BOLU ABANT IZZET BAYSAL UNIVERSITY

THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

MORPHOLOGICAL STUDIES AND POPULATION OBSERVATIONS ON NATURALLY GROWING ORCHIDS IN BOLU

MASTER OF SCIENCE

MUSTAFA BAŞARAN

BOLU, MAY 2019

BOLU ABANT IZZET BAYSAL UNIVERSITY

THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

DEPARTMENT OF BIOLOGY

MORPHOLOGICAL STUDIES AND POPULATION OBSERVATIONS ON NATURALLY GROWING ORCHIDS IN BOLU

MASTER OF SCIENCE

MUSTAFA BAŞARAN

BOLU, MAY 2019

APPROVAL OF THE THESIS

Morphological Studies and Population Observations on Naturally Growing Orchids in Bolu submitted by **Mustafa BAŞARAN** and defended before the below named jury in partial fulfillment of the requirements for the degree of **Master of Science** in **Department of Biology, The Graduate School of Natural and Applied Sciences of Bolu Abant Izzet Baysal University in 16.05.2019** by

Examining Committee Members	**Signature**
Supervisor Assoc. Prof. Dr. İsmail EKER Bolu Abant Izzet Baysal University	.....
Member Assoc. Prof. Dr. İsmail Gökhan DENİZ Akdeniz University	.....
Member Dr. Öğr. Üyesi Nursel İKİNCİ Bolu Abant Izzet Baysal University	.....

Prof. Dr. Ömer ÖZYURT .....

Director of Graduate School of Natural and Applied Sciences

To my family

DECLARATION

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Mustafa BAŞARAN

_____

ABSTRACT

MORPHOLOGICAL STUDIES AND POPULATION OBSERVATIONS ON NATURALLY GROWING ORCHIDS IN BOLU
MSC THESIS
MUSTAFA BAŞARAN
BOLU ABANT IZZET BAYSAL UNIVERSITY GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGY
(SUPERVISOR: ASSOC. PROF. DR. İSMAİL EKER)

BOLU, MAY 2019

This study was conducted to reveal the current diversity of Orchidaceae in Bolu province and to make detailed morphometric analyzes and population observations on taxa. In the research area, a total of 92 field studies were conducted from April 2014 to September 2017, and 2727 plant specimens belonging to 231 populations/stations were collected from the research area and 53 taxa belonging to 17 genera were determined. Of all the collected taxa, seven are endemic and one is rare. The IUCN threat categories of endemic and rare plants are as follows: 7 taxa "NE (not evaluated) at global level and 1 rare taxon is found in the "VU (vulnerable)" category at regional level. In the detailed morphological studies, two systems have been applied for evaluation of the taxa and compared: traditional taxonomy and numerical taxonomy. In the traditional morphological analyses, 41 quantitative, 28 qualitative characters were used. The detailed descriptions, habitat and locality characteristics, and regional conservation assessments of all taxa were given. For the numerical taxonomic analyses, as possible at 10 specimens from each population was sampled randomly. If there were not enough individuals in the population, 5 samples were taken. In the numerical evaluation of all taxa, principle component and cluster analyses were used to analyse the variation of 40 quantitative, 3 qualitative characters measured for 57 OTUs (operational taxonomic units).

In this study, one taxon (*Anacamptis* × *parvifolia* (Chaub.) H.Kretzschmar, Eccarius & H.Dietr.) for Turkey and nine taxa for Bolu were determined as new records. Concerning the life forms, 91% (48 taxa) of taxa are photosynthetic autotrophs while the remaining 9% (5 taxa) are saprophytes without chlorophyll. Considering phytogeographic regions of 53 taxa, 11 of them are Euro-Siberian elements, one of them is Irano-Turanian, one of them are Hyrcano-Euxine and 14 of them is Mediterranean elements. Some of the identified taxa (26 taxa) were widespread and of unknown phytogeographic origin. The genera with the most taxa in the research area are as follows: *Dactylorhiza* Neck. (10 taxa), *Anacamptis* Rich. (7 taxa), *Orchis* Tourn. ex L. (7 taxa), *Epipactis* Zinn (6 taxa) and *Ophrys* L. (5 taxa).

KEYWORDS: Bolu, Conservation, Morphology, Orchids, Salep, Taxonomy

ÖZET

BOLU'DA DOĞAL YAYILIŞ GÖSTEREN ORKİDELER ÜZERİNDE MORFOLOJİK ÇALIŞMALAR VE POPÜLASYON GÖZLEMLERİ
YÜKSEK LISANS TEZI
MUSTAFA BAŞARAN
BOLU ABANT İZZET BAYSAL ÜNİVERSİTESİ
FEN BİLİMLERİ ENSTİTÜSÜ
BIYOLOJI ANABILIM DALI
(TEZ DANIŞMANI: DOÇ. DR. İSMAİL EKER)

BOLU, MAYIS - 2019

Bu çalışma, Bolu ilindeki güncel Orchidaceae çeşitliliğini ortaya koymak ve taksonlar üzerinde detaylı morfometrik analizler ve popülasyon gözlemleri yapmak amacıyla yapılmıştır. Araştırma alanında, 2014 yılının Nisan ayından 2017 yılının Eylül ayına kadar toplam 92 saha çalışması yapılmış ve araştırma alanından 231 popülasyona/istasyona ait 2727 bitki örneği toplanmış ve 17 cinse ait 53 takson belirlenmiştir. Toplanan tüm taksonlardan yedisi endemik, biri nadirdir. Endemik ve nadir bitkilerin IUCN tehlike kategorileri aşağıdaki gibidir: küresel düzeyde 7 takson "NE (değerlendirilemeyen)" ve bölgesel düzeyde 1 nadir takson "VU (zarar görebilir)" kategorisinde bulunmaktadır. Detaylı morfolojik çalışmalarda, taksonların değerlendirilmesi için iki sistem uygulanmış ve karşılaştırılmıştır: geleneksel taksonomi ve sayısal taksonomi. Geleneksel morfolojik analizlerde 41 nicel, 28 nitel karakter kullanılmıştır. Tüm taksonların ayrıntılı betimleri, habitat ve lokalite özellikleri ile bölgesel koruma değerlendirmeleri verilmiştir. Sayısal taksonomik analizler için, rastgele her popülasyondan mümkün olduğunca 10 örnek alınmıştır. Popülasyonda yeterli birey yoksa, 5 örnek alınmıştır. Tüm taksonların sayısal değerlendirmesinde, 57 OTU (operasyonel taksonomik birim) için ölçülen 40 kantitatif, 3 kalitatif karakterin varyasyonunu analiz etmek için temel bileşenler ve küme analizleri kullanılmıştır.

Bu çalışmada, Türkiye için bir takson (*Anacamptis* × *parvifolia* (Chaub.) H.Kretzschmar, Eccarius & H.Dietr.), Bolu için dokuz takson yeni kayıt olarak belirlenmiştir. Yaşam formlarıyla ilgili olarak, taksonların %91'i (48 takson) fotosentetik ototrof, geri kalan %9'u (5 takson) klorofil içermeyen saprofitlerdir. 53 taksonun ait olduğu fitocoğrafik bölgeleri göz önüne alındığında, 11'i Avrupa-Sibirya, biri İran-Turan, biri Hirkano-Öksin ve 14'ü Akdeniz elementidir. Tanımlanan taksonların bazıları (26 takson) ya geniş yayılışlı ya da bilinmeyen fitocoğrafik kökenlidir. Araştırma alanındaki en fazla taksona sahip olan cinsler aşağıdaki gibidir: *Dactylorhiza* Neck. (10 takson), *Anacamptis* Rich. (7 takson), *Orchis* Tourn. ex L. (7 takson), *Epipactis* Zinn (6 takson) and *Ophrys* L. (5 takson).

ANAHTAR KELİMELER: Bolu, Koruma, Morfoloji, Orkideler, Salep, Taksonomi

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

LIST OF ABBREVIATIONS AND SYMBOLS

Abb. **:** Abbreviation

AIBU **:** Herbarium of Abant İzzet Baysal University

Basaran **:** Mustafa BAŞARAN

ch. : Character

Eker **:** İsmail EKER

ibid. **:** Same place

MG **:** Main group

OTUs **:** Operational taxonomic units

PCA **:** Principle component analysis

SG **:** Subgroup

SL **:** Similarity level

subsp. **:** Subspecies

var. **:** Variety

ACKNOWLEDGEMENTS

I would like to extend my sincere thanks to my supervisor Assoc. Prof. Dr. İsmail EKER, who is always with me by his guidance, advice, criticism, encouragements and insight throughout the research and my field studies. I would also like to thank him for helping me to improve my English and translate some parts of my thesis. I would like to thank my jury members Assoc. Prof. Dr. İsmail Gökhan DENİZ and Ass. Prof. Dr. Nursel İKİNCİ for their suggestions and contributions. I would also like to thank Prof. Dr. M. Tekin BABAÇ for his suggestions and aids for my morphological analyses.

I offer sincere thanks to my mother Nuriye BAŞARAN, my father İbrahim BAŞARAN and my sister Merve BAŞARAN for their unshakable faith in me.

Lastly I give my thanks to my dear captain Mehmet DURSUN who have puts up with all my troubles during my field studies.

1. INTRODUCTION

The orchid is a generic name given to the whole Orchidaceae taxa, which takes the family name from genus *Orchis*. There are different kinds of information about the species numbers of the Orchidaceae family on earth; according to Sezik (1967a) about 450 genera and 18000-20000 species, according to Cullen (1992) 700 genera and 22000-25000 species and about 800 genera, and according to Allaby 18000-22000 species (2001).

Turkey is very rich than the surrounding countries in terms of terrestrial orchids in the temperate zone. The first information about orchids in Turkey was given by Boissier in 1884. In this study, it was reported that the distribution of 60 species belonging to 15 genera in Turkey. In the work of Schlechter's "*Monographie und Iconographie der Orchideen Europas und des Mittelmeergebietes*", 19 genera and 69 species were given from Turkey. The first comprehensive study on Turkey's orchids were performed by Sezik (1967a) and the distribution of 18 genera and 93 species were given from Turkey. Baytop and Sezik (1968) reported 18 genera and 91 species in Turkey in their work called "*Türk salep çeşitleri üzerine araştırmalar*". The most important study covering all of the Turkish orchids was made by Renz and Taubenheim (1984) in the "*Flora of Turkey and the East Aegean Islands*". and a total of 113 taxa including 24 genera, 97 species, 23 subspecies and six varieties were described and distributions of all taxa were also given. Later on, a large number of many researches on orchids were carried out, mainly performed by Sezik (1982, 1984, 2002a, 2002b). These are systematic studies that provide information about the inventory, distribution and extinction risks of the Turkish orchids. Rückbrodt et al. (1992), in their detailed study, gave a total distribution of 126 taxa consisting of 101 species and 10 subspecies belonging to 24 genera in Turkey. Delforge (1995), in his study on orchids found in Europe and Britain stated that 126 taxa in Turkey. Kreutz (1998), in "*Die Orchideen der Türkei*" listed a total of 148 taxa including 143 species, 6 subspecies and 4 varieties belonging to 24 genera in Turkey. However, Kreutz (2000) added a total of 38 taxa including 37 species, 3 subspecies and 1 variety belonging to 8 genera which are not included in the 8th volume of "*Flora of*

Turkey and the East Aegean Islands", for the 11th volume of the same book. Moreover, he stated that two species and one variety given in 8th volume were undistributed taxa in Turkey. Sezik (2002b) indicated, in "*Turkish Orchids and Salep*", 148 species belonging to 24 genera in Turkey. The most recent detailed study on Turkish orchids is the book of "*Türkiye Orkideleri*", which is published in German and Turkish respectively (Kreutz, 1998; Kreutz and Çolak, 2009). Kreutz and Çolak (2009), in addition to the color photographs of the 170 orchid taxa belonging to 24 genera, which are naturally distributed in our country, gave the botanical characteristics of the plants as well as their distribution areas and some population information. In addition, ecological demands, life threats and protection measures of orchids are discussed in detail. According to the latest literature information; In our country, the Orchidaceae family is represented in the "*Turkish Plant List* (*Türkiye Bitkileri Listesi*)" with 184 taxa which belong to 23 genera, 35 of which are endemic. Also, 23 of 45 hybrid taxa in our country are endemic. Three of the hybrid taxa consist of hybrid genera while two of them are subspecies hybrids (Güler, 2012; Deniz, 2012). At "*Greek-Turkish White Paper*", considering additions and some changes in taxonomic level, the total number of Orchidaceae taxa in Turkey is estimated as 191 (Petrou et al., 2016). "*The Red Book of Turkish Plants* (Ekim vd., 2000)", which classifies Turkey's endangered endemic and rare species according to risk categories, gave risk categories belonging to 14 endemic and 11 rare species based on the study of "*Flora of Turkey and the East Aegean Islands* (Davis 1965-1988)". However, 10 of them (*Cephalanthera kotschyana* Renz & Taubenheim, *Dactylorhiza chuhensis* Renz & Taubenheim, *Dactylorhiza osmanica* (Klinge) Soó var. *osmanica, Epipactis pontica* Taubenheim, *Ophrys bornmuelleri* M.Schulze. subsp. *carduchorum* Renz & Taubenheim, *Ophrys cilicica* Schltr., *Ophrys holoserica* (Burm.f.) Greuter subsp. *heterochila* Renz & Taubenheim, *Ophrys phrygia* H.Fleischm. & Bornm., *Ophrys reinholdii* Spruner ex Fleischm subsp. *leucotenia* Renz & Taubenheim, *Ophrys transhyrcana* Czernjak. subsp. *amanensis* E.Nelson ex Renz & Taubenheim) are no longer endemic to Turkey (Govaerts, 2014). There is no common consensus on the number of endemic orchid taxa in Turkey. That is, Kreutz and Çolak (2009) argues that 30 of the orchid taxa are endemic to Turkey. "*Türkiye Bitkileri Listesi* (Güler, 2012; Deniz, 2012)" accepts 35 while "*World Checklist of Selected Plant Families* (Govaerts, 2014) accepts 11.

Some of the other studies about orchids in our country are regionally systematic studies and some of them include economic, molecular, pharmaceutical, ecological, ethnobotanical, tissue culture, anatomical and morphological properties of orchids. These studies are as follows: Ertem (1977) performed an anatomical study on *Ophrys bombyliflora* Link. Concerning the orchids around Edirne, Aybeke (1997) and Güler (1997) carried out karyological, morphological, palynological and chorological studies on *Ophrys* L. and on *Orchis* L. Sezik and Özer (1983) conducted researches on Kastamonu orchids. Kahramanmaraş surroundings by Sezik and Baykal (1991), Muğla surroundings by Hahn and Passin (1997), Ordu surroundings by Schönfelder and Schönfelder (1998), Kazdağları by Güler (2005), Van surroundings by İşler (2005), and Akdağmadeni (Yozgat) by Orhan (2006) have been studied. Aybeke (2004) investigated the anatomical characteristics of 40 orchid taxa in Thrace. Daşkın et al. (2007) have published the *Dactylorhiza maculata* (L.) Soó as a new record for the flora of Turkey. In another study conducted by Aybeke (2007), pollen and seed morphology of the eight taxa belonging to the genus *Ophrys* L., which were collected from the Balkans and Turkey, was studied. Güler et al. (2008) studied the morphological characteristics of 17 species belonging to 10 genera in Çan (Çanakkale) district, as well as their medical and economic potential. Arslan (2010), in his study on the systematic, chorological and morphological aspects of Ankara and its surrounding orchids, has included 22 taxa belonging to 9 genera. Aybeke et al. (2010) studied the root, tuber and stem anatomy of 27 taxa belonging to 3 genera (*Ophrys*, *Orchis* and *Dactylorhiza*) in Thrace region. Tekinşen and Güner (2010) investigated the chemical composition and physicochemical properties of 10 different orchid tubers. Koyuncu et al. (2011) carried out researches on the risk categories of orchids spreading in Osmaneli and evaluation of the destructive elements on them. In a survey conducted by Sandal Erzurumlu and Doran (2011), information about salep orchids and salep culture in Turkey was compiled. Bozkurt and Yıldırım (2015) published *Ophrys apollonae* Paulus and M.Hirth, as a new record for the Flora of Turkey. Altundag et al. (2012) studied on the chorological, ecological, morphological and conservation strategies on *Orchis anatolica* Boiss. Bektaş et al. (2013) conducted researches on the formation of protocorm, in vitro germination and plant development on *Orchis coriophora* L. Düşünen et al. (2013) conducted researches on the diversity of salep in Tekirdağ province. Güler (2016) studied on the seed micromorphology of the eight taxa of the *Anacamptis* Rich.,

Neotinea Rchb.f. and *Orchis* genera in Edirne province. Aybeke (2017) studied on the vascular anatomy of some orchids in Turkey. Sandal Erzurumlu et al. (2018) studied on the genetic and phenotypic variations among terrestrial orchid species in Turkey. Şenel et al. (2018) studied on the comparative anatomical characteristics of some orchid species that distribute in the north of Turkey.

The regulations, notices and announcements were organized in our country about salep trade from past to present. Yaman (2013) compiled legal arrangements regarding salep and its trade from the Republic of Turkey Official Newspaper archive from 1920 to the present. According to accessible official newspaper records, the first legal regulation on the protection of orchids was made on 12 December 1931 and published in the Official Newspaper (numbered as 1995) dated 1932. Accordingly, article 12 of the Forest Regulation has been amended and the salep, which was previously not subject to a license to be evacuated from the forest, was licensed after this date. In the article 20 of the Forest Law numbered 3116 published in the Official Newspaper dated 18 February 1937, it was decided not to take any fee from salep collectors. In the 23. article of the same law, it is stated that the removal of the salep from the forest is subject to permission. The first regulation published in the Official Gazette archive for the protection of orchids of salep corresponds to 1974. With a circular published in the Official Newspaper numbered 14973 dated 11 August 1974, the export of natural orchid species for the first time was added to the list of products linked to the license. Sezik (2002a) reported that the average export quantity was 10 tons in the years of this regulation and the annual consumption of salep with its domestic consumption was 20 tons. According to the Republic of Turkey State Institute of Statistics, a total of 236 tons of salep was exported between 1955-1993. When these data were analyzed, the average export amount between the years 1955-1989 was 3.7 tons and it reached to 33.8 ton between 1990-1993. Hágster and Dumont (1996) put forward that 45 tons of salep produced annually in Turkey, and 15 tons of it was exported abroad. Sezik (1967a, 1967b, 1969, 1982, 1984, 1988, 1989, 1990), in his many critical articles, mentioned the collection of tubers for the salep production in Turkey and also drew attention to the destructive factors on orchid populations in connection therewith. In the Communiqué published by the Ministry of Agriculture and Rural Affairs regarding the "Regulation, Production and Export of Natural Flower Bulbs" published in the Official Gazette dated 9 October

1991 and numbered 21016, the export of orchid (salep) species was completely prohibited. Besides, the oldest conservation organization "FFPS (Flora and Fauna Preservation Society)" founded by British and American naturalists in Africa in 1994 by calling for joint work has been collected donation for the protection of orchids in Turkey. In spite of these developments, Kreutz reported that during a visit to Taşköprü (Kastamonu) in 1996, a total of 600 kilograms of salep were offered for sale in a few shops. To obtain 600 kilograms of salep, 600.000 of tuber is required which it is assumed that the average weight of dried tubers is 1 gram. As a natural consequence of all this, orchids are no longer found in the vast forests around Taşköprü (Kreutz ve Çolak, 2009). In the Communiqué published by the Undersecretariat of Foreign Trade in the Official Gazette dated 19 July 1998 and numbered 23407, the export of salep (powder, tablet and all forms) was completely prohibited. Although salep collection is completely forbidden, the salep dismantling and illegal export are unfortunately still underway today. 1000-4000 tubers are required to obtain one kilogram of salep. The effect of rapidly increasing population, the dismantling for salep production of orchid tubers, excessive agricultural use and overgrazing factors are among the causes of extinction of orchids. Orchids that sustain their lives in graveyards are greatly rid of dismantling of orchid tubers for the purpose of obtaining salep (Kreutz and Çolak, 2009). Yaman (2013) attracted attention to the importance of education of farmers' families collecting orchid species from nature and stated that it was not possible to prevent the salep dismantling in the short term. Besides, with the development of cultural techniques, it was argued that the collection of salep from nature could be prevented by achieving a level of cultural production to meet the demand in the domestic market. Tamer et al. (2006) conducted a study on the components of salep and their effects on health. In this study, they stated that orchids were under threat by being exposed to excessive collecting. Moreover, they have pointed out the importance of protecting the orchid resources with the cultivation studies.

