to 2015. In this year, the highest annual pollen influxes belong to *Fraxinus* and *Carpinus* in TMF1 and TMF2. When the annual arboreal pollen influx in the years of 2015-2016 was examined, the pollen influxes of *Ulmus, Fraxinus, Carpinus, Acer* and *Alnus* were higher in TMF1 and TMF2. In 2016-2017, pollen influx of *Ulmus* was very high when it was compared with the other years (Figure 2; Figure 4).

3.2. Annual Pollen Influx in the Saka Lake Waterlogged Forest between 2009-2016

The pollen trap in the forest area (TSF3) was missing between 2009 and 2010 in the Saka Waterlogged Forests. *Carpinus*, *Fraxinus* and *Quercus* have the highest annual pollen influx (cm^2/year) between 2009 and 2010 in TSF2 (forest edge) and in the open area (TSF1). The pollen traps in TSF1 and TSF2 were missing from 2010 to 2011. When the annual arboreal pollen influx in the years of 2010-2011 was examined in TSF3, the pollen influxes of *Fraxinus, Corylus, Acer* and *Carpinus* were higher in this sample area. The pollen trap in TSF2 was missing between 2011-2012. Annual pollen influxes of *Carpinus, Fraxinus, Quercus* and *Corylus* were higher in the forest area (TSF3) and open area (TSF1) from 2011 to 2012. All the traps were missing in the years of 2012-2013. The traps in TSF1 and TSF2 were also missing between 2013 and 2014. When the annual arboreal pollen influx in the years of 2013-2014 was examined in TSF3, the pollen influxes of *Fraxinus, Corylus, Acer, Hedera helix* and *Quercus* were higher in this sample area. In the years of 2014-2015, the pollen trap in TSF2 was missing. Annual pollen influxes of *Fraxinus, Corylus, Carpinus Hedera helix* and *Alnus* were higher in the forest area (TSF3) and open area (TSF1) from 2014 to 2015. The pollen trap in TSF2 was missing between 2015 and 2016 again. When the annual arboreal pollen influx in the years of 2015-2016 was examined, the pollen influxes of *Corylus, Carpinus, Fraxinus*, *Quercus* and *Alnus* were higher in TSF1 and TSF3. Total annual pollen influx in the years of 2015-2016 was very higher than the other years (Figure 3; Figure 4).