International trade of naturally growing plants in the world has been regulated by the "*Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES), which was first introduced in 1976. CITES divided the plants into three lists according to their status. In this contract, the species of orchids that are prohibited from trade have been defined, and the volume of orchid trade between

the years 2000-2005 has been reported to be 370 million (Roe, 2008). In the list of CITES, the 55 of the Turkish orchids appears to be on the list Appendix-2. The species in this list are not faced with an absolute risk of extinction. However, it contains species that are linked to certain principles of trade in order to prevent their use unsuitable with the continuation of their generations. The sustainability of natural resources is of great importance for orchids. The most recent study in Turkey for the preservation and production of orchids is the "Salep Action Plan", which was carried out by Republic of Turkey Ministry of forestry and Water Affairs, the General Directorate of Forestry between 2014-2018 years. The regions where the Salep Action Plan has been implemented are the boundaries of Antalya, Elazığ, Isparta, Kahramanmaraş, Kastamonu and Muğla Forestry Regional Directorates, but the orchid rich Bolu province is not included among the determined provinces. The objectives of this study focused on six main subjects (Anonymous, 2014):

1. Preparation of protection plans by making field and product inventory
2. Reproduction in natural habitat
3. Research to growth of salep in natural habitat
4. Transfer of salep members to be grown in nurseries to natural distribution areas
5. Creation of seed gardens for the purpose of gene source
6. Training of local people and resource managers

The orchids are plants that require ecologically specific habitats. The environments where they grow should have an appropriate climate and habitat. It is difficult to produce from seeds and requires a long process. The lack of endosperm in orchid seeds and the need fungus to germinate make the development of plants difficult and cause the development process of orchids to take too many years. Even though conditions necessary for germination are appropriate, individuals who can achieve germination at least in 9-12 years take many years to bloom by creating leaves and tubers. This period is between 2-4 years shortest. This situation led researchers to study the reproduction of salep orchids in vitro conditions (Sezik, 1984; Sezik et al., 2007). With the fact that orchids are still not easy to reproduce outside of their natural habitat, a few studies have been made on the production of terrestrial orchids with tissue culture in our country, but a practical achievement is not achieved (Gönülşen et al., 1996).

There are many floristic and vegetation studies conducted in Bolu province, but no studies on direct orchids have been found. The studies on Bolu's floristic diversity in chronological order are as follows; Gerede and Aktaş Forests, and Köroğlu Mountain by Akman and Ketenoğlu (1979a, 1979b), Bolu and Semen Mountains by Akman and Yurdakulol (1981a; 1981b), Yedigöller Natural Park by Ekim and İlarslan (1982), campus flora of Abant İzzet Baysal University by Turgut (1996), Gökçeler Mountain by Uluğ (1999), Lake Abant by Türker and Güner (2003), Lake Yeniçağa by Sümer (2002), Lake Gölcük by İkinci and Güner (2007), Karakiriş Mountain by Aksoy (2009), Lake Sünnet by İkinci (2011), Kartalkaya by Sungurlu (2011), Taşlıyayla and Kızık surrounding by Tunçkol (2012), Kale-Bolu Hazelnut Nature Reserve Area by Arslan et al. (2013), aquatic plants of Gölköy and Yumrukaya by Bayındır (2013), *in situ* conservation facilities of some endemic plant species in Gölköy Campus by Doğan (2014), petaloid monocotyledonous flora of Bolu by Demir and Eker (2015), Lake Sülüklü by Kanoğlu et al. (2016), aquatic plants of Bolu by İkinci and Bayındır (2019), Gölköy Campus by Eker et al. (2018), endemic and rare plants of Bolu by Eker et al. (2019) were studied. The vegetational studies are as follows: Köroğlu Mountains by Akman and Ketenoğlu (1978), Bolu and Semen Mountains by Akman et al. (1983a; 1983b), Gerede-Aktaş forest by Ketenoğlu (1983) and Mudurnu surroundings by Akman and İlarslan (1983) were studied. In these studies, records of some orchid taxa were given. In the most comprehensive regional revision study involving also orchids in Bolu province, the geophytes of the province were studied by Demir and Eker (2015). In this study, 36 orchid taxa, including one endemic, belonging to 15 genera were identified in Bolu province. However, this study is a large-scale inventory study, which does not include morphological analyzes and detailed population observations on orchids. Only the general population observations of some species are included. Also, in this study, it is stated that most of the populations identified are under the risk of extinction, 1-2 individuals has been reached for some of them and some records of taxa have inadequate location information and some of them are doubtful records that could not be collected after the first collection. In the study conducted by Kreutz and Çolak (2009) based on Kreutz's observations between 1988 and 1996, the number of individuals in the natural populations of some orchid taxa in Bolu province are stated as hundreds. However, Demir and Eker (2015) reported 1-2 individuals for the same species in the same regions. In this study, only one

individual of *Coeloglossum viride* (L.) Hartm. could be reached in two vegetations period. In addition, only a few individuals could be collected from *Dactylorhiza saccifera* (Brongn.) Soó subsp. *bithynica*, *Epipactis microphylla* (Ehrh.) Sw., *Epipactis persica* (Soó) Hausskn. ex Nannf. and *Epipogium aphyllum* Sw. Kreutz (2009) reached many *Dactylorhiza* Neck. ex Nevski species on Abant road and stated that there are hybrid species in this area. However, Demir and Eker (2015) could not reach any of the four *Dactylorhiza* hybrids (*Dactylorhiza x boluiana* H.Baumann, *Dactylorhiza x vogtiana* H.Baumann, *Dactylorhiza x abantiana* H.Baumann & Künkele, *Dactylorhiza x renzii* H.Baumann & Künkele). Demir and Eker (2015) also pointed out that the distribution of *Dactylorhiza incarnata* (L.) Soó subsp. *incarnata* was narrow and the regional risk category was VU. In the study of Demir and Eker (2015), the list of 38 orchid taxa found in Bolu is as follows;

1. *Anacamptis coriophora* (L.) R.M.Bateman, Pridgeon & M.W.Chase subsp. *coriophora* (as *A. coriophora* (L.) R.M.Bateman, Pridgeon & M.W.Chase)
2. *Anacamptis laxiflora* (Lam.) R.M.Bateman, Pridgeon & M.W.Chase subsp. *laxiflora* (as *A. laxiflora* (L.) R.M.Bateman, Pridgeon & M.W.Chase)
3. *Anacamptis morio* (L.) R.M.Bateman, Pridgeon & M.W.Chase subsp. *morio*
4. *Anacamptis palustris* (Jacq.) R.M.Bateman, Pridgeon & M.W.Chase subsp. *palustris* (as *A. palustris* (Jacq.) R.M.Bateman, Pridgeon & M.W.Chase)
5. *Anacamptis pyramidalis* (L.) Rich.
6. *Cephalanthera damasonium* (Mill.) Druce
7. *Cephalanthera epipactoides* Fisch. & C.A.Mey.
8. *Cephalanthera longifolia* (L.) Fritsch
9. *Cephalanthera rubra* (L.) Rich.
10. *Dactylorhiza iberica* (M.Bieb. ex Willd.) Soó
11. *Coeloglossum viride* (L.) Hartm.
12. *Dactylorhiza incarnata* (L.) Soó subsp. *incarnata*
13. *Dactylorhiza nieschalkiorum* H.Baumann & Künkele (Endemik)
14. *Dactylorhiza romana* (Sebast.) Soó subsp. *romana*
15. *Dactylorhiza saccifera* (Brongn.) Soó subsp. *bithynica* (as *D. saccifera* (Brongn.) Soó subsp. *saccifera*)
16. *Epipactis helleborine* (L.) Crantz subsp. *helleborine*
17. *Epipactis microphylla* (Ehrh.) Sw.

18. *Epipactis palustris* (L.) Crantz
19. *Epipactis persica* (Soó) Hausskn. ex Nannf.
20. *Epipactis pontica* Taubenheim
21. *Epipactis turcica* Kreutz
22. *Epipogium aphyllum* Sw.
23. *Himantoglossum caprinum* (M.Bieb.) Spreng.
24. *Himantoglossum comperianum* (Steven) P.Delforge
25. *Limodorum abortivum* (L.) Sw. var. *abortivum*
26. *Neotinea tridentata* (Scop.) R.M.Bateman, Pridgeon & M.W.Chase

(as *N. tridentata* (Scop.) R.M.Bateman, Pridgeon & M.W.Chase subsp. *tridentata*)

27. *Neottia nidus-avis* (L.) Rich.
28. *Ophrys apifera* Huds.
29. *Ophrys oestrifera* M.Bieb. subsp. *oestrifera*
30. *Ophrys transhyrcana* Czerniak. subsp. *paphlagonica* Kreutz

(as *O. sphegodes* Mill. subsp. *mammosa* (Desf.) Soó ex E.Nelson)

31. *Orchis mascula* (L.) L. subsp. *pinetorum* (Boiss. & Kotschy) E.G.Camus

(as *O. mascula* (L.) L. subsp. *mascula*)

32. *Orchis purpurea* Huds. subsp. *purpurea*
33. *Orchis pallens* L.
34. *Orchis simia* Lam. (as *O. simia* Lam. subsp. *simia*)
35. *Platanthera chlorantha* (Custer) Rchb.
36. *Serapias bergonii* E.G.Camus
37. *Spiranthes spiralis* (L.) Chevall.
38. *Steveniella satyrioides* (Spreng.) Schltr.

In the study of Demir and Eker (2015), taxa that cannot be detected in the studies following the first gathering record from the research area are given as follows;

1. *Orchis provincialis* Balbis ex DC.
2. *Orchis punctulata* Steven ex Lindley
3. *Orchis spitzelii* Sauter ex W.Koch
4 *Dactylorhiza urvilleana* (Steud.) H.Baumann & Künkele
5. *Dactylorhiza x boluiana* H.Baumann
6. *Dactylorhiza x vogtiana* H.Baumann

7. *Dactylorhiza x abantiana* H.Baumann & Künkele
8. *Dactylorhiza x renzii* H.Baumann & Künkele

In light of the above considerations and literature, necessity of making a detailed study of the orchids in the province of Bolu can be explained as follows: the lives of orchids in Turkey is under serious threat and many species are facing extinction. In our country for many years by the community and/or foreign collectors as food or drug plant unconsciously or for commercial purposes are collected, so their generations are in danger. The examination of the current status of these plants in their natural habitats is important in terms of shedding light on the works to be carried out for conservation purposes. In light of changing and developing new systematic knowledge, relationships between taxa and their nomenclature situations need to be reviewed. With each passing day, the taxonomic categories of some species are changed, and some of them are reduced to synonym. Especially, herbarium specimens belonging to some plant records that were given in the studies before the volume eight of Flora of Turkey (Davis 1984) (which contains the orchids) are can not be achieved. For this reason, especially records related to wrong or doubtful identification cannot be verified or some of the old records cannot be reached due to insufficient locality information. Detailed land survey studies are needed at the regional level in order to solve such problems.

This study includes the first morphological analyzes of the orchid species in Bolu at the population level, and the detailed population and habitat observations and the identification of threat and risk factors at the local level.

2. AIM AND SCOPE OF THE STUDY

This study was conducted to reveal the current diversity of orchids in Bolu province and to make detailed morphometric analyzes and population observations on taxa. The detailed descriptions, habitat and locality characteristics, and regional conservation assessments of all taxa were given.

This study is not only a floristic study but also a regional revision work on orchids. Both the methods used in morphometric analyzes and the samples and characters will be an important source for further research. Within this frame, preparation of inventory of orchids and determination of habitat features and intensity of populations will contribute to both Bolu and Turkish Floras.

The orchids, considered as world's most valuable ornamental plants, are mainly used in the floriculture, food and pharmaceutical industries. Our country is one of the important centers of biodiversity in the world in terms of terrestrial orchids, especially the Aegean coast and the Mediterranean region. This rich diversity has attracted the attention of local people, especially foreign plant traders and researchers since the 1930s, and the orchids were collected as ornamental, food or medicinal plants for many years. As in this study, in addition to the emergence of scientific findings, it is of great importance to establish basic data for the development of strategies for the in situ conservation of orchids.

3. MATERIAL AND METHODS

In the research area, a total of 92 field studies were conducted from April 2014 to September 2017 and a total of 2727 specimens were collected from 231 populations or stations. In addition, previously collected 251 herbarium specimens stored in AIBU herbarium were used for morphological measurements. As a result of the identification of these specimens, 53 taxa belonging to 17 genera, seven of which are endemic and one of which is rare, were determined. In this study, 1 taxon for Turkey and 9 taxa for Bolu were determined as new records.

3.1 Morphological Analyses

The description of taxa is based on measurements and examinations made on fresh and dried plants. All of the quantitative characters and most of the qualitative characters excluding the features of colour and position of plant parts are measured/examined on dried plants. The features of colour and position of plant parts were observed during the field study and supported with photographs in the habitat of species. Measurements/observations of microscopic structures were taken with a ruler under the stereo-microscope while measurements/observations of macroscopic structures were taken with a ruler.

In the morphological studies, two systems were applied for evaluation of the taxa: traditional taxonomy and numerical taxonomy: For the numerical taxonomic analyses, as possible at 10 specimens from each population were sampled randomly. When there were not enough individuals in the population, 5 samples were taken. In the morphological analyses, 41 quantitative, 28 qualitative characters were used. Totally, (41 quantitative ch. + 28 qualitative ch.) × 1986 = 137034 characters were measured/observed. Qualitative and quantitative characters used in the plant descriptions are listed in Table 3.1-3.2 below. In addition, some of the quantitative characters are represented in the Figure 3.1.

Table 3.1. Qualitative characters

No	Abbreviation of character	Explanation of character
1	BD	Bract direction
2	BSO	Bract surface ornamentation
3	SC	Speculum color
4	SL	Speculum location
5	SML	Speculum margin color
6	SP	Speculum pattern
7	SSO	Speculum surface ornamentation
8	FBL	First blooming location
9	AD	Appendix direction
10	ESO	Epichile surface ornamentation
11	HSO	Hypochile surface ornamentation
12	LLD	Labellum lateral lobe direction
13	LLSO	Labellum lateral lobe surface ornamentation
14	MLD	Labellum middle lobe direction
15	MLSO	Labellum middle lobe surface ornamentation
16	LS	Lobules shape
17	LC	Leaf color
18	LBP	Leaf blotch presence
19	LSO	Leaf surface ornamentation
20	OSO	Ovary surface ornamentation
21	PMP	Petal margin property
22	PSO	Petal surface ornamentation
23	USS	Underground stem shape
24	DSSO	Dorsal sepal surface ornamentation
25	LSSO	Lateral sepal surface ornamentation
26	SD	Spur direction
27	SS	Spur shape
28	LF	Life form

Table 3.2. Quantitative characters

No	Abbreviation of character	Explanation of character
1	BL	Bract length
2	BW	Bract width
3	FN	Flower number
4	BCL	Beak of column length
5	BCW	Beak of column width
6	CL	Column length
7	CW	Column width
8	IL	Inflorescence length
9	AL	Appendix length
10	AW	Appendix width

Table 3.2. (cont'd)

11	EL	Epichile length
12	EW	Epichile width
13	HL	Hypochile length
14	HW	Hypochile width
15	LHL	Labellum horn - hump length
16	LLLL	Labellum lateral lobe length
17	LLLW	Labellum lateral lobe width
18	LLN	Labellum lobe number
19	LMLL	Labellum middle lobe length
20	LMLW	Labellum middle lobe width
21	LL	Labellum length
22	LW	Labellum width
23	LTL	Labellum tooth length
24	LTW	Labellum tooth width
25	LOL	Lobules length
26	LOW	Lobules width
27	LN	Leaf number
28	LEL	Leaf length
29	LEW	Leaf width
30	PCL	Pedicel length
31	PCW	Pedicel width
32	PL	Petal length
33	PW	Petal width
34	DSL	Dorsal sepal length
35	DSW	Dorsal sepal width
36	LSL	Lateral sepal length
37	LSW	Lateral sepal width
38	SUL	Spur length
39	SUW	Spur width
40	STL	Stem length
41	SSN	Stem sheathing scale number

* Leaf measurements were taken from the top mature leaves.
* Pedicel measurements were performed including ovary measurements.
* Bract, pedicel and flower measurements were taken from the lowest flower.
* Inflorescence length measurements were made from pedicel base of bottom flower to tip of inflorescence.

Figure 3.1. Measurement locations of the some important quantitative characters

Taxonomic nomenclature of the taxa are given in the following order:

- Sequential number, valid species name, author(s)
- Description: The description of taxa is based on measurements/observations made on fresh and dried specimens. In consideration of description, the variation ranges of characters were indicated covering the total variation exhibited by a taxon. Extreme values have been placed in paranthesis before/after or at the both sides of ranges of taxa.
- Phenology
- Habitat and altitude
- Specimen examined: Citation of a specimen is constituted of locality, habitat, altitude, GPS (Global Position System) coordinate, date of collection, collector number, herbarium acronyms.
- Regional conservation assessment

All qualitative and quantitative characters are coded according to Sneath and Sokal (1973), and Abbott et al. (1985). Qualitative characters with multi-state characters were coded as in ordered series of discrete states, e.g., by scoring “0” for petal surface ornamentation is “glabrous”, “1” for petal surface ornamentation is “slightly pubescent on outer surface”, “2” for petal surface ornamentation is “minutely pubescent on both surface”, and “3” for petal surface ornamentation is “pubescent on both surface” (Table 3.3).

Quantitative characters were measured in millimeters according to the metric system. The mean values of each character were calculated. The raw measurements of each character were obtained for each of five or ten individuals from a single population or station. Then, mean values of the raw measurements were calculated for every character from each population and each taxon. Afterwards, according to the modified Whisker’s graph (Massart et al., 2005), the mean values of each characters with their standard errors were plotted on one group graph by using Graphpad program (Figure 3.2). When means and standard error lines of each quantitative characters belonging to different populations have overlapped with each other, they were grouped and coded as the same state of the character in ascending order (modified from Almeida and Bisby, 1984). After all quantitative characters were coded in this technique, a taxonomic matrix was generated (Appendix A).

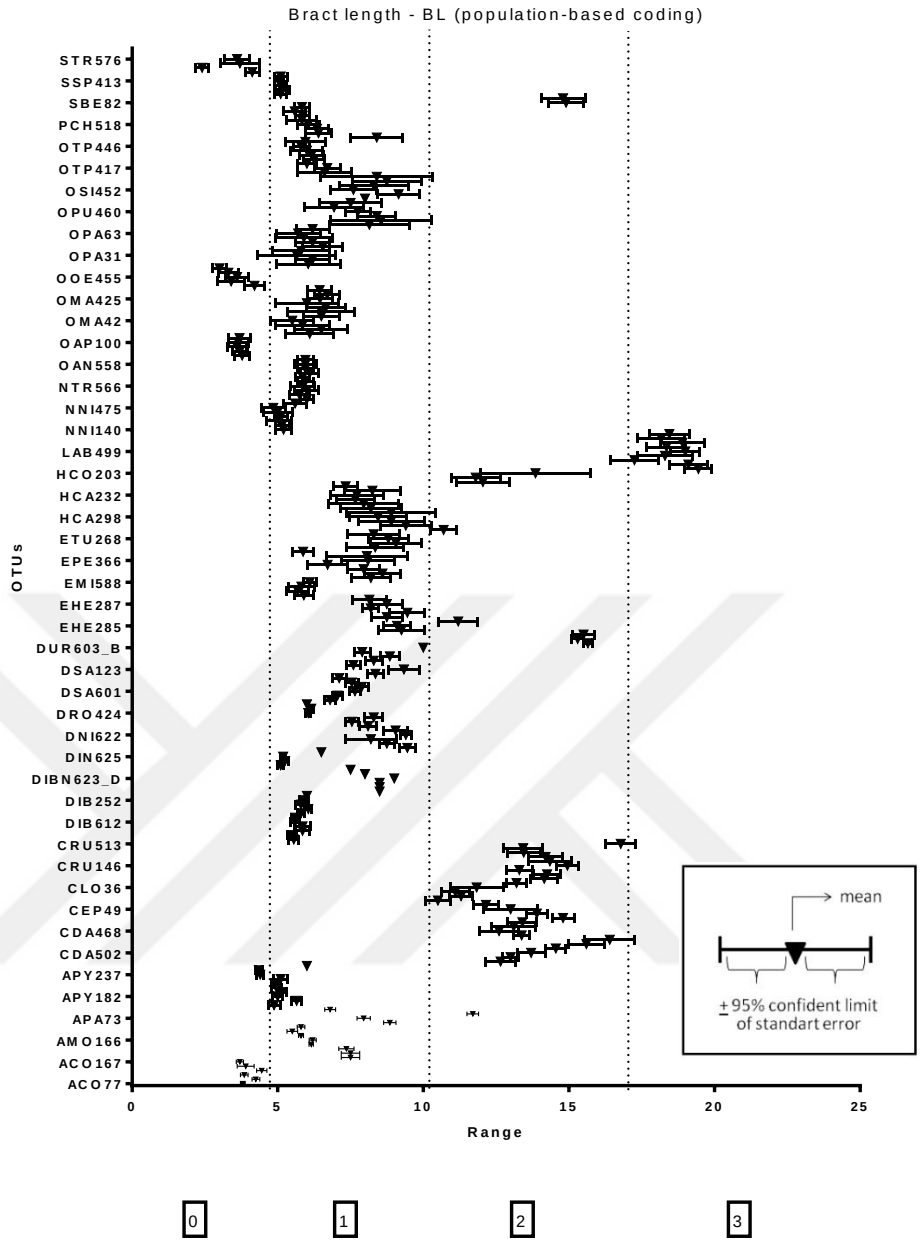


Figure 3.2. Grouping and coding the character states of a quantitative character on a modified Whisker's graph. The character states of this character were coded as follows: the mean values are less than 4.74 was scored by 0, the mean values are between 4.74 and 10.2 was scored by 1, the mean values are between 10.2 and 17.1 was scored by 2,and finally the mean values are more than 17.1 was scored by 3 (<4.74: 0, 4.74 – 10.2: 1, 10.2 – 17.1: 2, and 17.1 <: 3).