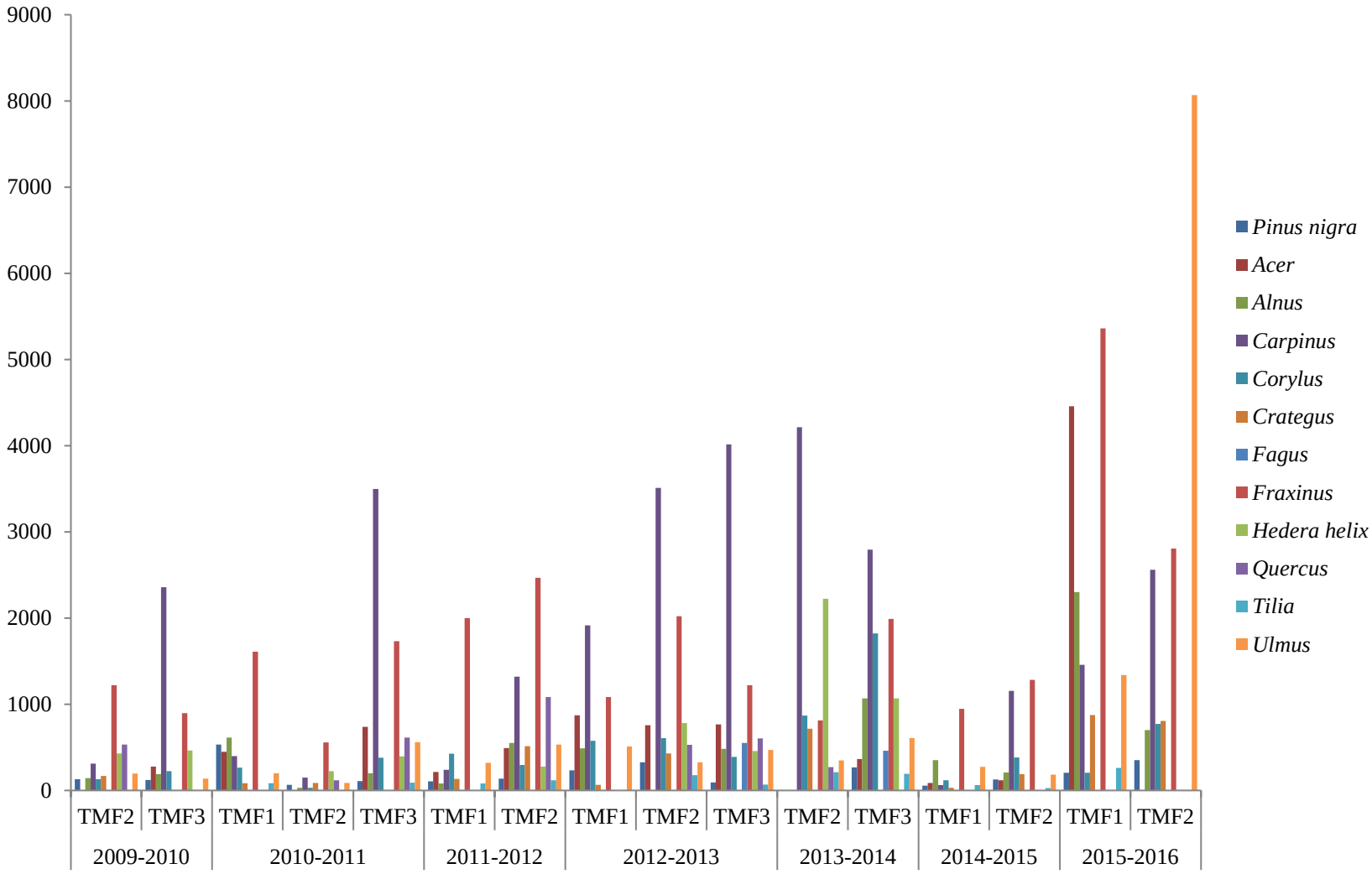

Figure 2. Annual pollen influx (cm^2/year) of arboreal plants in Mert Lake Waterlogged Forest between 2009-2016.
(TMF1: Open area TMF2: Forest edge TMF3:In the Forest area)