MINITAB (Meyer and Krueger, 2004) statistical package program was used for cluster and principal component analysis (PCA). In cluster analysis, for measuring the distance between OTUs in n-dimentional space, Average Linkage between groups was used because of strengthening the tree diagrams geometrically.

In analysis of clusters and establishing of dendrogram, Euclidean block method was used.

Cluster analysis techniques can group the OTUs according to their similarities or dissimilarities quite well according to the distances measured among the OTUs. But real places of the OTUs in n-dimensional space, their connection levels, and the group structures can not be shown easily by cluster analysis. Because of these reasons, the PCA is performed to overcome these restrictions of cluster analysis. During the PCA, two-dimensional case factor scatter-plots were generated by using most appropriate components which are the components 1 and 2. The two dimensional plotted graphs of OTUs were created according to the components 1 and 2 which gave the most meaningful groups of OTUs. The PCA analyses were generated by using the MINITAB (Meyer and Krueger, 2004) and SPSS (Levesque, 2007) statistical package programs.

Table 3.3. Qualitative characters and character states used in numerical analyses.

	List of characters	**Abb.**	**Character states (Coding)**
1	Bract direction	BD	erect to suberect (0)/patent to deflexed (1)/suberect to deflexed (2)
2	Bract surface ornamentation	BSO	glabrous (0)/minutely pubescent (1)/slightly pubescent (2)/pubescent (3)
3	Speculum color	SC	absent (0)/greyish-blue (1)/dull bluish-violet (2)/bluish-brown (3)/violet or reddish-brown (4)
4	Speculum location	SL	absent (0)/from base to middle (1)/occupying most of middle lobe (2)/from base to near apex (3)/ covers almost all surface (4)
5	Speculum margin color	SML	absent (0)/whitish-blue (1)/yellow (2)/yellowish to greenish (3)/yellowish to greyish-blue lines (4)
6	Speculum pattern	SP	absent (0)/bipartite, w shaped (1)/H-shaped (2)/H-shaped with lateral spots (3)/scutelliform, H-shaped (4)/scutelliform at the base extending laterally and apically (5)
7	Speculum surface ornamentation	SSO	absent (0)/glabrous (1)/slightly velutinous (2)
8	First blooming location	FBL	bottom flowers (0)/terminal flowers (1)
9	Appendix direction	AD	absent (0)/deflexed (1)/ directed forwards (2)/slightly upcurved (3)/directed upwards (4)

Table 3.3. (cont'd)

10	Epichile surface ornamentation	ESO	absent (0)/glabrous (1)/glabrous, with crests (2)/glabrous, with papillae and crests (3)/glabrous, with protuberances (4)/slightly hairy near base, with papillae (5)
11	Hypochile surface ornamentation	HSO	absent (0)/glabrous (1)/glabrous, with crests (2)/slightly to densely hairy (3)
12	Labellum lateral lobe direction	LLD	absent (0)/deflexed (1)/directed forwards (2)/directed forwards to deflexed (3)/directed forwards to upcurved (4)/upcurved (5)/convex (6)
13	Labellum lateral lobe surface ornamentation	LLSO	absent (0)/glabrous (1)/obscurely papillose (2)/minutely papillose (3)/papillose (4)/minutely velutinous and papillose (5)/papillose, minutely velutinous and pilose (6)/papillose, minutely velutinous and villous (7)/papillose and tuft of long papillae and/or hairs (8)/papillose and velutinous (9)
14	Labellum middle lobe direction	MLD	absent (0)/deflexed (1)/directed forwards (2)/directed forwards to deflexed (3)/directed forwards with upcurved lobules (4)/convex (5)
15	Labellum middle lobe surface ornamentation	MLSO	absent (0)/glabrous (1)/obscurely papillose (2)/minutely papillose (3)/papillose (4)/minutely velutinous and papillose (5)/papillose, minutely velutinous and pilose (6)/papillose, minutely velutinous and villous (7)/papillose and tuft of long papillae and/or hairs (8)/papillose and velutinous (9)
16	Lobules shape	LS	absent (0)/filiform (1)/strap-shaped (2)/narrowly linear (3)/oblong (4)/obovate-oblong (5)/
17	Leaf color	LC	absent (0)/green (1)/glossy green (2)/dark green (3)/glaucous (4)/green, with or without pinkish tip (5)
18	Leaf blotch presence	LBP	absent (0)/with blotch (1)/with or without blotch (2)/without blotch (3)
19	Leaf surface ornamentation	LSO	absent (0)/glabrous (1)/minutely pubescent (2)
20	Ovary surface ornamentation	OSO	glabrous (0)/glabrous to pubescent (1)/minutely pubescent (2)/pubescent (3)/densely pubescent (4)/with scattered glandular hairs (5)
21	Petal margin property	PMP	entire (0)/entire to revolute (1)/slightly undulate (2)/undulate (3)/scarcely crenulate (4)
22	Petal surface ornamentation	PSO	glabrous 0/slightly pubescent on outer surface (1)/minutely pubescent on both surface (2)/pubescent on both surface (3)
23	Underground stem shape	USS	rhizome (0)/rounded tuber (1)/divided tuber (2)

Table 3.3. (cont'd)

24	Dorsal sepal surface ornamentation	DSSO	glabrous (0)/sparsely pubescent on outer surface (1)/pubescent on outer surface (2)/scattered glandular hairs on outer surface (3)
25	Lateral sepal surface ornamentation	LSSO	glabrous (0)/sparsely pubescent on outer surface (1)/pubescent on outer surface (2)/scattered glandular hairs on outer surface (3)
26	Spur direction	SD	absent (0)/directed downwards (1)/directed downwards to upwards (2)/horizontal to directed downwards (3)/horizontal to directed upwards (4)/directed upwards (5)
27	Spur shape	SS	absent (0)/more or less filiform (1)/more or less cylindrical (2)/more or less conical (3)/more or less saccate (4)/more or less saccate (5)/more or less saccate (6)
28	Life form	LF	photosynthetic autotroph (0)/saprophyte without chlorophyll (1)

Table 3.4. Abbreviations of taxa

No	**Abb.**	**Taxa**
1	ACO	*Anacamptis coriophora* (L.) R.M.Bateman, Pridgeon & M.W.Chase subsp. *coriophora*
2	ALA	*Anacamptis laxiflora* (Lam.) R.M.Bateman, Pridgeon & M.W.Chase subsp. *laxiflora*
3	AMO	*Anacamptis morio* (L.) R.M.Bateman, Pridgeon & M.W.Chase subsp. *morio*
4	APA	*Anacamptis palustris* (Jacq.) R.M.Bateman, Pridgeon & M.W.Chase subsp. *palustris*
5	APP	*Anacamptis papilionacea* (L.) R.M.Bateman, Pridgeon & M.W.Chase subsp. *papilionacea*
6	ALAC	*Anacamptis* × *parvifolia* (Chaub.) H.Kretzschmar, Eccarius & H.Dietr.
7	APY	*Anacamptis pyramidalis* (L.) Rich.
8	CDA	*Cephalanthera damasonium* (Mill.) Druce
9	CEP	*Cephalanthera epipactoides* Fisch. & C.A.Mey.
10	CLO	*Cephalanthera longifolia* (L.) Fritsch
11	CRU	*Cephalanthera rubra* (L.) Rich.
12	CVI	*Coeloglossum viride* (L.) Hartm.
13	CTR	*Corallorhiza trifida* Châtel.
14	DIBN	*Dactylorhiza* × *abantiana* H.Baumann & Künkele
15	DIBU	*Dactylorhiza* × *balabaniana* H.Baumann
16	DIB	*Dactylorhiza iberica* (M.Bieb. ex Willd.) Soó
17	DIN	*Dactylorhiza incarnata* (L.) Soó subsp. *incarnata*
18	DNI	*Dactylorhiza nieschalkiorum* H.Baumann & Künkele

Table 3.4 (cont'd)

19	DINN	*Dactylorhiza* × *renzii* H.Baumann & Künkele
20	DRO	*Dactylorhiza romana* (Sebast.) Soó subsp. *romana*
21	DSA	*Dactylorhiza saccifera* (Brongn.) Soó subsp. *bithynica* (H.Baumann) Kreutz
22	DUR	*Dactylorhiza urvilleana* (Steud.) H.Baumann & Künkele subsp. *ilgazica* (Kreutz) Kreutz
23	DIBI	*Dactylorhiza* × *vogtiana* H.Baumann
24	EHE	*Epipactis helleborine* (L.) Crantz subsp. *helleborine*
25	EMI	*Epipactis microphylla* (Ehrh.) Sw.
26	EPA	*Epipactis palustris* (L.) Crantz
27	EPE	*Epipactis persica* (Soó) Hausskn. ex Nannf.
28	EPO	*Epipactis pontica* Taubenheim
29	ETU	*Epipactis turcica* Kreutz
30	EAP	*Epipogium aphyllum* Sw.
31	HAF	*Himantoglossum affine* (Boiss.) Schltr.
32	HCA	*Himantoglossum caprinum* (M. Bieb.) Spreng.
33	HCO	*Himantoglossum comperianum* (Steven) P.Delforge
34	LAB	*Limodorum abortivum* (L.) Sw. var. *abortivum*
35	LRU	*Limodorum abortivum* (L.) Sw. var. *rubrum* H.Sund. ex Kreutz
36	NTR	*Neotinea tridentata* (Scop.) R.M.Bateman, Pridgeon & M.W.Chase
37	NNI	*Neottia nidus-avis* (L.) Rich.
38	OAP	*Ophrys apifera* Huds.
39	OFU	*Ophrys fusca* Link subsp. *thracica* Kreutz
40	OOE	*Ophrys oestrifera* M.Bieb. subsp. *oestrifera*
41	OTP	*Ophrys transhyrcana* Czerniak. subsp. *paphlagonica* Kreutz
42	OTR	*Ophrys tremoris* Gämperle & Gölz
43	OAN	*Orchis anatolica* Boiss.
44	OPUS	*Orchis* × *angusticruris* Franch.
45	OMA	*Orchis mascula* (L.) L. subsp. *pinetorum* (Boiss. & Kotschy) E.G.Camus
46	OPA	*Orchis pallens* L.
47	OPU	*Orchis purpurea* Huds. subsp. *purpurea*
48	OSI	*Orchis simia* Lam.
49	OSP	*Orchis spitzelii* Saut. ex W.D.J.Koch
50	PCH	*Platanthera chlorantha* (Custer) Rchb.
51	SBE	*Serapias bergonii* E.G.Camus
52	SSP	*Spiranthes spiralis* (L.) Chevall.
53	STR	*Steveniella satyrioides* (Spreng.) Schltr.

4. RESULTS

In the research area, a total of 92 field studies were conducted from April 2014 to September 2017 and a total of 2727 specimens were collected. In addition, the other 251 herbarium specimens stored in AIBU herbarium were used for morphological measurements. As a result of the identification of these specimens, 53 taxa belonging to 17 genera, seven of which are endemic and one of which is rare, were determined. In this study, 1 taxon for Turkey and 9 taxa for Bolu were determined as new records.

A total of 231 populations were identified during the study. The taxa with the highest population number are as follows; *Cephalanthera rubra* (L.) Rich., *Himantoglossum caprinum* (M. Bieb.) Spreng., *Anacamptis pyramidalis* (L.) Rich., *Orchis mascula* (L.) L. subsp. *pinetorum* (Boiss. & Kotschy) E.G.Camus. The taxa with the lowest population number are as follows; *Anacamptis papilionacea* (L.) R.M.Bateman, Pridgeon & M.W.Chase subsp. *papilionacea*, *Coeloglossum viride* (L.) Hartm., *Corallorhiza trifida* Châtel., *Anacamptis palustris* (Jacq.) R.M.Bateman, Pridgeon & M.W.Chase subsp. *palustris*, *Orchis spitzelii* Saut. ex W.D.J.Koch, *Serapias bergonii* E.G.Camus, and *Himantoglossum affine* (Boiss.) Schltr.

Concerning the life forms, 91% (48 taxa) of taxa are photosynthetic autotrophs while the remaining 9% (5 taxa) are saprophytes without chlorophyll (Figure 4.1). According to the underground stem metamorphosis, of all collected taxa, 27% (14 taxa) were rhizomatous, 73% (28 taxa) were tuberous, 11 (21%) were divided tuberous and 27 (52%) were rounded tuberous (Figure 4.1).

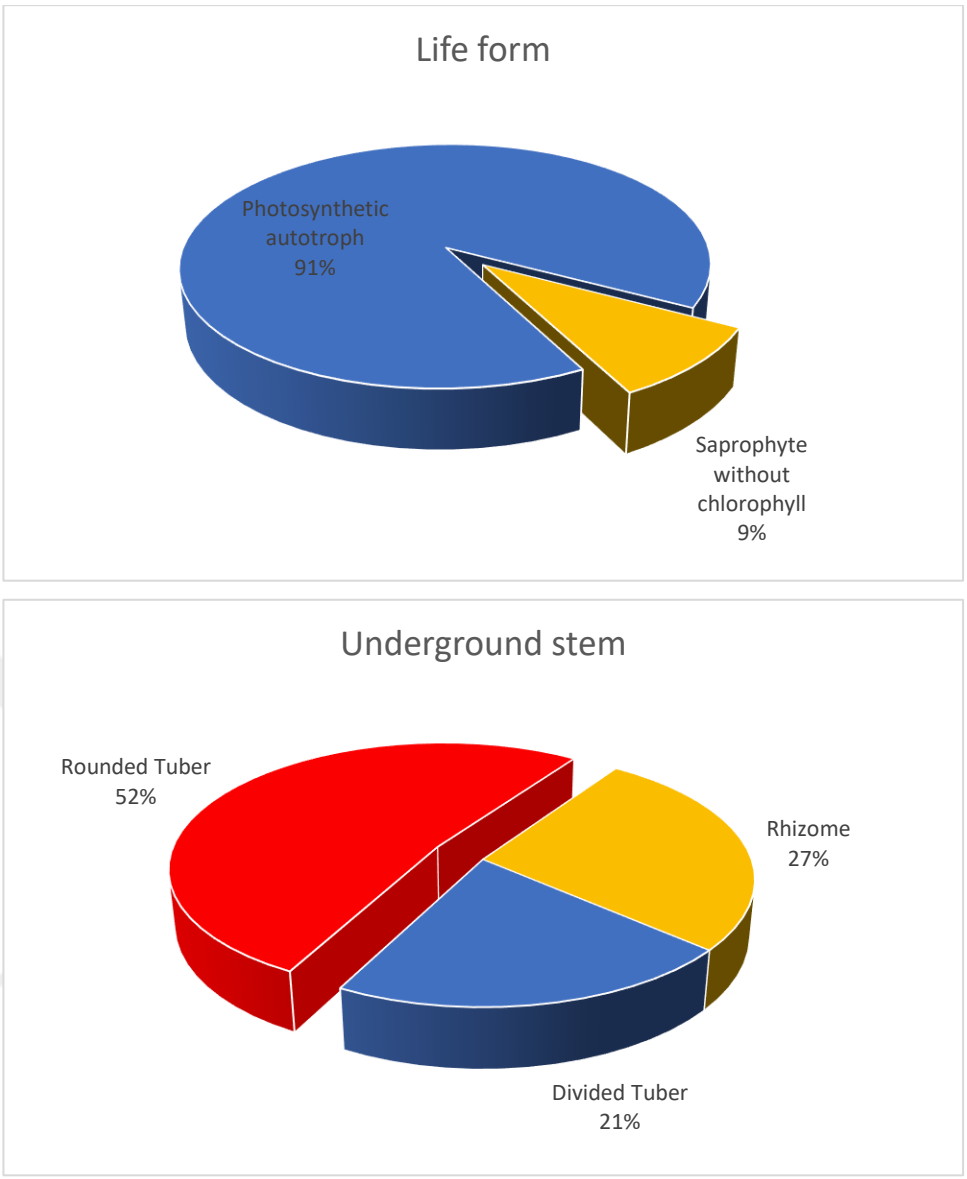


Figure 4.1. Life forms and underground stem metamorphosis of taxa

Considering phytogeographic regions of 53 taxa, 11 of them were Euro-Siberian elements, one of them were Irano-Turanian, one of them were Hyrcano – Euxine and 14 of them were Mediterranean elements. Some of the identified species (26) were widespread and of unknown phytogeographic origin (Figure 4.3) The genera with the most taxa in the research area are as follows: *Dactylorhiza* Neck. (10), *Anacamptis* Rich. (7), *Orchis* (7), *Epipactis* Zinn (6) and *Ophrys* L. (5) (Figure 4.2).

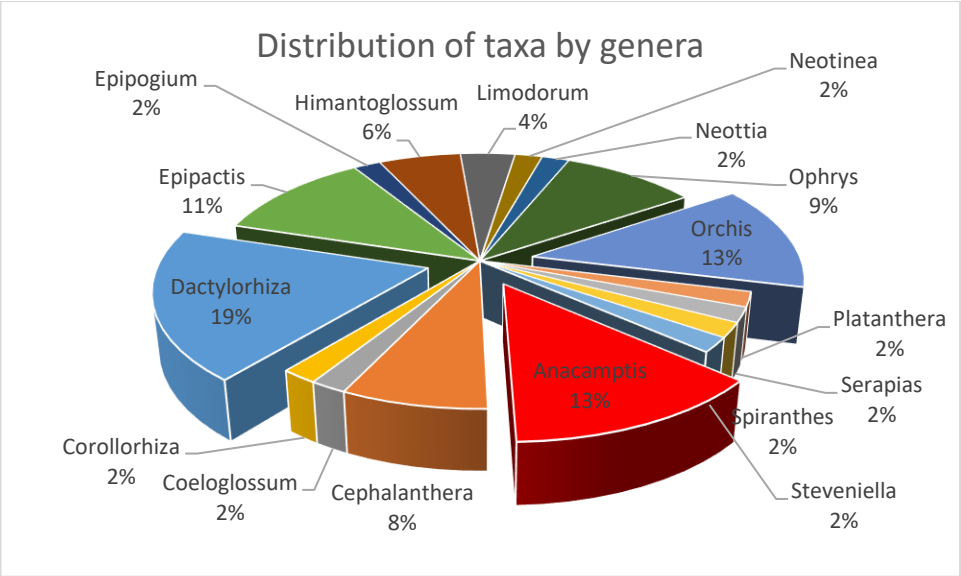


Figure 4.2. Distribution of taxa by genera

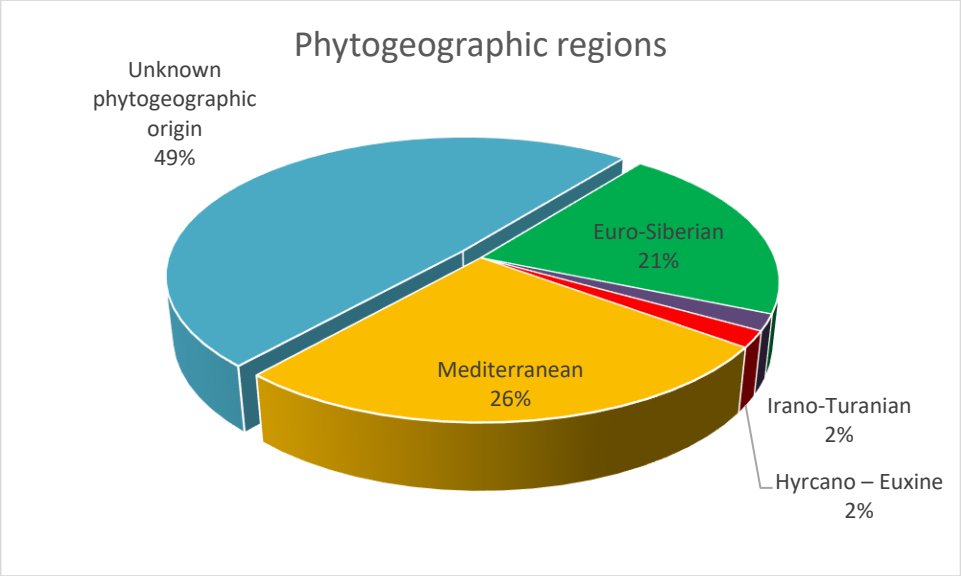


Figure 4.3. Phytogeographic regions of 53 taxa

4.1 Morphological Features of Taxa

4.1.1 *Anacamptis coriophora* (L.) R.M.Bateman, Pridgeon & M.W.Chase subsp. *coriophora*

Plant 15−36 cm, photosynthetic autotroph. Tubers subglobose or ellipsoid. Stem glabrous. Leaves 5−10(−11), erect to spreading, linear to lanceolate, acuminate, glabrous, green without blotch, (4.5−)5.9−11.5(−13) × 0.8−1.7 cm. Inflorescence (2.5−)3.5−10(−12) cm long, densely 13−44(−61) flowered, oblong or cylindrical. Bracts 9−17 × (1−)1.5−3(−4) mm, erect, lanceolate, acuminate, glabrous, green with more or less purple-tinged on the margin. Pedicel (including ovary) (6−)7−12(−14) × (1−)1.5−2.5(−3) mm, glabrous, reddish-green. Sepals united into a hood; lateral sepals 5.5−8 × (1.5−)2−3(−4) mm, obliquely ovate-elliptic, acute, glabrous, brownish-red, whitish centrally; dorsal sepal 4.5−6(−6.5) × 1.5−2 mm, ovate-lanceolate, acuminate, glabrous, brownish-red, whitish centrally. Petals 3.5−5 × 1(−1.5) mm, linear-lanceolate, acute or acuminate, glabrous, brownish-red. Labellum 3-lobed, with reddish blotches, 5.5−8 × 4−7 mm; lateral lobes 1−2 × 1−2.5(−3.5) mm, straight to deflexed, rhombic to semi-ovate, entire to dentate margin at apex, papillose, reddish-green; middle lobe 2−3(−3.5) × 1−2.5 mm, straight to deflexed, ligulate-oblong, obtuse, with entire margin, papillose, reddish-green. Spur (4−)4.5−7.5 × (1−)1.5−2.5(−3) mm, directed downwards, conical, obtuse, light pink to reddish. Column 2.5−3.5 × 0.5−1 mm.

Phenology: Flowering from middle of May to early July.

Habitat and altitude: Wet meadows and glades, 813−1729 m.

Specimens examined: A3 Bolu: Yeniçağa, Ömerler village, 2 km from the village mosque, wet meadows, 1100 m, 12 June 2015, Başaran 77 & Eker (AIBU)!; Abant road, 1.5 km from Abant road crossroad to Abant, wet meadows, 813 m, 14 June 2015, Başaran 83 & Eker (AIBU)!; ibid., 819 m, 25 July 2015, Başaran 297 & Eker (AIBU)!; ibid., 823 m, 23 May 2013, Demir 655 & Eker (AIBU)!; Abant road, 3 km from Abant road crossroad to Abant, glades, 851 m, 14 June 2015, Başaran 88 & Eker (AIBU)!; Mudurnu, Abant, North of National Parks Abant Conservation Area,

wet meadows, 1372 m, 19 June 2015, Başaran 119 & Eker (AIBU)!; Tokadi Hayrettin Tomb road, 380 m from D100 crossroad to Tokadi Hayrettin Tomb, wet meadows, 844 m, 20 May 2016, Başaran 478 & Eker (AIBU)!; Seben, west of Seben pond, around Dedeler plateau crossroad, wet meadows, 1466 m, 9 June 2016, Başaran 505 & Eker (AIBU)!; Seben, Dereceören to Kuzgölcük plateau, above valley of Aladağ stream, glades, 1358 m, 11 June 2016, Başaran 506 & Eker (AIBU)!; Seben, 4 km from Kızık-Kuzgölcük crossroad to Kızık, wet meadows, 1568 m, 1 July 2016, Başaran 552 & Eker (AIBU)!; Mudurnu, Abant, west of the lake, at the beginning of the wooden walkway, wet meadows, 1324 m, 19 June 2015, Başaran 130 & Eker (AIBU)!; Yedigöller road, 2.5 km from Çelegölcük forest storage road to forest storage, glades, 1142 m, 26 June 2015, Başaran 153 & Eker (AIBU)!; BAİBÜ central campus, north of the FEF laboratories, glades, 858 m, 14 May 2019, Başaran 633 & Eker (AIBU)!; **A4 Bolu:** Gerede, North of Gerede, 7.44 km from Gerede traffic lights, Northeast of the Seviller plateau, wet meadows, 1729 m, 1 July 2015, Başaran 167 & Eker (AIBU)!; Mengen, southwest of Düzağaç village, glades, 978 m, 1 July 2015, Başaran 186 & Eker (AIBU)!

Regional conservation assessment: During field studies, six populations were determined. The taxon has a restricted spread. There is no significant threat for habitats of three populations (ACO506, ACO505, ACO167) for now. However, the ACO130 population in Abant is threatened by grazing. The area where the ACO83 population located on the Abant road, is under grazing and human pressure, and there is a risk that the area will be transformed into settlement or agricultural area. There is also a risk that the area where the ACO77 population located in Yeniçağa is converted into agricultural area. These three populations need conservation.

Figure 4.4. *Anacamptis coriophora* subsp. *coriophora*
a) Habit, b) Inflorescence

4.1.2 ***Anacamptis laxiflora*** (Lam.) R.M.Bateman, Pridgeon & M.W.Chase subsp. ***laxiflora***

Plant 20−55 cm, photosynthetic autotroph. Tubers subglobose or ellipsoid. Stem glabrous. Leaves 6−9, erect to spreading, linear to lanceolate, acute, glabrous, green without blotch, (8−)10−21.5 × 0.8−1.8 cm. Inflorescence (3.5−)6−10(−25.5) cm long, loosely (6−)7−27 flowered, ovoid or cylindrical. Bracts (13−)17−25(−32) × 2−4.5 mm, suberect, lanceolate, acute, glabrous, purple. Pedicel (including ovary) (13−)16−27 × 1−3 mm, glabrous, green and slightly suffused with purple. Lateral sepals (6−)7−11.5 × (2.5−)3−4(−4.5) mm, deflexed, oblong to oblong-ovate, obtuse, glabrous, purple; dorsal sepal (7.5−)8−10 × 2−3.5(−4) mm, more or less erect, mostly connivent with the petals, oblong, obtuse, glabrous, purple. Petals 6.5−8.5(−10) × (2−)2.5−3(−4) mm, ovate to obliquely oblong, obtuse, glabrous, purple. Labellum indistinctly 3-lobed, with or without reddish blotches, 7−12(−14) × (8−)11−16(−20) mm; lateral lobes 1.5−3(−5) × 3−6 mm, strongly deflexed, oblong to oblong-orbicular, with entire margin, glabrous, purple; middle lobe 1−2 × (2−)2.5−4.5(−6) mm, straight, directed forwards, rounded, with entire margin, glabrous, purplish-white. Spur 8−13(−14) × 1−2 mm, horizontal to directed upwards, cylindrical, obtuse or slightly notched at apex, purple. Column 3.5−5 × 0.5−1 mm.

Phenology: Flowering from middle of May to middle of June.

Habitat and altitude: Wet meadows, 805−1372 m.

Specimens examined: A3 Bolu: Abant, Abant road, 3 km to Abant, wet meadows, 823 m, 23 May 2013, Demir 654 & Eker (AIBU)!; Abant road, 1.5 km from Abant crossroad to Abant, wet meadows, 813 m, 14 June 2015, Başaran 80 & Eker (AIBU)!; ibid., 819 m, 25 July 2015, Başaran 296 & Eker (AIBU)!; ibid., 819 m, 20 May 2016, Başaran 480 & Eker (AIBU)!; BAİBÜ central campus, north of Gölköy dam lake, wet meadows, 806 m, 26 May 2014, Başaran 21 & Eker (AIBU)!; ibid., 805 m, 13 May 2016, Başaran 454 & Eker (AIBU)!; Mudurnu, Abant, 1.3 km northeast of Örencik plateau, wet meadows, 1483 m, 19 June 2015, Başaran 115 & Eker (AIBU)!; Mudurnu, Abant, North of National Parks Abant Conservation Area, wet meadows, 1372 m, 19 June 2015, Başaran 120 & Eker (AIBU)!; Tokadi Hayrettin Tomb road, 380 m from D100 crossroad to Tokadi Hayrettin Tomb, wet meadows, 844 m, 20 May 2016, Başaran 477 & Eker (AIBU)!; ibid., Başaran 479 & Eker (AIBU)!

Regional conservation assessment: During field studies, three populations were determined. There is a very limited spread of taxon. The ALA120 population in Abant is threatened by grazing. The area where the ALA80 population located on the Abant road, is under grazing and human pressure, and there is a risk that the area will be transformed into settlement or agricultural area. Also, ALA454 population in Gölköy is under the threat of both grazing and agricultural activities. These three populations need conservation.

Figure 4.5. *Anacamptis laxiflora* subsp. *laxiflora* a) Habit, b) Inflorescence

4.1.3 *Anacamptis morio* (L.) R.M.Bateman, Pridgeon & M.W.Chase subsp. ***morio***

Plant 10−34.2 cm, photosynthetic autotroph. Tubers globose or ovoid. Stem glabrous, mostly suffused with reddish-purple above. Leaves 5−10, spreading, linear-oblong to narrowly lanceolate, glabrous, green without blotch, 4.5−9.5(−11) × (7−)8−14(−16) cm. Inflorescence 23−76(−10.7) cm long, densely or rather loosely 4−20(−26) flowered, cylindrical or pyramidal. Bracts 9−22(−29) × 1.5−3(−6) mm, suberect, lanceolate, acuminate, glabrous, green with more or less purple-tinged on the margin. Pedicel (including ovary) 10−20 × 1−2 mm, glabrous, dull purple to dark purple. Perianth segments united into a galea. Sepals mostly with conspicuous green or dark purple veins; lateral sepals 7−10 × 2−4 mm, oblong-ovate, obtuse, glabrous, purple; dorsal sepal 6−9 × 2−2.5 mm, oblong-ovate, obtuse, purple. Petals 5−6.5 × 1.5−2 mm, oblong, obtuse, glabrous, lilac to purple. Labellum 3-lobed, whitish at center with dark purple blotches, 7.5−12 × (6.5−)7−10 mm; lateral lobes 1−2.5 × 1−3 mm, directed forwards to deflexed, broadly rounded, with entire or dentate margin, minutely velutinous and papillose, lilac to purple; middle lobe (0.5−)1−2 × 3−5(−6) mm, directed forwards, truncate or retuse, minutely velutinous and papillose, lilac to purple, whitish at center with dark purple blotches. Spur 7−12 × 1−2 mm, horizontal to directed upwards, cylindrical, dilated at tip, obtuse or mostly notched, lilac to purple. Column 2.5−3 × 0.5 mm.

Phenology: Flowering from end of April to end of June.

Habitat and altitude: Meadows, 824−1729 m.

Specimens examined: A3 Bolu: Abant road, 1.5 km from Abant crossroad to Abant, meadows, 824 m, 2 May 2016, Başaran 430 & Eker (AIBU)!; BAİBÜ central campus, north of Gölköy dam lake, meadows, 845 m, 4 May 2012, Demir 53 & Eker (AIBU)!; BAİBÜ central campus, around the Cultural Center of BAİBÜ, wet meadows, 875 m, 30 April 2014, Başaran 17 & Eker (AIBU)!; BAİBÜ central campus, north of Gölköy dam lake, meadows, 805 m, 13 May 2016, Başaran 457 & Eker (AIBU)!; ibid., 837 m, 25 May 2016, Başaran 485 & Eker (AIBU)!; BAİBÜ central campus, rector's office road, meadows, 833 m, 23 April 2016, Başaran 427 & Eker (AIBU)!; Yeniçağa, Ömerler village, 2 km from the village mosque, meadows,

1100 m, 12 June 2015, Başaran 75 & Eker (AIBU)!; ibid., Başaran 76 & Eker (AIBU)!; ibid., 1102 m, 5 May 2016, Başaran 438 & Eker (AIBU)!; **A4 Bolu:** Gerede, Gerede's northern border, 8 km from Gerede traffic lights, northeast of the Seviller Plateau, wet meadows, 1739 m, 1 July 2015, Başaran 168 & Eker (AIBU)!; Gerede, north of Gerede, 5 km from Gerede traffic lights, wet meadows, 1713 m, 1 July 2015, Başaran 165 & Eker (AIBU)!; Gerede, north of Gerede, 7.44 km from Gerede traffic lights, northeast of Seviller plateau, wet meadows, 1729 m, 1 July 2015, Başaran 166 & Eker (AIBU)!; west of Bürnük village, meadows, 958 m, 6 May 2016, Başaran 449 & Eker (AIBU)!

Regional conservation assessment: During field studies, five populations were determined. There is a limited spread of taxon. There is no significant threat for habitats of three populations for now. However, the area where the AMO430 population located on the Abant road, is under grazing and human pressure, and there is a risk that the area will be transformed into settlement or agricultural area. The AMO427 population in Gölköy is under the threat of both grazing and agricultural activities. There is also a risk that the area where the AMO75 population located in Yeniçağa is converted into agricultural area. These three populations need conservation.

Figure 4.6. *Anacamptis morio* subsp. *morio* – a) Habit, b) Inflorescence

4.1.4 *Anacamptis palustris* (Jacq.) R.M.Bateman, Pridgeon & M.W.Chase subsp. ***palustris***

Plant 42.5−91 cm, photosynthetic autotroph. Tubers subglobose or ellipsoid. Stem glabrous, fistulose in robust specimens, mostly suffused with reddish-purple above. Leaves 5−8, erect to slightly spreading, linear to linear-lanceolate, acuminate, glabrous, green without blotch, 12−22 × 1.5−2.6 cm. Inflorescence 15−26(−34.5) cm long, densely or loosely 18−42 flowered, cylindrical, mostly elongated. Bracts (15−)21−41(−52) × 2.5−4 mm, suberect, linear-lanceolate, acuminate, glabrous, green with more or less purple-tinged on the margin. Pedicel (including ovary) 12−25 × 1.5−3 mm, glabrous, green and more or less suffused with purple. Lateral sepals 8−11(−13) × (2−)2.5−4 mm, deflexed to spreading, ovate-lanceolate to oblong-ovate, obtuse, glabrous, purple; dorsal sepal 6−10(−12) × 2−4 mm, curving forwards converging with the petals, oblong-ovate, rotund, glabrous, purple. Petals 7−10 × 2−4 mm, obliquely oblong, obtuse, glabrous, purple, paler at base. Labellum 3-lobed, 14−16(−21) × 9−15 mm; lateral lobes 0.5−1.5 × 3−4(−5) mm, directed forwards to deflexed, oblong-orbiculate, glabrous, purple to pale purple; middle lobe 0.5−1.5 × 3−7 mm, directed forwards, subquadrate or obcordate, entire or retuse, glabrous, purple to pale purple. Spur 10−17 × 2−3(−4) mm, horizontal to directed downwards, cylindrical, obtuse, purple to pale purple. Column 3.5−4 × 1 mm.

Phenology: Flowering from early May to end of July.

Habitat and altitude: Marshes, 900−1000 m.

Specimens examined: A3 Bolu: Yeniçağa, Yeniçağa road, Hamzabey, Örenköy and Kemaller village crossroad, marshes, 1001 m, 12 June 2015, Başaran 70 & Eker (AIBU)!; Yeniçağa, Yeniçağa-Hamzabey village road, 500 m to Hamzabey village, marshes, 999 m, 12 June 2015, Başaran 73 & Eker (AIBU)!; Yeniçağa, Yeniçağa road, Hamzabey, Örenköy and Kemaller village crossroad, marshes, 1011 m, 17 June 2016, Başaran 520 & Eker (AIBU)!

Regional conservation assessment: Only two locations were determined in Yeniçağa during field studies. Due to grazing and cultivation activities carried out in the region, the habitats of taxon are under threat of extinction. This taxon needs immediate conservation.

Figure 4.7. *Anacamptis palustris* subsp. *palustris*
a) Habit, b) Inflorescence

4.1.5 ***Anacamptis papilionacea*** (L.) R.M.Bateman, Pridgeon & M.W.Chase **subsp. *papilionacea***

Plant 24−26 cm, photosynthetic autotroph. Tubers globose. Stem glabrous. Leaves 5−7, erect to suberect, lanceolate to linear-lanceolate, acuminate, glabrous, green without blotch, 6.4−7 × 0.8−1 cm. Inflorescence 4−5.5 cm long, loosely 4−7 flowered, ovate to oblong. Bracts 24−26 × 4.5−5 mm, erect, lanceolate, acuminate, glabrous, reddish-purple. Pedicel (including ovary) 19−23 × 1.5−2 mm, glabrous, green slightly suffused with reddish. Perianth segments united into a loose galea. Sepals with conspicuous dark purple veins; lateral sepals 14−15 × 4−5 mm, oblong-ovate to lanceolate, acute, glabrous, purple to reddish-purple; dorsal sepal 12−13 × 2.5−3 mm, oblong-ovate to lanceolate, acute, glabrous, purple to reddish-purple. Petals 11−12 × 2.5−3 mm, lanceolate to ovate-lanceolate, acute, glabrous, purple to reddish-purple with conspicuous dark purple veins. Labellum undivided, whitish at center with dark purple longitudinal stripes and blotches, 15−17 × 7.5−9.5 mm, sides

upcurved, obovate, constricted at the base, with crenate-denticulate margin, minutely papillose, reddish-purple to pink. Spur 11−12 × 1.5−2 mm, directed downwards, cylindrical, attenuate towards apex, white to purple. Column 4−4.5 × 0.5 mm.

Phenology: Flowering in middle of April.

Habitat and altitude: Dry grassy places, 597 m.

Specimen examined: A3 Bolu: Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti, dry grassy places, 597 m, 16 April 2016, Başaran 418 & Eker (AIBU)!

Regional conservation assessment: This taxon was only found at one locality and only five individuals were counted in the area. Morphological measurements were made during the field study and one individual was sampled. In field studies conducted in the same area in the following years after the first detection, no individual was found. However, the ruins of *Himantoglossum caprinum* were observed in the area due to commercial harvesting of salep orchids in 2015 before the first detection of *A. papilionacea* in 2016. This situation explains that why taxon could not be found in this area in the following years.

Figure 4.8. *Anacamptis papilionacea* subsp. *papilionacea*
a) Habit, b) Inflorescence

4.1.6 *Anacamptis* × *parvifolia* (Chaub.) H.Kretzschmar, Eccarius & H.Dietr.[*Anacamptis coriophora* (L.) R.M.Bateman, Pridgeon & M.W.Chase subsp. *coriophora* × *Anacamptis laxiflora* (Lam.) R.M.Bateman, Pridgeon & M.W.Chase subsp. *laxiflora*]

Plant 25−28 cm, photosynthetic autotroph. Tubers subglobose or ovoid. Stem glabrous. Leaves 7−8, erect to spreading, linear to linear-lanceolate, acute to acuminate, glabrous, green without blotch, 8−10.3 × 0.9−1.3 cm. Inflorescence 5.3−7 cm long, loosely 15−16 flowered, cylindrical. Bracts 11.5−13 × 2−2.5 mm, erect, lanceolate, acute, glabrous, green, more or less suffused with purple. Pedicel (including ovary) 13−15 × 2−2.5 mm, glabrous, green, suffused with purple. Perianth segments united into a loose galea. Lateral sepals 7−7.5 × 3−3.5 mm, obliquely ovate-lanceolate, subobtuse, with incurved margin at the tip, purple; dorsal sepal 6.5 × 2 mm, ovate-elliptic, obtuse, with incurved margin at the tip, purple. Petals 6 × 2 mm, ovate-lanceolate, subobtuse, glabrous, purple. Labellum 3-lobed, with purple blotches, 6 × 5−7.5 mm; lateral lobes 2−2.5 × 3.5 mm, deflexed, rhombic to oblong-orbicular, dentate margin at apex, papillose, purple; middle lobe 2 × 2 mm, directed downwards, ligulate-oblong, papillose, purple. Spur 8.5−11 × 2 mm, directed downwards to upwards, conical-cylindrical, obtuse, purple. Column 3.5 × 0.5 mm.

Phenology: Flowering middle of June.

Habitat and altitude: Wet meadows, 813 m.

Specimen examined: A3 Bolu: Abant road, 1.5 km from Abant crossroad to Abant, wet meadows, 813 m, 14 June 2015, Başaran 87 & Eker (AIBU)!

Regional conservation assessment: This hybrid taxon was only found at one locality and only 2 individuals were counted and sampled. Hybrid taxon area is under grazing and human pressure, and there is a risk that the area will be transformed into settlement or agricultural area.

Figure 4.9. *Anacamptis* × *parvifolia* – a) Habit, b) Inflorescence

4.1.7 ***Anacamptis pyramidalis*** (L.) Rich.

Plant (23.5−)28.2−59(−72) cm, photosynthetic autotroph. Tubers subglobose or ellipsoid. Stem glabrous. Leaves 4−10, erect to spreading, linear to linear-lanceolate, acute to acuminate, glabrous, green without blotch, (6.4−)8−17 × (0.5−)0.8−1.8 cm. Inflorescence 2−8.7 cm long, densely 20−70(−76) flowered, ovoid-pyramidal. Bracts 8−20(−24) × 1−3 mm, suberect, linear-lanceolate, acute to acuminate, purplish-pink. Pedicel (including ovary) (7−)9−17(−19) × 1−2 mm, glabrous, green to dark pink. Perianth segments united into a loose galea. Lateral sepals 4−10(−12) × 1.5−3(−3.5) mm, slightly spreading, ovate-lanceolate to ovate-elliptic, acute, glabrous, dark reddish-pink to pale pink; dorsal sepal 3.5−7(−7.5) × 1.5−2.5 mm, slightly curving forwards converging with the petals, oblong-ovate to ovate-elliptic, acute, glabrous, dark reddish-pink to pale pink. Petals 4−7(−8) × (1.5−)2−3.5(−4) mm, ovate-lanceolate, acute, glabrous, dark reddish-pink to pale pink. Labellum 3-lobed, with 2 longitudinal ridges extending from the entrance of the spur towards the centre, 5−9 × (5−)6−10(−11) mm; lateral lobes (1.5−)2−4(−9) × (1.5−)2−4 mm, directed forwards, oblong-rhombic, obtuse to truncate or somewhat denticulate at apex, obscurely papillose, dark reddish-pink to pale pink; middle lobe (1.5−)2−4(−5) × (1−)1.5−2.5(−3.5) mm, directed forwards, oblong-rhombic, with entire margin, obtuse to truncate at apex, obscurely papillose, dark reddish-pink to pale pink. Spur (8−)9−17(−20) × 1−1.5 mm, horizontal to directed downwards, filiform, acute, dark reddish-pink to pale pink. Column (−1)1.5−2 × 0.5−1 mm.