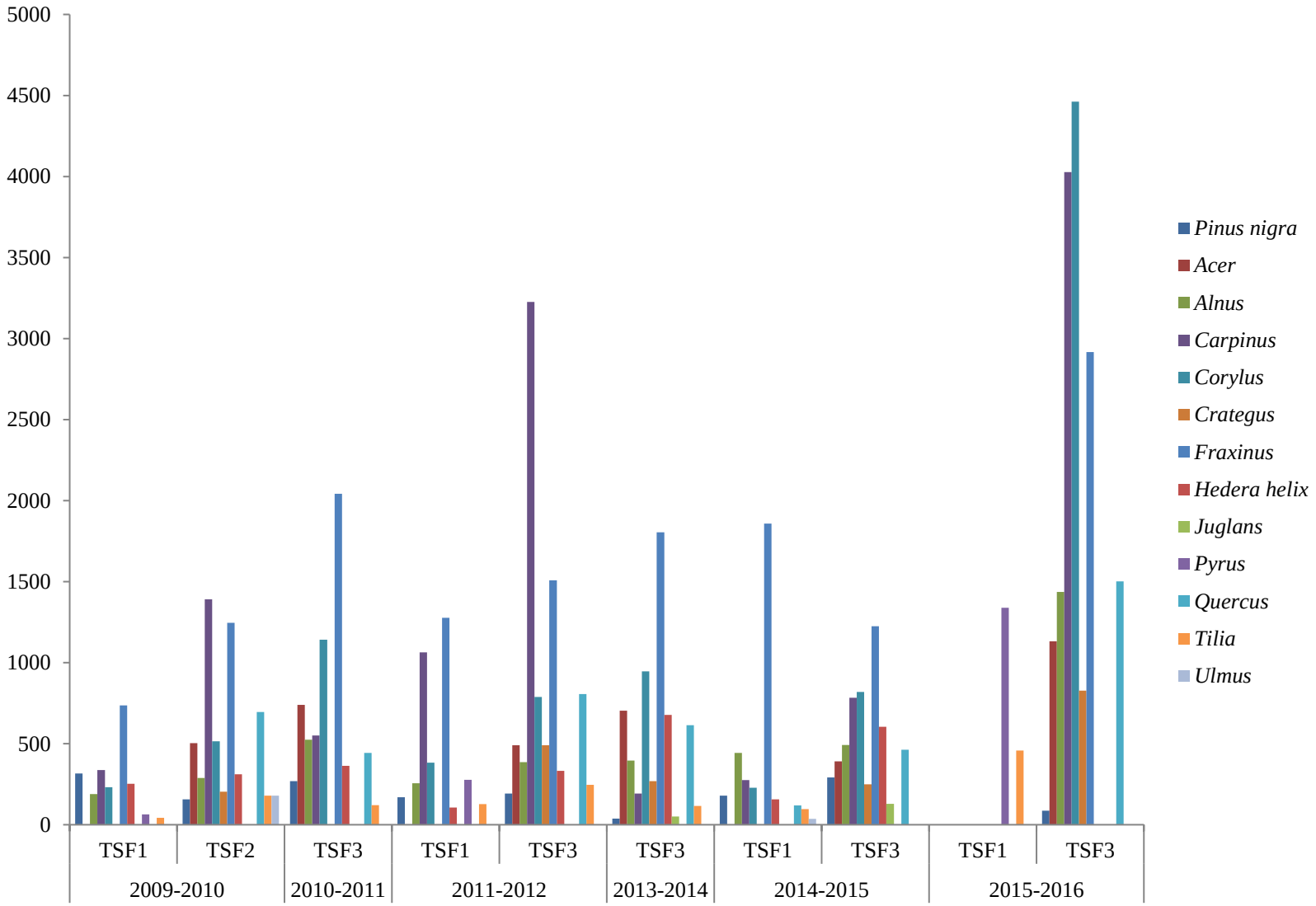

Figure 3. Annual pollen influx (cm^2/year) of arboreal plants in Saka Lake Waterlogged Forest between 2009-2016.
(TSF1: Open area TSF2: Forest edge TSF3:In the Forest area)