Phenology: Flowering from end of May to end of July.

Habitat and altitude: Glades, roadsides, grassy places and *Quercus* L. forest, 394−1088 m.

Specimens examined: A3 Bolu: 6.5 km from Kartalkaya-D100 crossroad to Kartalkaya, roadside slopes, 1190 m, 14 August 2015, Başaran 371 & Eker (AIBU)!; Abant road, 1.5 km from Abant crossroad to Abant, grassy places, 813 m, 14 June 2015, Başaran 86 & Eker (AIBU)!; Abant road, 3 km from Abant crossroad to Abant, grassy places, 851 m, 14 June 2015, Başaran 90 & Eker (AIBU)!; Abant road, 700 m from the crossroad of Akçaalan village to the village, roadsides, 928 m, 25 July 2015, Başaran 299 & Eker (AIBU)!; Abant road, west of Akçaalan village, mountain road, 390 m from village, glades, 1015 m, 14 June 2015, Başaran 97 & Eker (AIBU)!; around south entrance of Değirmenderesi village, grassy places, 865 m, 25 June 2016, Başaran 538 & Eker (AIBU)!; BAİBÜ central campus, north of Gölköy dam lake, *Quercus* forest, 799 m, 30 June 2016, Başaran 548 & Eker (AIBU)!; Banaz village road, 2.6 km from Anadolu highway, around Çetinkaya fountain, glades, 867 m, 27 July 2015, Başaran 307 & Eker (AIBU)!; Bolu-Bilecik road, 12.5 km from BAİBÜ Central Campus crossroad, glades, 894 m, 7 July 2015, Başaran 191 & Eker (AIBU)!; ibid., 882 m, 15 September 2015 (in fruit), Başaran 402 & Eker (AIBU)!; Dere village, east of Merkeşler village, roadsides, 767 m, 12 July 2015, Başaran 230 & Eker (AIBU)!; Göynük, Sünnet village-Alanköy road, 3.08 km from Sünnet village, roadsides, 1262 m, 7 July 2015, Başaran 415 & Eker (AIBU)!; Mengen, Bolu-Mengen road, 47 km from Bolu, 230 m to Gökçesu, grassy places, 527 m, 14 July 2015, Başaran 233 & Eker (AIBU)!; Mengen, Bolu-Mengen road, 8 km to Mengen, around Sayar village, grassy places, 574 m, 14 July 2015, Başaran 241 & Eker (AIBU)!; Mengen, east of Düzağaç village, 700 m to the village, grassy places, 981 m, 23 June 2016, Başaran 532 & Eker (AIBU)!; Mengen, Gökçesu-Kayabükü road, around Karakaya village, grassy places, 457 m, 23 June 2016, Başaran 530 & Eker (AIBU)!; Mengen, Gökçesu-Mengen road, 1 km from Gökçesu, grassy places, 563 m, 14 July 2015, Başaran 235 & Eker (AIBU)!; Mengen, Gökçesu-Mengen road, 2.27 km from Gökçesu, grassy places, 632 m, 14 July 2015, Başaran 237 & Eker (AIBU)!; Mudurnu, Sülükgölöl-Taşkesti road, 4 km from Sülüklügöl, glades, 816 m, 31 May 2015, Başaran 61 & Eker (AIBU)!;

Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti , grassy places, 587 m, 24 June 2015, Başaran 143 & Eker (AIBU)!; Mudurnu, Tavşansuyu-Taşkesti road, 1 km from Tavşansuyu, near the Akyokuş village crossroad, grassy places, 442 m, 7 August 2015 (in fruit), Başaran 352 & Eker (AIBU)!; Mudurnu, Tavşansuyu-Taşkesti road, 800 m from Tavşansuyu, near the Akyokuş village crossroad, grassy places, 394 m, 24 June 2015, Başaran 147 & Eker (AIBU)!; north of Merkeşler village, 160 m from Merkeşler village crossroad, glades, 975 m, 12 July 2015, Başaran 225 & Eker (AIBU)!; Seben, around Musasofular village crossroad, roadsides, 920 m, 3 June 2017, Başaran 583 & Eker (AIBU)!; southwest of Banaz village, grassy places, 895 m, 12 July 2015, Başaran 221 & Eker (AIBU)!; Yakabayat Village-Gölcük village road, 1.45 km from Yakabayat village, glades, 1058 m, 16 August 2015 (in fruit), Başaran 372 & Eker (AIBU)!; Yedigöller road, 500 m from Anatolian highway, grassy places, 847 m, 26 June 2015, Başaran 151 & Eker (AIBU)!; Yedigöller road, 500 m from Anatolian highway, glades, 835 m, 16 June 2016, Başaran 512 & Eker (AIBU)!; **A4 Bolu:** Mengen, Bürnük village-Şirinyazı pond road, 650 m to the pond, grassy places, 1062 m, 14 July 2015, Başaran 265 & Eker (AIBU)!; Mengen, east of Düzağaç village, 1 km to the village, glades, 1004 m, 1 July 2015, Başaran 181 & Eker (AIBU)!; Mengen, east of Düzağaç village, 700 m to the village, grassy places, 978 m, 1 July 2015, Başaran 182 & Eker (AIBU)!; Mengen, east of Düzağaç village, 700 m to the village, grassy places, 992 m, 1 September 2015 (in fruit), Başaran 389 & Eker (AIBU)!; Mengen, Mengen-Eskipazar road, 890 m from Sazlar village crossroad to the village, grassy places, 651 m, 14 July 2015, Başaran 243 & Eker (AIBU)!; Mengen, north of the Şirinyazı pond, glades, 1088 m, 14 July 2015, Başaran 249 & Eker (AIBU)!; Mengen, northwest of Bürnük village, glades, 1014 m, 14 July 2015, Başaran 247 & Eker (AIBU)!

Regional conservation assessment: During field studies, 11 populations were determined. These populations show a wide spread. There is no significant threat for habitats of five populations for now. However, the area where APY143 population located in Taşkesti/Mudurnu is under grazing and human pressure and there is a risk that the area will be transformed into settlement or agricultural area. The population of APY147 near Tavşansuyu/Mudurnu is threatened with extinction due to grazing and cultivation activities. The APY191 population on the Bolu-Bilecik road and

APY249 population in the Şirinyazı pond/Mengen are under human pressure. The the area where the APY143 population located on the Bolu-Mengen road is under grazing pressure. The APY182 population in Mengen is under grazing pressure and there is a risk that the area will be converted into agricultural area. These populations need conservation. However, since taxon is distributed in a wide range, it is foreseeable that all populations in the region will not threatened for a long time.

Figure 4.10. *Anacamptis pyramidalis* – a) Habit, b) Inflorescence

4.1.8 ***Cephalanthera damasonium*** (Mill.) Druce

Plant 20−64.5 cm, photosynthetic autotroph. Rhizome woody, with numerous roots. Stem glabrous. Leaves 1−5, horizontal to suberect, oblong-ovate to ovate-lanceolate, subobtuse to acuminate, glabrous, green without blotch, (2.2−)4−10.5 × 0.9−3.9 cm. Inflorescence 2.5−21(−27.5) cm long, loosely 1−14 flowered. Flowers mostly closed, sometimes slightly opened. Bracts (13−)19−70(−100) × (1.5−)6−20(−28) mm, spreading, ovate-lanceolate to lanceolate, lower leaf-like, acute to acuminate, glabrous, green. Pedicel (including ovary) 10−30 × 1.5−4 mm, erect and much elongated after flowering, glabrous, green. Lateral sepals 13−25 × 4−7(−9) mm, more or less closely connivent, oblong-lanceolate, obtuse to acute, glabrous, white to creamy-white; dorsal sepal 12.5−25 × 4−8(−9.5) mm, oblong-lanceolate, obtuse to acute, glabrous, white to creamy-white. Petals 11−18.5 × 4−8 mm, oblong-lanceolate, obtuse to acute, glabrous, white to creamy-white. Labellum divided into

hypochile and epichile, 8.5−14 × 7.5−14 mm; hypochile 4−8.5 × 7.5−14 mm, saccate, with rounded side-lobes clasping the column, glabrous, white, with orange-yellow patch inside; epichile 4−7.5 × 6−15 mm, cordate-triangular, obtuse, white, with orange-yellow longitudinal crests. Column 6−10 × 1−3 mm.

Phenology: Flowering from early May to early July.

Habitat and altitude: *Quercus* forest, *Fagus* L. forest, *Pinus* L. forest, coniferous forest and glades, 830−1605 m.

Specimens examined: A3 Bolu: Abant road, 4.3 km from Abant-Gökdere crossroad, coniferous forest, 1146 m, 14 June 2015, Başaran 96 & Eker (AIBU)!; Abant Road, 5.5 km to Abant, between road and stream, *Fagus* forest, 1076 m, 14 June 2015, Başaran 107 & Eker (AIBU)!; BAİBÜ central campus, north of Gölköy dam lake, *Quercus* forest, 817 m, 13 May 2016, Başaran 458 & Eker (AIBU)!; Bolu-Bilecik road, 12.6 km from BAİBÜ Central Campus crossroad, roadside slopes, 894 m, 7 July 2015 (in fruit), Başaran 197 & Eker (AIBU)!; Göynük, Alanköy-Yeniköy road, 3.42 km to Yeniköy, *Pinus* forest, 950 m, 16 May 2016, Başaran 468 & Eker (AIBU)!; Karacasu-Gölcük road, 1.66 km from Karacasu, *Fagus* forest, 844 m, 18 May 2016, Başaran 473 & Eker (AIBU)!; Mengen, Gökçesu-Mengen road, 1 km from Gökçesu, *Pinus* forest, 567 m, 16 October 2015 (in fruit), Başaran 406 & Eker (AIBU)!; Mudurnu, Abant, 2.18 km northeast of Örencik plateau, glades, 1481 m, 18 August 2015 (in fruit), Başaran 383 & Eker (AIBU)!; Mudurnu, Abant, northeast of the lake, glades, 1343 m, 19 June 2015, Başaran 133 & Eker (AIBU)!; Mudurnu, Abant, south of the lake, *Fagus* forest, 1345 m, 19 June 2015, Başaran 131 & Eker (AIBU)!; Mudurnu, Abant-Taşkesti road, 3 km from Abant, around Ekizoluk crossroad, *Pinus* forest, 1402 m, 21 June 2016, Başaran 528 & Eker (AIBU)!; Mudurnu, Abant-Taşkesti road, 6 km from Gölcük village crossroad, İğneciler village, glades, 869 m, 29 May 2015, Başaran 45 & Eker (AIBU)!; Mudurnu, Sülüklügöl road, 2 km to the lake, glades, 829 m, 31 May 2015, Başaran 57 & Eker (AIBU)!; north of Merkeşler village, 5 km from Merkeşler village crossroad, glades, 1165 m, 2 June 2015, Başaran 68 & Eker (AIBU)!; Seben, Haccağız village-Musasofular village road, 1.07 km to Musasofular village, *Pinus* forest, 940 m, 11 June 2016, Başaran 510 & Eker (AIBU)!; Seben, Kabakköy-Kızık road, south slopes of Kabakköy, glades, 1210 m, 9 June 2016, Başaran 502 & Eker (AIBU)!; Seben,

Kesenözü village-Çatak plateau road, 4.5 km from the village, *Pinus* forest, 810 m, 12 August 2015 (in fruit), Başaran 369 & Eker (AIBU)!; ibid., 6.58 km from the village, *Pinus* forest, 830 m, 7 June 2016, Başaran 501 & Eker (AIBU)!; Yedigöller road, 1.80 km from Anatolian highway, *Pinus* forest, 913 m, 11 August 2015 (in fruit), Başaran 363 & Eker (AIBU)!; **A4 Bolu:** Gerede, 3 km from Gerede traffic lights, plateau district, Vahdettin beyin fountain, *Pinus* forest, 1605 m, 1 July 2015, Başaran 164 & Eker (AIBU)!; ibid., *Pinus* forest, 1621 m, 1 September 2015 (in fruit), Başaran 386 & Eker (AIBU)!; Gerede, Koçumlar village, glades, 1352 m, 8 July 2015, Başaran 207 & Eker (AIBU)!; Mengen, Bürnük village-Şirinyazı pond road, 650 m to the pond, *Pinus* forest, 1062 m, 14 July 2015 (in fruit), Başaran 264 & Eker (AIBU)!; Mengen, north of the Şirinyazı pond, glades, 1088 m, 14 July 2015 (in fruit), Başaran 248 & Eker (AIBU)!; ibid., 1100 m, 1 September 2015 (in fruit), Başaran 392 & Eker (AIBU)!; Mengen, northeast of Mengen, north of Gezginder plateau, glades, 1433 m, 1 July 2015, Başaran 170 & Eker (AIBU)!

Regional conservation assessment: During field studies, 10 populations were determined. These populations show a wide spread and there is no significant threat for their habitats for now.

Figure 4.11. *Cephalanthera damasonium* – a) Habit, b) Inflorescence

4.1.9 *Cephalanthera epipactoides* Fisch. & C.A.Mey.

Plant 19.5−58.5 cm, photosynthetic autotroph. Rhizome woody, with numerous roots. Stem sparsely and minutely papillose. Leaves 2−8, erect, amplexicaul, ovate to ovate-lanceolate, acute, glabrous, glaucescent without blotch, 2.4−4.9 × 0.5−2 cm. Inflorescence (4.5−)7.5−31.5 cm long, densely (4−)7−32 flowered. Bracts 21−42 × 4−16 mm, suberect, lanceolate, acuminate, glabrous, glaucescent. Pedicel (including ovary) 9−21 × 1.5−2.5 mm, glabrous, green. Lateral sepals 13−23 × 4−7.5 mm, slightly spreading, ovate-lanceolate to narrowly lanceolate, subobtuse to acute, glabrous, white to greenish-yellow; dorsal sepal 12−21.5 × 3.5−6 mm, mostly connivent with the petals, ovate-lanceolate to narrowly lanceolate, subobtuse to acute, glabrous, white to greenish-yellow. Petals 8−17 × 4−6.5 mm, ovate-lanceolate to oblong-ovate, acute, glabrous, white to greenish-yellow. Labellum divided into hypochile and epichile, 10−14.5 × 6.5−11 mm; hypochile 3.5−5.5 × 6.5−11 mm, concave at base with truncate lateral side-lobes, glabrous, creamy-white to greenish-yellow; epichile 6−10 × 6−9 mm, ovate-lanceolate to triangular-lanceolate, obtuse, creamy-white to greenish-yellow with brownish-yellow longitudinal crests. Spur 2−4.5 × 1.5−2.5 mm, directed downwards, conical, subacute, greenish to yellowish. Column 5−7 × 1−1.5 mm.

Phenology: Flowering from middle of April to middle of June.

Habitat and altitude: *Quercus* forest, *Pinus* forest, coniferous forest and glades, 606−1077 m.

Specimens examined: A3 Bolu: Abant road, 3 km from Abant crossroad to Abant, *Quercus* forest, 851 m, 14 June 2015, Başaran 93 & Eker (AIBU)!; ibid., 858 m, 2 May 2016, Başaran 432 & Eker (AIBU)!; BAİBÜ central campus, between İzzet Baysal Arboretum and BAİBÜ social facilities, *Quercus* forest, 862 m, 25 May 2016, Başaran 481B & Eker (AIBU)!; BAİBÜ central campus, north of Gölköy dam lake, *Quercus* forest, 800 m, 13 May 2016, Başaran 450 & Eker (AIBU)!; D100-At plateau road, 2.65 km from the crossroad of the BAİBÜ central campus, glades, 898

m, 20 May 2016, Başaran 476 & Eker (AIBU)!; Mengen, Mengen road, 3 km from Akahmetler village crossroad, glades, 715 m, 6 May 2016, Başaran 444 & Eker (AIBU)!; Mudurnu, Sülüklügöl road, 3 km to the lake, glades, 816 m, 31 May 2015, Başaran 58 & Eker (AIBU)!; Mudurnu, Sülüklügöl road, 500 m to the lake, glades, 1060 m, 31 May 2015, Başaran 56 & Eker (AIBU)!; Mudurnu, Sülüklügöl, northwest of the lake, glades, 1089 m, 31 May 2015, Başaran 55 & Eker (AIBU)!; Mudurnu, Taşkesti-Abant road, 2 km from Taşkesti, *Quercus* forest, 570 m, 31 May 2015, Başaran 62 & Eker (AIBU)!; Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti, *Quercus* forest, 606 m, 29 May 2015, Başaran 49 & Eker (AIBU)!; ibid., glades, 597 m, 16 April 2016, Başaran 420 & Eker (AIBU)!

Regional conservation assessment: During field studies, five populations were determined. These populations show a restricted spread. However, there is no significant threat for their habitats for now.

Figure 4.12. *Cephalanthera epipactoides* – a) Habit, b) Inflorescence

4.1.10 *Cephalanthera longifolia* (L.) Fritsch

Plant (17.7−)20−56 cm, photosynthetic autotroph. Rhizome rather short, with numerous cordlike stiff roots. Stem glabrous, densely leafy, distichous. Leaves (5−)6−9(−10), suberect to spreading, linear-lanceolate to lanceolate, acuminate, glabrous, green without blotch, 5.5−11.5(−14) × (3.5−)5−14(−16) cm. Inflorescence 4−15.5(−21.5) cm long, densely or loosely 3−21(−38) flowered. Flowers more or

less opened, mostly more open than those of *Cephalanthera damasonium*. Bracts (20−)41−100(−185) × 2.5−9.5 mm, spreading to suberect, linear to linear-lanceolate, upper ones scalelike, acuminate, glabrous, green. Pedicel (including ovary) 8−19 × 1−2(−2.5) mm, glabrous, green. Lateral sepals 11−20 × (3−)3.5−5.5(−6) mm, more or less spreading, lanceolate, acute, glabrous, white; dorsal sepal 10−20 × 3−6 mm, curving forwards converging with the petals, lanceolate, acute, glabrous, white. Petals 8.5−14.5 × (3−)3.5−5(−5.5) mm, obovate-oblong, obtuse, glabrous, white. Labellum divided into hypochile and epichile, 8−11 × 6−11 mm; hypochile 4−5.5 × 6−11 mm, concave at base with triangular obtuse side-lobes, glabrous, white, with orange-yellow patch inside; epichile 4−6 × 5.5−9.5 mm, reniform-ovate, papillose, white with orange-yellow longitudinal crests. Column 5−7.5 × 1−1.5(−2) mm.

Phenology: Flowering from end of April to end of May.

Habitat and altitude: *Quercus* forest, coniferous forest and glades, 487−940 m.

Specimens examined: A3 Bolu: Abant road, 3 km from Abant crossroad to Abant, glades, 858 m, 2 May 2016, Başaran 431 & Eker (AIBU)!; BAİBÜ central campus, north of Gölköy dam lake, *Quercus* forest, 800 m, 13 May 2016, Başaran 451 & Eker (AIBU)!; Karacasu-Gölcük road, 1.66 km from Karacasu, *Fagus* forest, 844 m, 18 May 2016, Başaran 474 & Eker (AIBU)!; Karacasu-Gölcük road, 3 km to Gölcük, *Fagus* forest, 940 m, 5 May 2016, Başaran 440 & Eker (AIBU)!; Mudurnu, Abant-Taşkesti road, 6 km from Gölcük village crossroad, İğneciler village, glades, 869 m, 29 May 2015, Başaran 46 & Eker (AIBU)!; Mudurnu, Sülüklügöl, west of the lake, glades, 1077 m, 31 May 2015, Başaran 52 & Eker (AIBU)!; Yedigöller-Mengen road, 7 km from Yedigöller, *Quercus* forest, 487 m, 27 May 2015, Başaran 36 & Eker (AIBU)!

Regional conservation assessment: During field studies, five populations were determined. These populations show a restricted spread. However, there is no significant threat for their habitats for now.

Figure 4.13. *Cephalanthera longifolia* – a) Habit, b) Inflorescence

4.1.11 *Cephalanthera rubra* (L.) Rich.

Plant 20−62.4 cm, photosynthetic autotroph. Rhizome with numerous filiform roots. Stem pubescent above. Leaves (2−)4−7, suberect to spreading, oblong-lanceolate to linear-lanceolate, acute, glabrous, green without blotch, (2.2−)3−8.8 × 0.2−1.4 cm. Inflorescence 4−17 cm long, loosely 3−16 flowered. Bracts 11−37 × (1−)1.5−5 mm, suberect, lanceolate, acuminate, glabrous, green. Pedicel (including ovary) 8−20 × 1.5−3 mm, pubescent, green. Lateral sepals 12−23.5 × 2.5−7 mm, spreading to horizontal, oblong-lanceolate to lanceolate, subacute, pubescent, light pink to purplish-dark pink; dorsal sepal 12−22 × 3.5−6 mm, spreading to curving forwards converging with the petals, oblong-lanceolate to lanceolate, subacute, pubescent, light pink to purplish-dark pink. Petals 11−20 × 3−7 mm, ovate-lanceolate, subacute, glabrous, light pink to purplish-dark pink. Labellum divided into hypochile and epichile, 10−19.5 × 3−6 mm; hypochile 4−7 × 3−6 mm, concave with oblique-oblong obtuse side-lobes clasping the column, glabrous, white; epichile 6−13 × (1.5−)3−6 mm, ovate-lanceolate, acute, white with pinkish margin and tip, with yellowish-brown longitudinal crests. Column (5.5−)6−7.5(−8) mm.

Phenology: Flowering from end of May to end of July.

Habitat and altitude: Coniferous forest, *Quercus* forest, *Fagus* forest, *Pinus* forest, roadside slopes and glades, 635−1487 m.

Specimens examined: A3 Bolu: Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti , *Quercus* forest, 606 m, 29 May 2015, Başaran 50 & Eker (AIBU)!; 4 km from Çaltepe-Çeletepe crossroad to Çaltepe, glades, 1363 m, 26 June 2015, Başaran 156 & Eker (AIBU)!; Abant road, 1.5 km from Abant crossroad to Abant, glades, 813 m, 14 June 2015, Başaran 85 & Eker (AIBU)!; Abant road, 2.75 km from Abant-Gökdere crossroad, glades, 996 m, 14 June 2015, Başaran 94 & Eker (AIBU)!; Abant road, 3 km from Abant crossroad to Abant, *Quercus* forest, 851 m, 14 June 2015, Başaran 92 & Eker (AIBU)!; Abant road, west of Akçaalan village, mountain road, 390 m from village, glades, 1015 m, 14 June 2015, Başaran 101 & Eker (AIBU)!; BAİBÜ central campus, south of the FEF laboratories, glades, 876 m, 30 June 2015, Başaran 161 & Eker (AIBU)!; Bolu-Aladağlar road, 18 km from Karacasu, around Mühendisin Çeşmesi, glades, 1487 m, 29 July 2015, Başaran 319 & Eker (AIBU)!; Bolu-Bilecik road, 12.5 km from BAİBÜ Central Campus crossroad, *Pinus* forest, 894 m, 7 July 2015, Başaran 190 & Eker (AIBU)!; Bolu-Bilecik road, 12.6 km from BAİBÜ Central Campus crossroad, glades, 894 m, 7 July 2015 (in fruit), Başaran 198 & Eker (AIBU)!; Göynük, Sünnet lake, north of the lake, *Pinus* forest, 1046 m, 7 July 2015, Başaran 200 & Eker (AIBU)!; Göynük, Sünnet lake, Sünnet village road, *Pinus* forest, 1044 m, 7 July 2015, Başaran 202 & Eker (AIBU)!; Mengen, Gökçesu-Mengen road, 2.27 km from Gökçesu, *Pinus* forest, 632 m, 14 July 2015, Başaran 238 & Eker (AIBU)!; ibid., 595 m, 16 October 2015 (in fruit), Başaran 409 & Eker (AIBU)!; Mengen, north of Afşar village, southeast foothills of Çaltepe, *Fagus* forest, 1225 m, 23 July 2015, Başaran 289 & Eker (AIBU)!; ibid., glades, 1265 m, 23 July 2015, Başaran 290 & Eker (AIBU)!; Merkeşler-Çaltepe road, 840 m to Merkeşler, glades, 1027 m, 26 June 2015, Başaran 159 & Eker (AIBU)!; Merkeşler-Hayranlar road, 1.45 km to Hayranlar, glades, 730 m, 25 June 2016, Başaran 540 & Eker (AIBU)!; Mudurnu, Sülüklügöl road, 3 km to the lake, glades, 842 m, 29 June 2016, Başaran 544 & Eker (AIBU)!; Mudurnu, Sülüklügöl, north of the lake, glades, 1071 m, 24 June 2015, Başaran 146 & Eker (AIBU)!; Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti , *Quercus* forest, 587 m, 24 June 2015, Başaran 142 & Eker (AIBU)!; ibid., 606 m, 7 August 2015 (in fruit), Başaran 348 & Eker (AIBU)!; ibid., 635 m, 2 June 2016, Başaran 489 & Eker (AIBU)!; ibid., 607 m, 29 June 2016, Başaran 542 & Eker (AIBU)!; north of Merkeşler village, 300 m from Merkeşler village crossroad, roadside slopes, 969 m, 12 July 2015, Başaran 226 & Eker (AIBU)!; ibid., glades, 998 m, 4 June 2016,

Başaran 498 & Eker (AIBU)!; northern foothills of Çaltepe-Çeletepe, Quercus and *Pinus* forest, 1315 m, 27 July 2015, Başaran 315 & Eker (AIBU)!; Seben, Kesenözü village-Çatak plateau road, 4.5 km from the village, *Pinus* forest, 810 m, 12 August 2015 (in fruit), Başaran 368 & Eker (AIBU)!; Seben, Kesenözü village-Karakiriş summit road, north of the village, *Pinus* forest, 1280 m, 12 August 2015 (in fruit), Başaran 367 & Eker (AIBU)!; south road of At plateau, 240 m from beginning of the forest, glades, 1097 m, 18 August 2015 (in fruit), Başaran 376 & Eker (AIBU)!; Yedigöller road, 500 m from Anatolian highway, *Pinus* forest, 847 m, 26 June 2015, Başaran 149 & Eker (AIBU)!; ibid., 835 m, 16 June 2016, Başaran 513 & Eker (AIBU)!; Yedigöller road, Kapankaya seyir tepesi district, glades, 1285 m, 11 July 2015, Başaran 220 & Eker (AIBU)!; Yedigöller, near waterfalls, *Fagus* forest, 835 m, 11 July 2015, Başaran 215 & Eker (AIBU)!; **A4 Bolu:** Gerede, 3 km from Gerede traffic lights, plateau district, Vahdettin beyin fountain, *Pinus* forest, 1621 m, 1 September 2015 (in fruit), Başaran 385 & Eker (AIBU)!; Gerede, plateau to the east of Afşar Tarakçı plateau, west entrance of the plateau, glades, 1740 m, 24 July 2017, Başaran 613 & Eker (AIBU)!; Mengen, Bürnük village-Şirinyazı pond road, 650 m to the pond, *Pinus* forest, 1062 m, 14 July 2015, Başaran 262 & Eker (AIBU)!; Mengen, north of the Şirinyazı pond, *Pinus* forest, 1088 m, 14 July 2015, Başaran 250 & Eker (AIBU)!; ibid., 1100 m, 1 September 2015 (in fruit), Başaran 391 & Eker (AIBU)!; Mengen, northeast of Mengen, east of Düzağaç village, *Fagus* forest, 1071 m, 1 July 2015, Başaran 180 & Eker (AIBU)!; Mengen, northeast of Mengen, north of Gezginder plateau, glades, 1347 m, 1 July 2015, Başaran 177 & Eker (AIBU)!; Mengen, western road of the Şirinyazı pond, between Şirinyazı pond and Yenice mountain house, northeastern hills of Mengen, *Pinus* forest, 1330 m, 14 July 2015, Başaran 257 & Eker (AIBU)!

Regional conservation assessment: During field studies, 12 populations were determined. These populations show an extensive spread and there is no significant threat for their habitats for now.

Figure 4.14. *Cephalanthera rubra* – a) Habit, b) Inflorescence

4.1.12 *Coeloglossum viride* (L.) Hartm.

Plant 11.1−31.5 cm, photosynthetic autotroph. Tubers 2-parted, each one palmately divided. Stem glabrous. Leaves (2−)3−5, erect to spreading, ovate-oblong, upper lanceolate, obtuse to acute, green without blotch, 4.3−8.3 × 1−2.2 cm. Inflorescence 3.9−9.2 cm long, mostly densely or loosely 8−19 flowered, cylindrical. Bracts 20−30(−38) × 3−6 mm, suberect to spreading, linear-lanceolate to lanceolate, subacute, glabrous, green. Pedicel (including ovary) 7−9 × (1−)1.5−2 mm, glabrous, green. Perianth segments united into a somewhat globose galea. Lateral sepals 7−8 × 3−4 mm, ovate, obtuse, glabrous, yellowish-green; dorsal sepal (5−)6−6.5 × 2.5−3 mm, ovate, obtuse, glabrous, yellowish-green. Petals 4−6.5 × 1 mm, linear-lanceolate, subobtuse, glabrous, yellowish-green. Labellum 3-lobed, 8−10 × 4−6(−7) mm; lateral lobes 1.5−3 × 1.5−2(−2.5) mm, directed forwards, oblong, with entire margin, minutely papillose, yellowish-green; middle lobe 0.5−1(−1.5) × 1−1.5 mm, directed forwards, tooth-like, subobtuse, minutely papillose, yellowish-green. Spur 2−2.5 × 1−1.5 mm, directed downwards, saccate, obtuse, glossy greenish. Column 1.5−2 × 0.5 mm.

Phenology: Flowering from early June to end of July.

Habitat and altitude: Pastures, 1336 m.

Specimens examined: A3 Bolu: Mudurnu, Abant, northeast of the lake, pastures, 1343 m, 19 June 2015, Başaran 132 & Eker (AIBU)!; ibid., 1336 m, 2 June 2016, Başaran 492 & Eker (AIBU)!

Regional conservation assessment: This taxon was only found at one locality in Abant/Bolu. This locality is near the picnic area and is under human pressure. Thus, this population needs immediate conservation.

Figure 4.15. *Coeloglossum viride* – a) Habit, b) Inflorescence

4.1.13 *Corallorhiza trifida* Châtel.

Plant 11.6−26.3 cm, leafless saprophyte without chlorophyll. Rhizome coralloid with short divisions. Stem glabrous, yellowish-green, reddish-green at base, with 2−4 membranous yellowish-green sheathing scales. Inflorescence 1.1−6.2 cm long, loosely 3−12 flowered, cylindrical. Flowers nodding. Bracts 1−2 × 0.5 mm, horizontal, lanceolate, acuminate, glabrous, green, more or less tinged with reddish-brown. Pedicel (including ovary) 6−11 × 1.5−3.5 mm, glabrous, green. Lateral sepals 5.5−6.5 × 1−1.5 mm, curving forwards, linear-lanceolate to oblong-lanceolate, with incurved margin, obtuse, glabrous, green, more or less tinged with reddish-brown; dorsal sepal 5−6.5(−7) × 1−2 mm, curving forwards converging with the petals, linear-lanceolate to oblong-lanceolate, with incurved margin, obtuse, glabrous, green, more or less tinged with reddish-brown. Petals 4.5−6 × 1−1.5 mm, oblong-lanceolate, obtuse, glabrous, greenish or yellowish and tinged with red. Labellum

undivided, 4−5 × 1.5−2 mm, directed forwards or slightly deflexed, oblong-ligulate, white, with 2 longitudinal basal protuberances and red blotches. Column 3−3.5 × 0.5−1 mm.

Phenology: Flowering from end of June to end of July.

Habitat and altitude: Damp places in *Abies* Mill. forest, 1726−1728 m.

Specimens examined: A3 Bolu: 24 km from Kartalkaya-D100 crossroad to Kartalkaya, damp places in *Abies* forest, 1726 m, 21 July 2015, Başaran 266 & Eker (AIBU)!; 3 km from Sarıalan forest warehouse to Kartalkaya, damp places in *Abies* forest, 1638 m, 21 July 2015, Başaran 275 & Eker (AIBU)!; A3 Bolu: Gerede, north of the Koçumlar village, 3.30 km from the village, near the fountain, damp places in *Abies* forest, 1728 m, 1 July 2015, Başaran 188 & Eker (AIBU)!; Gerede, north of the Koçumlar village, 3.30 km from the village, near the fountain, damp places in *Abies* forest, 1718 m, 8 July 2015, Başaran 209 & Eker (AIBU)!; ibid., 1734 m, 1 September 2015 (in fruit), Başaran 396 & Eker (AIBU)!

Regional conservation assessment: During field studies, only two populations were determined. These populations show a very limited spread. However, there is no significant threat for their habitats for now.

Figure 4.16. *Corallorhiza trifida* – a) Habit, b) Inflorescence

4.1.14 *Dactylorhiza* × *abantiana* H.Baumann & Künkele [*Dactylorhiza iberica* (M. Bieb. ex Willd.) Soó × *Dactylorhiza nieschalkiorum* H. Baumann & Künkele]

Plant 34.6−75.4 cm, photosynthetic autotroph. Tubers parted. Stem glabrous. Leaves 5−6, erect to spreading, ovate-lanceolate to lanceolate, subacute to acute, green without blotch, 9.6−13.4 × 1−2 cm. Inflorescence 10.1−15.4 cm long, somewhat densely 30−41 flowered, cylindrical. Bracts 18−50 × 4−6 mm, erect to suberect, lanceolate, acuminate, glabrous, green to more or less suffused with purplish. Pedicel (including ovary) 10−12 × 1−2 mm, glabrous, green, more or less suffused with purplish. Lateral sepals 10−10.5 × 3−4.5 mm, slightly deflexed to spreading, ovate-lanceolate, subacute, glabrous, light pink to pinkish-purple, mostly with purple blotches inside; dorsal sepal 9−9.5 × 2.5−4 mm, curving forwards converging with the petals, ovate-lanceolate, subacute, glabrous, light pink to pinkish-purple, mostly with purple blotches inside. Labellum 3-lobed, mostly densely covered with blotches, regular or irregular streaks and fine broken lines, mostly slightly yellowish-green at base, whitish with purple blotches at center and near base, 9−11.5 × 9.5−12.5 mm; lateral lobes 1−2 × 4−6 mm, directed forwards to slightly upcurved, somewhat falcately rounded, with entire to shallowly crenulate and undulate margin, minutely papillose, light pink to pinkish-purple; middle lobe 1−2.5 × 1.5−2.5 mm, slightly deflexed to upcurved, mostly directed forwards, with entire to undulate margin, broadly triangular to narrowly triangular, minutely papillose, light pink to pinkish-purple. Spur 8−9.5 × 2.5−3.5 mm, directed downwards, inflated cylindrical to cylindrical, obtuse, light pink to pinkish-purple, mostly slightly yellowish-green at base. Column 3−4 × 1 mm.

Phenology: Flowering from middle of July to end of July.

Habitat and altitude: Marshes, 1319−1665 m.

Specimens examined: A3 Bolu: Mudurnu, Abant, west of the lake, 100 m from Taksim International Abant Palace Hotel, marshes, 1319 m, 14 July 2017, Başaran 594 & Eker (AIBU)!; ibid., Başaran 596 & Eker (AIBU)!; A3 Bolu: Gerede, Afşar Tarakçı plateau, marshes, 1665 m, 24 July 2017, Başaran 623 & Eker (AIBU)!

Regional conservation assessment: This hybrid taxon, which is endemic to Turkey, was only known from Abant. A second spread area from Gerede was detected during this study. The habitats of DIBN594, DIBN596 individuals in Abant and the DIBN623 individuals in the Afşar Tarakçı Plateau/Gerede are under human pressure and the threat of grazing. Thus, these populations need immediate conservation.

Figure 4.17. *Dactylorhiza* × *abantiana* – a) Habit, b) Inflorescence

4.1.15 ***Dactylorhiza* × *balabaniana*** H.Baumann

[***Dactylorhiza iberica*** (M. Bieb. ex Willd.) Soó **×** ***Dactylorhiza urvilleana*** (Steud.) H.Baumann & Künkele subsp. ***ilgazica*** (Kreutz) Kreutz]

Plant 30.5−33.1 cm, photosynthetic autotroph. Tubers parted. Stem glabrous, green, more or less suffused with reddish-purple above. Leaves 4−5, erect to spreading, oblong-lanceolate to lanceolate, subobtuse to acute, green without blotch, 11.2−12 × 1−1.1 cm. Inflorescence 8.2−9.3 cm long, somewhat densely 20−31 flowered, cylindrical. Bracts 19−20 × 3−3.5 mm, erect to suberect, narrowly lanceolate to lanceolate, acuminate, glabrous, green, more or less suffused with reddish-purple. Pedicel (including ovary) 11 × 2 mm, glabrous, green, more or less suffused with reddish-purple. Lateral sepals 8−9.5 × 3−3.5 mm, more or less spreading, ovate-lanceolate, subobtuse, glabrous, with pinkish-purple with reddish-purple blotches inside; dorsal sepal 7.5−8.5 × 3 mm, curving forwards converging with the petals, ovate-lanceolate, subobtuse, glabrous, pinkish-purple. Petals 7.5−8 × 2−2.5 mm,

ovate to ovate-lanceolate, subobtuse, glabrous, pinkish-purple. Labellum 3-lobed, especially covered with regular or irregular streaks and fine broken lines at center, slightly yellowish at base, whitish with purple blotches at center and near base, 10−11.5 × 8.5−12 mm; lateral lobes 1−1.5 × 4.5−5 mm, directed forwards to slightly upcurved, rounded to somewhat falcately rounded, with irregularly and shallowly crenate-dentate margin, minutely papillose, pinkish-purple; middle lobe 1−2 × 2−2.4 mm, directed forwards, triangular to broadly triangular, with entire margin, minutely papillose, pinkish-purple. Spur 6−8 × 2−2.5 mm, directed downwards, cylindrical, obtuse to subobtuse, pinkish-purple, slightly yellowish at base. Column 4 × 1 mm.

Phenology: Flowering end of July.

Habitat and altitude: Wet meadows, 1687 m.

Specimens examined: A4 Bolu: Gerede, 1.91 km east of Afşar Tarakçı plateau, wet meadows, 1687 m, 24 July 2017, Başaran 618 & Eker (AIBU)!; ibid., Başaran 619 & Eker (AIBU)!

Regional conservation assessment: This hybrid taxon was only found at one locality in Gerede and only two individuals were counted and sampled. However, there is no significant threat for its habitat for now.

Figure 4.18. *Dactylorhiza* × *balabaniana* – a) Habit, b) Inflorescence

4.1.16 *Dactylorhiza iberica* (M.Bieb. ex Willd.) Soó

Plant (15.3−)21.3−53.1(−63.8) cm, photosynthetic autotroph. Tubers napiform, parted near apex. Stem glabrous. Leaves 3−5, erect to suberect, linear-lanceolate, subobtuse to acuminate, green without blotch, 7.4−18.5(−20.3) × 0.5−2 cm. Inflorescence (3−)4−13.7(−15.1) cm long, loosely (6−)10−41 flowered, cylindrical. Bracts 10−25 × (1.5−)2−5.5 mm, suberect, lanceolate, acute to acuminate, glabrous, green and mostly more or less reddish-tinged on the margin. Pedicel (including ovary) (6.5−)7−11(−12) × (0.5−)1−2(−3) mm, glabrous, green to slightly suffused with purple. Perianth segments united into a galea. Lateral sepals (5.5−)6−8(−10) × (2−)2.5−3(−4) mm, ovate-lanceolate, obtuse, glabrous, light pink to pink; dorsal sepal 5.5−9 × 2−3 mm, ovate-lanceolate, obtuse, glabrous, light pink to pink. Petals 5−6.5(−8) × 1−2(−2.5) mm, lanceolate to linear-lanceolate, acute to acuminate, glabrous, light pink to pink. Labellum shortly 3-lobed, mostly slightly yellowish-green at base, whitish at center with reddish to pinkish blotches and lines, (6−)7−11(−14) × 5−8.5(−9) mm; lateral lobes (0.5−)1−2.5 × (1.5−)2−4.5(−5) mm, directed forwards, falcately rounded, with crenulate margin, minutely papillose, light pink to pink with reddish to pinkish blotches and lines; middle lobe 0.5−2.5 × 1−2.5 mm, directed forwards, narrowly triangular to tooth-like, with entire margin, minutely papillose, light pink to pink with reddish to pinkish blotches. Spur (2.5−)3−6(−6.5) × 1−1.5(−2) mm, horizontal to directed downwards, narrowly cylindrical, obtuse to subacute, whitish, pinkish towards apex, slightly yellowish-green at base. Column 2.5−3.5 × 0.5−1 mm.

Phenology: Flowering from middle of June to end of July.

Habitat and altitude: Marshes, roadside wetlands and wet meadows, 971−1718 m.

Specimens examined: A3 Bolu: Göynük, Sünnet lake, southwest road of the lake, roadside wetlands, 1154 m, 7 July 2015, Başaran 206 & Eker (AIBU)!; Mudurnu, Abant, west of the lake, 100 m from Taksim International Abant Palace Hotel, marshes, 1328 m, 25 July 2015, Başaran 303 & Eker (AIBU)!; Mudurnu, Abant, northeast of the lake, marshes, 1321 m, 25 July 2015, Başaran 306 & Eker (AIBU)!; Mudurnu, Abant, west of the lake, 100 m from Taksim International Abant Palace Hotel, marshes, 1321 m, 18 August 2015 (in fruit), Başaran 378 & Eker (AIBU)!;

Mudurnu, Abant, North of National Parks Abant Conservation Area, marshes, 1367 m, 21 June 2016, Başaran 525 & Eker (AIBU)!; Seben, southeast of Çatak plateau, Ercebin spring district, wet meadows, 1206 m, 13 July 2017, Başaran 592 & Eker (AIBU)!; Mudurnu, Abant, west of the lake, 100 m from Taksim International Abant Palace Hotel, marshes, 1319 m, 14 July 2017, Başaran 597 & Eker (AIBU)!; **A4 Bolu:** Gerede, plateau to the east of Afşar Tarakçı plateau, west entrance of the plateau, wet meadows, 1635 m, 24 July 2017, Başaran 612 & Eker (AIBU)!; Gerede, north of the Koçumlar village, 3.30 km from the village, near the fountain, wet meadows, 1718 m, 8 July 2015, Başaran 210 & Eker (AIBU)!; Mengen, northwest of Bürnük village, roadside wetlands, 1014 m, 14 July 2015, Başaran 244 & Eker (AIBU)!; Mengen, west of the Şirinyazı pond, marshes, 1088 m, 14 July 2015, Başaran 251 & Eker (AIBU)!; ibid., 1095 m, 14 July 2015, Başaran 252 & Eker (AIBU)!; Mengen, Bürnük village-Şirinyazı pond road, 650 m to the pond, roadside wetlands, 1062 m, 14 July 2015, Başaran 259 & Eker (AIBU)!; Mengen, west of the Şirinyazı pond, marshes, 1058 m, 1 September 2015 (in fruit), Başaran 394 & Eker (AIBU)!