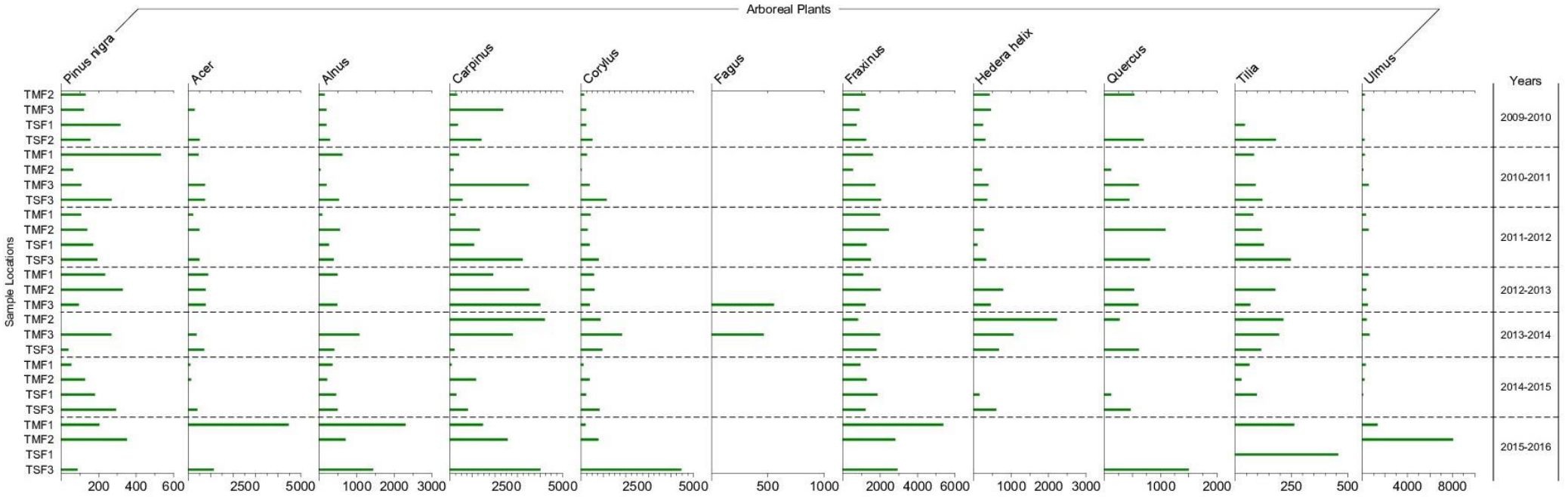

Figure 4. Seven years of arboreal pollen monitoring in İğneada Waterlogged Forests between 2009 and 2016.

The arboreal plant species around the Tauber pollen traps

The identification of the arboreal plant species around the Tauber pollen traps is very important to show how far the pollen grains are transported in the sample areas. Therefore, all woody plant taxa around the pollen traps were listed in Table 1.

Table 1. The arboreal plant species around pollen traps surrounding circle with the radius 10.5 m

TMF1	*Acer campestre, Crataegus monogyna, Fraxinus angustifolia, Prunus x domestica, Rubus sanctus, Ulmus minor.*
TMF2	*Acer campestre, Crataegus monogyna, Fraxinus angustifolia, Hedera helix, Prunus x domestica, Rosa canina, Ruscus aculeatus, Smilax excelsa, Ulmus minor.*
TMF3	*Acer campestre, Carpinus betulus, Corylus avellana, Fagus orientalis, Fraxinus angustifolia, Hedera helix, Rubus sanctus, Ruscus aculeatus, Smilax excelsa, Sorbus torminalis, Tilia tomentosa.*
TSF1	*Fraxinus angustifolia, Pyrus elaeagnifolia, Rosa canina.*
TSF2	*Acer campestre, Crataegus monogyna, Fraxinus angustifolia, Hedera helix, Malus sylvestris, Quercus robur, Rosa canina, Ruscus aculeatus, Smilax excelsa.*
TSF3	*Acer campestre, Carpinus betulus, Cornus mas, Corylus avellana, Crataegus monogyna Fraxinus angustifolia, Hedera helix, Quercus robur, Ruscus aculeatus, Smilax excelsa.*

Discussion

According to the results of pollen analysis in the pollen traps, the annual pollen influxes (cm²/year) of *Fraxinus, Carpinus, Quercus, Acer, Corylus, Ulmus, Hedera helix* and *Alnus* was higher respectively between 2009 and 2016 in the İğneada Waterlogged Forests. Total annual pollen influx between 2015 and 2016 was higher than the other years. Seven-year arboreal pollen influx data of pollen traps reflect the current vegetation in this forest. Karlıoğlu and Akkemik (2012), Karlıoğlu et al. (2015), Şenkul et al. (2018a; 2018b), and Karlıoğlu Kılıç et al. (2019) found that annual pollen influx (cm^2/year) is very related to the modern vegetation in the different regions of Turkey.

Pinus sp. does not exist in all sample areas of İğneada Waterlogged Forests, but it has pollen influx in the all traps. Pollen grains of *Pinus* have 2 air-filled bladders (sacci), and these air sacs increase surface area, but don't increase the pollen mass. Thereby, the pollen grains of *Pinus* can be easily transported to long distances by wind (Schwendemann et al., 2007; Szczepanek et al., 2017).

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