Regional conservation assessment: During field studies, seven populations were determined. These populations show an extensive spread. There is no significant threat for habitats of five populations for now. However, the DIB252 population in Abant and the DIB597 population in the Şirinazı pond/Mengen are under human pressure and the threat of grazing. Thus, these populations need conservation.

Figure 4.19. *Dactylorhiza iberica* – a) Habit, b) Inflorescence

4.1.17 *Dactylorhiza incarnata* (L.) Soó subsp. *incarnata*

Plant 23.1−58.3 cm, photosynthetic autotroph. Tubers deeply parted. Stem glabrous, fistulose. Leaves 4−6, erect to suberect, lanceolate to linear-lanceolate, cucullate at apex, acute, green without blotch, 8−18 × 1.4−2.6(−3.2) cm. Inflorescence 5.3−18.8 cm long, densely 21−64 flowered, cylindrical. Bracts 23−50 × 4−8(−12) mm, erect, lanceolate, acute, glabrous, green, more or less suffused with reddish-purple. Pedicel (including ovary) 12−16 × 1.5−3 mm, glabrous, green and mostly slightly suffused with reddish-purple. Lateral sepals 6−7.5 × 2.5−3(−4) mm, deflexed, ovate-lanceolate, obtuse, glabrous, light pink to pinkish-purple with reddish-purple blotches inside; dorsal sepal (5−)5.5−6.5 × (2−)2.5−3 mm, curving forwards converging with the petals, ovate-lanceolate, obtuse, glabrous, light pink to pinkish-purple with reddish-purple blotches inside. Petals (4.5−)5−5.5 × 2−3 mm, lanceolate to ovate-lanceolate, obtuse, light pink to pinkish-purple. Labellum 3-lobed, with pinkinsh-purple blotches at center and near base, looks like bow tie, 6−8(−8.5) × (5−)5.5−8 mm; lateral lobes 1−2(−3) × 2−3(−4) mm, more or less deflexed, rounded, with shallowly crenulate margin, minutely papillose, light pink to pinkish-purple; middle lobe 1.5−2 × 1.5−3 mm, directed forwards, oblong-triangular, with entire margin, minutely papillose, light pink to pinkish-purple. Spur 5.5−7.5(−8) × 2−2.5(−3) mm, horizontal to directed downwards, conical to conical-cylindrical, obtuse, light pink to pinkish-purple. Column 2.5−3 × 0.5−1 mm.

Phenology: Flowering from end of May to end of July.

Habitat and altitude: Marshes and wet meadows, 1001−1712 m.

Specimens examined: A3 Bolu: Yeniçağa, Yeniçağa road, Hamzabey, Örenköy and Kemaller village crossroad, marshes, 1001 m, 12 June 2015, Başaran 71 & Eker (AIBU)!; Mudurnu, Abant, west of the lake, 100 m from Taksim International Abant Palace Hotel, marshes, 1332 m, 14 June 2015, Başaran 111 & Eker (AIBU)!; Mudurnu, Abant, North of National Parks Abant Conservation Area, marshes, 1372 m, 19 June 2015, Başaran 121 & Eker (AIBU)!; Mudurnu, Abant, west of the lake, 100 m from Taksim International Abant Palace Hotel, marshes, 1321 m, 18 August 2015 (in fruit), Başaran 380 & Eker (AIBU)!; Yeniçağa, Yeniçağa road, Hamzabey, Örenköy and Kemaller village crossroad, marshes, 1011 m, 17 June 2016, Başaran

521 & Eker (AIBU)!; Mudurnu, Abant, west of the lake, 100 m from Taksim International Abant Palace Hotel, marshes, 1327 m, 21 June 2016, Başaran 524 & Eker (AIBU)!; Yeniçağa, Yeniçağa road, Hamzabey, Örenköy and Kemaller village crossroad, marshes, 989 m, 24 May 2017, Başaran 570 & Eker (AIBU)!; **A4 Bolu:** Gerede, north of Koçumlar village, 4.70 km from the village, around plateau, wet meadows, 1712 m, 24 July 2017, Başaran 625 & Eker (AIBU)!

Regional conservation assessment: *Dactylorhiza incarnata* subsp. *incarnata*, which is shown in "VU (Vulnarable)" category among rare plants according to "*Red Data Book of Turkish plants* (Ekim et al., 2000)", were determined from three populations during field studies. The distribution of these populations is very limited. There is no significant threat for habitat of DIN625 population for now. However, the DIN111 population in Abant is under human pressure and the threat of grazing. The area where the DIN71 population loacted in Yeniçağa is also under threat of extinction due to grazing and cultivation activities. Thus, these two populations need immediate conservation. We propose the regional threat category as "EN (Endangered)" due to the fact that the area of occupancy (AOO) of the species is less than 500 km^2, the number of localities is less than 5, the number of mature individuals of the plant is low and the quality of the habitat decreases [Criterion B2ab(ii,iii,iv,v)] (IUCN, 2017).

Figure 4.20. *Dactylorhiza incarnata* subsp. *incarnata*
a) Habit, b) Inflorescence

4.1.18 *Dactylorhiza nieschalkiorum* H.Baumann & Künkele

Plant (13.5−)20.7−72.1(−76.2) cm, photosynthetic autotroph. Tubers deeply parted. Stem glabrous, fistulose. Leaves 3−6(−7), erect to spreading, broadly elliptic-obovate to lanceolate, obtuse to acute, green with or without blotch, blotches mainly concentrated towards apex, (5.3−)6.6−17.5(−23) × 1−3 cm. Inflorescence (3.1−)3.8−18.5(−20.3) cm long, densely 9−74 flowered, pyramidal at first, later broadly cylindrical. Bracts 15−63(−78) × (2.5−)3.5−9 mm, erect to suberect, lanceolate, acuminate, glabrous, green, more or less suffused with reddish-purple. Pedicel (including ovary) 10−19(−27) × 1−5 mm, glabrous, green, more or less suffused with reddish-purple. Lateral sepals 9−15 × (2.5−)3−5.5 mm, deflexed to spreading, lanceolate to ovate-lanceolate, subacute, glabrous, pink to pinkish-purple, sometimes with reddish-purple blotches inside; dorsal sepal 7.5−13 × (2−)2.5−5 mm, curving forwards converging with the petals, lanceolate to ovate-lanceolate, subacute, glabrous, pink to pinkish-purple sometimes with reddish-purple blotches inside. Petals (6.5−)7−11.5 × 2.5−4.5 mm, lanceolate to ovate-lanceolate, subacute, glabrous, pink to pinkish-purple. Labellum undivided or 3-lobed at apex, mostly densely covered with blotches and/or fine broken lines, whitish with purple blotches at center and near base, (8−)10−15(−16.5) × (9−)11−16 mm; lateral lobes absent or 1−5 × 3−8.5 mm, directed forwards to upcurved, rounded, with undulate and shallowly crenulate to erose-dentate margin, minutely papillose, pink to pinkish-purple; middle lobe absent or 1.5−4 × 1.5−4.5 mm, directed forwards to slightly upcurved, triangular, with entire margin, minutely papillose, pink to pinkish-purple. Spur 8−14 × 2−5 mm, horizontal to directed downwards, inflated cylindrical, obtuse to acute, pink to pinkish-purple with whitish base. Column 4.5−5.5 × 1 mm.

Phenology: Flowering from middle of June to early August.

Habitat and altitude: Marshes, marshy slopes and wet meadows, 855−1806 m.

Specimens examined: A3 Bolu: Mudurnu, Abant, west of the lake, 100 m from Taksim International Abant Palace Hotel, marshes, 1332 m, 14 June 2015, Başaran 112 & Eker (AIBU)!; Mudurnu, Abant, west of the lake, at the beginning of the wooden walkway, marshes, 1324 m, 19 June 2015, Başaran 122 & Eker (AIBU)!; ibid., Başaran 124 & Eker (AIBU)!; ibid., Başaran 125 & Eker (AIBU)!; ibid.,

Başaran 126 & Eker (AIBU)!; ibid., Başaran 127 & Eker (AIBU)!; Mudurnu, Abant, northeast of the lake, marshes, 1343 m, 19 June 2015, Başaran 134 & Eker (AIBU)!; ibid., Başaran 135 & Eker (AIBU)!; 4 km from Çaltepe-Çeletepe crossroad to Çaltepe, marshes, 1363 m, 26 June 2015, Başaran 155 & Eker (AIBU)!; south of Çaltepe-Çeletepe, marshes, 1504 m, 26 June 2015, Başaran 157 & Eker (AIBU)!; Yedigöller road, 1.45 km from Anatolian highway, marshy slopes, 1383 m, 11 July 2015, Başaran 213 & Eker (AIBU)!; ibid., Başaran 214 & Eker (AIBU)!; 22.5 km from Kartalkaya-D100 crossroad to Kartalkaya, marshes, 1615 m, 21 July 2015, Başaran 271 & Eker (AIBU)!; Yedigöller road, between Gurbettaşı and Çaltepe road, 1 km from Gurbettaşı, marshy slopes, 1610 m, 3 August 2015, Başaran 342 & Eker (AIBU)!; Mudurnu, Abant, west of the lake, 100 m from Taksim International Abant Palace Hotel, marshes, 1321 m, 18 August 2015 (in fruit), Başaran 379 & Eker (AIBU)!; Yedigöller road, 14.5 km from the Anatolian highway, grassy places, 1399 m, 10 September 2015 (in fruit), Başaran 398 & Eker (AIBU)!; Mudurnu, Abant, west of the lake, at the beginning of the wooden walkway, marshes, 1340 m, 21 June 2016, Başaran 522 & Eker (AIBU)!; ibid., Başaran 523 & Eker (AIBU)!; Mudurnu, Abant, west of the lake, 100 m from Taksim International Abant Palace Hotel, marshes, 1319 m, 14 July 2017, Başaran 598 & Eker (AIBU)!; 3 km to Kartalkaya, around plateau, wet meadows, 1806 m, 26 July 2017, Başaran 628 & Eker (AIBU)!; Mudurnu, Abant, west of the lake, 100 m from Taksim International Abant Palace Hotel, marshes, 1332 m, 14 June 2015, Başaran 114 & Eker (AIBU)!; **A4 Bolu:** Gerede, north of Gerede, Sungurlar plateau, marshes, 1751 m, 1 July 2015, Başaran 187 & Eker (AIBU)!; Gerede, north of the Koçumlar village, 3.30 km from the village, near the fountain, wet meadows, 1718 m, 8 July 2015, Başaran 211 & Eker (AIBU)!; Gerede, north of Gerede, Sungurlar plateau, marshes, 1748 m, 1 September 2015 (in fruit), Başaran 395 & Eker (AIBU)!; Gerede, Afşar Tarakçı plateau, marshes, 1665 m, 24 July 2017, Başaran 622 & Eker (AIBU)!; Gerede, north entrance of Hacı Veli Plateau road, marshes, 1567 m, 24 July 2017, Başaran 627 & Eker (AIBU)!

Regional conservation assessment: *Dactylorhiza nieschalkiorum,* which is shown in "LC (Least concern)" category among endemic plants according to "*Red Data Book of Turkish plants* (Ekim et al., 2000)", were determined from eight populations during field studies. These populations show an extensive spread. There is no

significant threat for habitats of five populations for now. However, the DNI598 population in Abant, the DNI622 population in the Afşar Tarakçı Plateau/Gerede and the DNI627 population in the Hacı Veli Plateau/Gerede are under human pressure and the threat of grazing. Thus, these populations need conservation. However, since there are a large number of populations of the species, and there is no serious threat to most habitats, we propose the species's threat category as "LC" at regional level (IUCN, 2017).

Figure 4.21. *Dactylorhiza nieschalkiorum* – a) Habit, b) Inflorescence

4.1.19 ***Dactylorhiza* × *renzii*** H.Baumann & Künkele

[***Dactylorhiza incarnata*** (L.) Soó subsp. ***incarnata* × *Dactylorhiza nieschalkiorum*** H. Baumann & Künkele]

Plant 65 cm, photosynthetic autotroph. Tubers deeply parted. Stem glabrous. Leaves 5, erect to suberect, oblong-lanceolate to lanceolate, obtuse to acuminate, green with blotch, blotches prominent on the bottom leaves, 9.6 × 1.3 cm. Inflorescence 10.6 cm long, somewhat densely towards tip, 28 flowered, cylindrical. Bracts 29.5 × 4 mm, erect to suberect, lanceolate to narrowly lanceolate, acuminate, glabrous, more or less suffused with reddish-purple. Pedicel (including ovary) 12 × 2.5 mm, glabrous, green, more or less suffused with reddish-purple. Lateral sepals 9 × 4 mm, deflexed, ovate-lanceolate to oblong-lanceolate, obtuse, glabrous, pinkish-purple with reddish-purple blotches inside; dorsal sepal 7 × 3 mm, more or less curving forwards

converging with the petals, oblong-lanceolate, obtuse, glabrous, pinkish-purple. Petals 6.5 × 2.5 mm, ovate-lanceolate, obtuse, glabrous, pinkish-purple. Labellum 3-lobed, whitish at center, sparsely covered with purple blotches, looks like bow tie at center, 9.5 × 9 mm; lateral lobes 1 × 4 mm, directed forwards to deflexed, rounded, with shallowly erose-dentate margin, minutely papillose, pinkish-purple; middle lobe 1.5 × 2 mm, directed forwards, triangular, with entire margin, minutely papillose, pinkish-purple. Spur 10.5 × 3 mm, horizontal to directed downwards, conical to inflated cylindrical, obtuse to subacute, pinkish-purple. Column 4 × 1 mm.

Phenology: Flowering middle of July.

Habitat and altitude: Marshes, 1319 m.

Specimens examined: A3 Bolu: Mudurnu, Abant, west of the lake, 100 m from Taksim International Abant Palace Hotel, marshes, 1319 m, 14 July 2017, Başaran 595 & Eker (AIBU)!

Regional conservation assessment: This hybrid taxon, which is endemic to Turkey, was only known from Abant. It was only found at one locality in Abant and only one individual was counted and sampled. However, habitat is under human pressure and the threat of grazing. Thus, this area needs immediate conservation.

Figure 4.22. *Dactylorhiza* × *renzii* – a) Habit, b) Inflorescence

4.1.20 *Dactylorhiza romana* (Sebast.) Soó subsp. *romana*

Plant (10.2−)15.3−27.6 cm, photosynthetic autotroph. Tubers parted. Stem glabrous. Leaves 5−13, suberect to spreading, densely distributed especially in a basal rosette of the stem, linear to linear-lanceolate, obtuse, green without blotch, (5.7−)7.3−10.7 × 0.5−0.9(−1.3) cm. Inflorescence 4.1−8.7 cm long, mostly loosely 7−23 flowered, ovate to cylindrical. Flowers dull red to purplish, yellowish or rarely whitish. Bracts 17−32 × 3−6 mm, erect to suberect, lanceolate to elliptic-lanceolate, obtuse to acute, glabrous, green to dark reddish-purple. Pedicel (including ovary) 13−17 × 1−2 mm, glabrous, green to purplish. Lateral sepals 7−9 × 3.5−4 mm, deflexed, oblong to ovate-lanceolate, obtuse, glabrous, dull red to purplish, yellowish or rarely whitish; dorsal sepal 6.5−8 × 2.5−3 mm, slightly curving forwards converging with the petals, oblong to ovate-lanceolate, obtuse, glabrous, dull red to purplish, yellowish or rarely whitish. Petals (5.5−)6−6.5 × (3.5−)4−5.5(−6) mm, obliquely ovate, obtuse, pinkish-purple to whitish-yellow. Labellum 3-lobed, (8−)9−11(−13) × 8−12 mm; lateral lobes 0.5−1.5(−2) × 3−5 mm, directed forwards to deflexed, rounded, with entire margin, glabrous, pinkish-purple to yellowish; middle lobe 1−2.5 × 2−3 mm, directed forwards to slightly deflexed, oblong to subquadrate, more or less notched at apex, minutely papillose, pinkish-purple to yellowish. Spur (11−)13−17 × 1.5−2(−3) mm, horizontal to more or less directed upwards, cylindrical, obtuse or slightly notched at apex, pinkish-purple to yellowish. Column 2.5−3.5(−4) × 0.5 mm.

Phenology: Flowering from end of April to middle of May.

Habitat and altitude: Coniferous forest, *Pinus* forest, *Quercus* forest, 824−1420 m.

Specimens examined: A3 Bolu: Yeniçağa, Dereköy, *Pinus* forest, 1120 m, 12 June 2015 (in fruit), Başaran 79 & Eker (AIBU)!; ibid., 1420 m, 22 April 2016, Başaran 424 & Eker (AIBU)!; BAİBÜ central campus, north of Gölköy dam lake, *Quercus* forest, 824 m, 25 May 2016, Başaran 484 & Eker (AIBU)!; Karacasu-Gölcük road, 2.32 km from Karacasu, grassy places, 902 m, 12 May 2017, Başaran 567 & Eker (AIBU)!; **A4 Bolu:** Mengen, Sarıkadılar village road, 2.08 km from Eskipazar-Mengen crossroad, *Quercus* forest, 960 m, 22 June 2017 (in fruit), Başaran 587 & Eker (AIBU)!

Regional conservation assessment: During field studies, only three populations were determined. These populations show a very limited spread. However, there is no significant threat for their habitats for now.

Figure 4.23. *Dactylorhiza romana* subsp. *romana*
a) Habit, b) Inflorescence

4.1.21 ***Dactylorhiza saccifera*** (Brongn.) Soó subsp. ***bithynica*** **(H.Baumann) Kreutz**

Plant (14.2−)19.3−61.5(−67.4) cm, photosynthetic autotroph. Tubers parted. Stem glabrous, solid. Leaves 3−6, suberect to spreading, ovate to obovate below, ovate-lanceolate to linear-lanceolate above, obtuse to acuminate, green with or rarely without blotch, blotches conspicuous, (4.6−)7−14.9(−19.2) × (0.4−)0.8−3.2 cm. Inflorescence 3.2−20.3 cm long, densely or loosely 8−79 flowered, conical at first, later cylindrical. Bracts 11−50 × 2−7 mm, horizontal to suberect, lanceolate to linear-lanceolate, acuminate, glabrous, green and more or less suffused with reddish. Pedicel (including ovary) 8−16 × 1−3(−4) mm, glabrous, green and more or less suffused with reddish. Lateral sepals 7−13 × 2−3.5(−4) mm, spreading to horizontal, lanceolate, acute, glabrous, light pink to purplish with reddish-purple blotches inside; dorsal sepal 7−11.5 × 2−4 mm, more or less curving forwards converging with the petals, lanceolate, subobtuse to acute, glabrous, light pink to purplish with reddish-purple blotches inside. Petals 6−11 × (1.5−)2−3.5 mm, lanceolate, subobtuse to

acute, light pink to purplish, more or less purple-tinged on the margin. Labellum 3-lobed, whitish covered with reddish-purple blotches and interrupted loops at center and near base, 8−12(−17) × (6−)7−12(−15) mm; lateral lobes 1.5−6 × (2−)2.5−6.5 mm, directed forwards, somewhat rhombic, with irregularly crenulate-dentate margin, minutely papillose, light pink to purplish; middle lobe 2−5(−6) × 1.5−3.5(−4.5) mm, directed forwards, triangular, with entire margin, minutely papillose, light pink to purplish. Spur 7−13.5 × 2−3 mm, horizontal to directed downwards, saccate to conical-cylindrical, obtuse, light pink to pinkish-purple with whitish base. Column 3−4 × 0.5−1 mm.

Phenology: Flowering from middle of June to end of July.

Habitat and altitude: Marshy slopes, roadside wetlands, streamsides and marshes, 967−1615 m.

Specimens examined: A3 Bolu: Abant Road, 5.5 km to Abant, between road and stream, streamsides, 1076 m, 14 June 2015, Başaran 105 & Eker (AIBU)!; ibid., 1076 m, 14 June 2015, Başaran 106 & Eker (AIBU)!; ibid., 1138 m, 14 June 2015, Başaran 109 & Eker (AIBU)!; Mudurnu, Abant, west of the lake, 100 m from Taksim International Abant Palace Hotel, marshes, 1332 m, 14 June 2015, Başaran 113 & Eker (AIBU)!; ibid., at the beginning of the wooden walkway, marshes, 1324 m, 19 June 2015, Başaran 123 & Eker (AIBU)!; ibid., at the beginning of the wooden walkway, marshes, 1324 m, 19 June 2015, Başaran 128 & Eker (AIBU)!; 22.5 km from Kartalkaya-D100 crossroad to Kartalkaya, marshes, 1615 m, 21 July 2015, Başaran 273 & Eker (AIBU)!; ibid., Başaran 274 & Eker (AIBU)!; Aladağlar, upper side of Karacasu plateau, roadside wetlands, 1420 m, 29 July 2015, Başaran 324 & Eker (AIBU)!; Berk plateau-Sebenardı village road, 2.46 km from Berk plateau, roadside wetlands, 1375 m, 29 July 2015, Başaran 326 & Eker (AIBU)!; Hıdırşeyhler village-Gölcük road, 1.13 km to Gölcük road, roadside wetlands, 967 m, 8 July 2017, Başaran 590 & Eker (AIBU)!; Abant Road, 5.5 km to Abant, between road and stream, streamsides, 1070 m, 14 July 2017, Başaran 601 & Eker (AIBU)!; **A4 Bolu:** Mengen, northeast of Mengen, north of Gezginder plateau, marshes, 1379 m, 1 July 2015, Başaran 171 & Eker (AIBU)!; ibid., Başaran 172 & Eker (AIBU)!; ibid., Başaran 173 & Eker (AIBU)!; ibid., Başaran 174 & Eker (AIBU)!; ibid., Başaran 175 & Eker (AIBU)!; ibid., Başaran 176 & Eker (AIBU)!; Mengen, western road of

the Şirinyazı pond, between Şirinyazı pond and Yenice mountain house, northeastern hills of Mengen, marshy slopes, 1249 m, 14 July 2015, Başaran 255 & Eker (AIBU)!; Mengen, northeast of Mengen, north of Gezginder plateau, marshes, 1372 m, 1 September 2015 (in fruit), Başaran 387 & Eker (AIBU)!

Regional conservation assessment: This taxon is endemic to Turkey and common in the northwestern Anatolia and the inner Aegean region. During field studies, eight populations were determined. These populations show an extensive spread. There is no significant threat for habitats of six populations for now. However, the DSA123 population in Abant is under human pressure and the threat of grazing. The DSA601 population located on Abant road is also under human pressure. Thus, these two populations need conservation. However, since this plant was published as a new taxon to science after "*Red Data Book of Turkish plants* (Ekim et al., 2000)", no threat category was appointed. In this study, since there are a large number of populations of the taxon, and there is no serious threat to most habitats, we propose the taxon's threat category as "LC" at regional level (IUCN, 2017).

Figure 4.24. *Dactylorhiza saccifera* subsp. *bithynica*
a) Habit, b) Inflorescence

4.1.22 ***Dactylorhiza urvilleana*** (Steud.) H.Baumann & Künkele subsp. ***ilgazica*** (Kreutz) Kreutz

Plant (24.4−)27.4−49.5(−55.1) cm, photosynthetic autotroph. Tubers parted. Stem glabrous, fistulose in robust specimens, angular and rarely suffused with reddish-

purple above. Leaves (3−)4−7, erect to spreading, oblong-lanceolate to lanceolate, acute, green with irregularly distributed blotces, (7.4−)8−14.2(−17.1) × (0.8−)1−2.8 cm. Inflorescence (4.2−)6.3−16.5(−18.4) cm long, almost densely 14−74 flowered, shortly ovate to cylindrical. Bracts 20−51(−57) × (3−)3.5−8 mm, erect to suberect, narrowly lanceolate to lanceolate, acuminate, glabrous, green, more or less suffused with reddish-purple. Pedicel (including ovary) 10−16 × 1.5−4.5 mm, glabrous, green, more or less suffused with reddish-purple. Lateral sepals 8.5−13.5(−14) × (2.5−)3.5−5(−5.5) mm, deflexed to spreading, oblong-lanceolate to ovate-lanceolate, subacute, glabrous, light pink to pinkish-purple, mostly with reddish-purple blotches inside; dorsal sepal (7.5−)8−12 × 2.5−4(−5) mm, curving forwards converging with the petals, oblong-lanceolate to ovate-lanceolate, subacute, glabrous, light pink to pinkish-purple, mostly with reddish-purple blotches inside. Petals 7−10(−11) × 3−4 mm, ovate-lanceolate to lanceolate, subobtuse, glabrous, light pink to pinkish-purple. Labellum undivided or 3-lobed at apex, mostly densely covered with blotches and/or streaks and fine broken lines, whitish at center, with pinkish-purple blotches at center and near base, 8−14.5 × 9.5−16 mm; lateral lobes absent or 1−3 × 4−7.5 mm, directed forwards to deflexed or slightly upcurved, rounded, with irregularly crenate-dentate and/or undulate margin, minutely papillose, light pink to pinkish-purple; middle lobe absent or 1−3.5 × 1.5−3.5 mm, directed forwards to deflexed, triangular, with entire to irregularly crenate-dentate margin, minutely papillose, light pink to pinkish-purple. Spur 8−13(−15) × 2.5−4.5(−6) mm, horizontal to slightly directed downwards, conical, obtuse to subacute, light pink to pinkish-purple. Column 4−5 × 1 mm.

Phenology: Flowering from middle of July to end of July.

Habitat and altitude: Wet meadows, 1684−1766 m.

Specimens examined: A3 Bolu: Kıbrıscık, Argözü valley, 9.88 km from Bölücekkaya village, Karadoğan plateau road, wet meadows, 1766 m, 17 July 2017, Başaran 604 & Eker (AIBU)!; ibid., Başaran 605 & Eker (AIBU)!; ibid., Başaran 606 & Eker (AIBU)!; ibid., Başaran 607 & Eker (AIBU)!; ibid., Başaran 608 & Eker (AIBU)!; A4 Bolu: Gerede, 1.91 km east of Afşar Tarakçı plateau, wet meadows, 1687 m, 24 July 2017, Başaran 617 & Eker (AIBU)!; ibid., Başaran 621 & Eker (AIBU)!; Mengen, Gerede plateaus-Karaşeyhler road, county border, wet meadows,

1736 m, 24 July 2017, Başaran 624 & Eker (AIBU)!; Gerede, north of Koçumlar village, 4.70 km from the village, around plateau, wet meadows, 1712 m, 24 July 2017, Başaran 626 & Eker (AIBU)!

Regional conservation assessment: This taxon is endemic to Turkey and common in the Black Sea region and the Upper Sakarya region. During field studies, four populations were determined. These populations show a restricted spread. However, there is no significant threat for their habitats for now. Since this plant was published as a new taxon to science after "*Red Data Book of Turkish plants* (Ekim et al., 2000)", no threat category was appointed. In this study, since there is no serious threat to its habitats, we propose the taxon's threat category as "LC" at regional level (IUCN, 2017).

Figure 4.25. *Dactylorhiza urvilleana* subsp. *ilgazica*
a) Habit, b) Inflorescence

4.1.23 ***Dactylorhiza* × *vogtiana*** H.Baumann

[***Dactylorhiza iberica*** (M. Bieb. ex Willd.) Soó × ***Dactylorhiza incarnata*** (L.) Soó subsp. ***incarnata***]

Plant 44.7 cm, photosynthetic autotroph. Tubers parted. Leaves 4, erect to suberect, lanceolate to linear-lanceolate, acute, green without blotch, 9.5 × 1.1 cm. Inflorescence 12.5 cm long, somewhat loosely 23 flowered, cylindrical. Bracts 30 × 4.5 mm, erect, lanceolate, acute to acuminate, glabrous, green, more or less suffused with purplish. Pedicel (including ovary) 11.5 × 1.5 mm, glabrous, green, more or less

suffused with purplish. Lateral sepals 8.5 × 4 mm, deflexed, oblong-elliptic to ovate-lanceolate, obtuse, glabrous, pinkish-purple with purple blotches inside; dorsal sepal 6.5 × 3 mm, curving forwards converging with the petals, oblong-elliptic, obtuse, glabrous, pinkish-purple with purple blotches inside. Petals 6 × 2.5 mm, ovate, obtuse, pinkish-purple with purple blotches inside. Labellum 3-lobed, sparsely covered with purple blotches, looks like bow tie at center, 8.5 × 6.5 mm; lateral lobes 3.5 × 4.5 mm, deflexed, rounded, with irregularly crenate-dentate to shallowly crenulate or nearly entire margin, minutely papillose, pinkish-purple with purple blotches; middle lobe 2 × 2.5 mm, directed forwards to slightly deflexed, oblong-triangular, with entire margin, pinkish-purple with purple blotches. Spur 9 × 3 mm, directed downwards, conical, obtuse, pinkish-purple. Column 5 × 0.5 mm.

Phenology: Flowering middle of July.

Habitat and altitude: Marshes, 1319 m.

Specimens examined: A3 Bolu: Mudurnu, Abant, west of the lake, 100 m from Taksim International Abant Palace Hotel, marshes, 1319 m, 14 July 2017, Başaran 599 & Eker (AIBU)!

Regional conservation assessment: This hybrid taxon, which is endemic to Turkey, was only known from Abant. It was only found at one locality in Abant and only one individual was counted and sampled. However, the habitat of hybrid taxon is under human pressure and the threat of grazing. Thus, this area needs conservation.

Figure 4.26. *Dactylorhiza* × *vogtiana* – a) Habit, b) Inflorescence

4.1.24 *Epipactis helleborine* (L.) Crantz subsp. *helleborine*

Plant 22.4−76.1(−102.1) cm, photosynthetic autotroph. Rhizome woody, with numerous narrow roots. Stem sparsely pubescent above, sometimes slightly suffused with purplish. Leaves 3−10, spreading almost horizontally, distributed along the stem, broadly ovate to ovate-elliptical to ovate-lanceolate, acute, the uppermost leaf bractlike, lanceolate, acute to shortly acuminate, green without blotch, 2.5−8.7 × 0.6−3.9 cm. Inflorescence (3−)8.2−33(−37.9) cm long, densely or loosely 7−60 flowered. Bracts 15−87 mm × (4.5−)5−24 mm, spreading, lanceolate to ovate-lanceolate, acute to shortly acuminate, glabrous, green. Pedicel (including ovary) 8−17 × 2−4.5(−5) mm, glabrous or sparsely pubescent, green. Perianth segments connivent to form an open bell. Lateral sepals 8−14 × 4−6 mm, ovate-lanceolate, acute, glabrous, light green to green, mostly suffused with purplish; dorsal sepal 7.5−14.5 × 4−6 mm, ovate-lanceolate, acute, glabrous, light green to green, mostly more or less suffused with purplish. Petals (7−)8−11.5(−12) × (3.5−)4−5.5(−6) mm, ovate, obtuse to acute, glabrous, light green to more or less suffused with purplish. Labellum divided into hypochile and epichile, 7.5−10.5 × 6−8 mm; hypochile 4−5.5(−6) × 6−8 mm, cup-shaped, saccate, glabrous, glossy inside, containing nectar, greenish outside, dark olive-brown to dark reddish-brown inside; epichile 3.5−5.5 × 4−5 mm, more or less deflexed at apex, broadly ovate to broadly cordate, mostly obtuse, with slightly crenulate or undulate margin, greenish-white, pink or purplish, with 2 darker protuberances at base. Column 4−5 × 1 mm.

Phenology: Flowering from middle of June to end of July.

Habitat and altitude: Roadside slopes, glades, *Fagus* forest and *Pinus* forest, 632−1511 m.

Specimens examined: A3 Bolu: Göynük, Sünnet lake, Sünnet village road, roadside slopes, 1080 m, 7 July 2015, Başaran 204 & Eker (AIBU)!; ibid., Başaran 205 & Eker (AIBU)!; Mengen, Gökçesu-Mengen yolu, Gökçesu'dan 2.27 km sonra, *Pinus* forest, 632 m, 14 July 2015, Başaran 236 & Eker (AIBU)!; Aladağlar, Demirciler plateau east entrance, *Pinus* forest, 1379 m, 21 July 2015, Başaran 279 & Eker (AIBU)!; Aladağlar, around Beşpınarlar Nature Park, *Pinus* forest, 1380 m, 21 July 2015, Başaran 281 & Eker (AIBU)!; ibid., Başaran 282 & Eker (AIBU)!; Seben, 1

km from Kızık village crossroad, *Pinus* forest, 1506 m, 21 July 2015, Başaran 284 & Eker (AIBU)!; Seben, 1.8 km from Kızık village crossroad, 50 m sonra from Kızık-Kuzgölcük crossroad, *Pinus* forest, 1509 m, 21 July 2015, Başaran 285 & Eker (AIBU)!; BAİBÜ central campus, north of the FEF laboratories, glades, 864 m, 22 July 2015, Başaran 287 & Eker (AIBU)!; southeast foothills of Çeletepe, roadside slopes, 1416 m, 27 July 2015, Başaran 311 & Eker (AIBU)!; northern foothills of Çaltepe-Çeletepe, *Quercus* and *Pinus* forest, 1315 m, 27 July 2015, Başaran 313 & Eker (AIBU)!; Berk plateau-Sebenardı village road, 2.46 km from Berk plateau, roadsides, 1375 m, 29 July 2015, Başaran 327 & Eker (AIBU)!; Aladağlar, between Seben ardı and Berk plateau, roadsides, 1357 m, 29 July 2015, Başaran 330 & Eker (AIBU)!; Seben, Seben pond, east of Dedeler plateau, *Pinus* forest, 1536 m, 29 July 2015, Başaran 336 & Eker (AIBU)!; southwest of Çaltepe, Kadıköy plateau-Merkeşler village road, 1.10 km from the plateau, roadsides, 1477 m, 9 August 2015, Başaran 359 & Eker (AIBU)!; Yedigöller road, 1.80 km from Anatolian highway, *Pinus* forest, 913 m, 11 August 2015, Başaran 362 & Eker (AIBU)!; around Bağışlar village, southeast of the village, Bağışlar village cemetery, *Pinus* forest, 958 m, 16 August 2015, Başaran 374 & Eker (AIBU)!; between Tokadi Hayrettin Tomb parking and artificial lake, *Fagus* forest, 954 m, 18 August 2015 (in fruit), Başaran 377 & Eker (AIBU)!; Bolu-Bilecik road, 12.5 km from BAİBÜ Central Campus crossroad, roadside slopes, 882 m, 15 September 2015 (in fruit), Başaran 400 & Eker (AIBU)!; Göynük, Sünnet lake, Sünnet village road, roadside slopes, 1061 m, 29 June 2016, Başaran 545 & Eker (AIBU)!; ibid., 29 June 2016, Başaran 546 & Eker (AIBU)!; Kıbrıscık, Argözü valley, 6.37 km from Bölücekkaya village, 200 m from Çimencik crossroad, *Pinus* forest, 1511 m, 17 July 2017, Başaran 610 & Eker (AIBU)!; Yedigöller road, Kapankayası district, *Fagus* forest, 1192 m, 29 July 2017, Başaran 632 & Eker (AIBU)!; **A4 Bolu:** Mengen, western road of the Şirinyazı pond, between Şirinyazı pond and Yenice mountain house, northeastern hills of Mengen, *Pinus* forest, 1330 m, 14 July 2015, Başaran 256 & Eker (AIBU)!

Regional conservation assessment: During field studies, nine populations were determined. These populations show a wide spread and there is no significant threat for their habitats for now.

Figure 4.27. *Epipactis helleborine* subsp. *helleborine*
a) Habit, b) Flower

4.1.25 ***Epipactis microphylla*** (Ehrh.) Sw.

Plant (20.8−)29−50.8(−52.2) cm, photosynthetic autotroph. Rhizome furnished with numerous, partly elongated roots. Stem pubescent above, green, sometimes slightly suffused with purplish. Leaves 3−6(−7), suberect to spreading, ovate to narrowly lanceolate, the uppermost leaf bractlike, narrowly lanceolate, acute to shortly acuminate, green to dark green without blotch, sometimes suffused with purplish, 1.6−3.2 0.2−0.6(−0.9) cm. Inflorescence 4−20 cm long, loosely 5−30(−40) flowered. Flowers almost one-sided. Bracts 9−29 × 2−6 mm, spreading to suberect, lanceolate, acuminate, sparsely pubescent, green and sometimes more or less suffused with purplish. Pedicel (including ovary) 8−16 × 2−8 mm, densely pubescent, green sometimes more or less suffused with purplish. Perianth segments connivent to form and open bell. Lateral sepals 6.5−8 × 3−4.5 mm, ovate-lanceolate, acute to subobtuse, sparsely pubescent, light greenish to slightly suffused with purplish; dorsal sepal 6−8 × (2−)2.5−3.5 mm, ovate-lanceolate, acute to subobtuse, sparsely pubescent, light greenish to slightly suffused with purplish. Petals 5−6.5 × 2.5−3.5 mm, triangular-ovate, acute, sparsely pubescent on base of mid-vein, light greenish to slightly suffused with purplish. Labellum divided into hypochile and epichile, (4.5−)5−7 × (3−)3.5−5 mm; hypochile 2−3.5 × (3−)3.5−5 mm, cup-shaped, saccate, glabrous, greenish-brown; epichile 2.5−4 × 2.5−3.5(−4) mm, straight to more or less deflexed at apex, rounded-ovate to cordate, obtuse to subobtuse, with slightly

crenulate or undulate margin, light yellowish to pinkish-white, with 2 whitish protuberances at base. Column 3−3.5 × 1 mm.

Phenology: Flowering from middle of June to middle of July.

Habitat and altitude: Roadsides, roadside slopes, *Pinus* forest, *Quercus* forest and *Abies* forest, 577−1379 m.

Specimens examined: A3 Bolu: Bolu-Bilecik road, 12.6 km from BAİBÜ Central Campus crossroad, roadside slopes, 894 m, 7 July 2015, Başaran 194 & Eker (AIBU)!; Mengen, Gökçesu-Mengen road, 1 km from Gökçesu, roadsides, 563 m, 14 July 2015 (in fruit), Başaran 234 & Eker (AIBU)!; Aladağlar, Demirciler plateau east entrance, *Pinus* forest, 1379 m, 21 July 2015, Başaran 278 & Eker (AIBU)!; Mudurnu, Abant, southeast of the lake, west of the picnic area, *Abies* forest, 1326 m, 25 July 2015, Başaran 305 & Eker (AIBU)!; Bolu-Aladağlar road, upper side of Karacasu plateau, 20 km from Karacasu, roadsides, 1420 m, 29 July 2015, Başaran 321 & Eker (AIBU)!; Seben, Seben pond, east of Dedeler plateau, *Pinus* forest, 1536 m, 29 July 2015 (in fruit), Başaran 337 & Eker (AIBU)!; Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti , roadsides, 606 m, 7 August 2015, Başaran 349 & Eker (AIBU)!; Mengen, 1 km from Küplüce village crossroad, roadside slopes, 668 m, 23 June 2016, Başaran 534 & Eker (AIBU)!; Mengen, Gökçesu-Mengen road, 1 km from Gökçesu, roadsides, 577 m, 22 June 2017, Başaran 588 & Eker (AIBU)!; Kıbrıscık, Argözü valley, 6.37 km from Bölücekkaya village, 200 m from Çimencik crossroad, *Pinus* forest, 1511 m, 17 July 2017, Başaran 609 & Eker (AIBU)!; Gerede, 3 km from Gerede traffic lights, plateau district, Vahdettin beyin fountain, *Pinus* forest, 1621 m, 1 September 2015 (in fruit), Başaran 384 & Eker (AIBU)!

Regional conservation assessment: During field studies, four populations were determined. These populations show a restricted spread. However, there is no significant threat for their habitats for now.

Figure 4.28. *Epipactis microphylla* – a) Habit, b) Flower

4.1.26 ***Epipactis palustris*** (L.) Crantz

Plant 23.2−75.7 cm, photosynthetic autotroph. Rhizome long, creeping. Stem pubescent above, sometimes suffused with purplish. Leaves (5−)6−8(−9), spreading to suberect, oblong-lanceolate to oblong-ovate, the uppermost lanceolate, acute to acuminate, green without blotch, 3.3−10.5 × 0.4−1.3 cm. Inflorescence 5.7−17.8 cm long, loosely 6−27 flowered. Bracts 16−47(−60) mm, deflexed to suberect, lanceolate, acute to acuminate, glabrous, green. Pedicel (including ovary) 13−24 × (1.5−)2−4 mm, pubescent, dull green to more or less suffused with purplish. Perianth segments connivent forming an open bell-shaped to spreading. Lateral sepals 8.5−12 × 3−4.5 mm, ovate-lanceolate, acute, sparsely pubescent, greenish to suffused with brownish-red; dorsal sepal 8−11 × 3.5−4.5(−5) mm, ovate-lanceolate, acute, sparsely pubescent, greenish to suffused with brownish-red. Petals 7−9.5 × (2.5−)3−3.5 mm, oblong-ovate, obtuse to acute, glabrous, whitish, slightly suffused with pinkish in lower part. Labellum divided into hypochile and epichile, 9.5−13 × 6−8 mm; hypochile 4.5−6 × 6−8 mm, cup-shaped, saccate with an upright triangular lobe on each side, whitish-pink outside, whitish with orange-yellow blotch and purplish longitudinal lines inside; epichile 5−7 × 5−6.5 mm, broadly ovate, obtuse, with crenulate and undulate margin, white with yellow cordate protuberances at base. Column 3.5−5 × 1 mm.

Phenology: Flowering from middle of July to end of July.

Habitat and altitude: Marshes, roadside wetlands and streamsides, 1014−1334 m.

Specimens examined: A3 Bolu: Mudurnu, Abant, west of the lake, at the beginning of the wooden walkway, marshes, 1334 m, 25 July 2015, Başaran 304 & Eker (AIBU)!; ibid., 1336 m, 18 August 2015 (in fruit), Başaran 381 & Eker (AIBU)!; **A4 Bolu:** Mengen, west of the Şirinyazı pond, marshes, 1058 m, 1 September 2015, (in fruit) Başaran 393 & Eker (AIBU)!; Mengen, northwest of Bürnük village, roadside wetlands, 1014 m, 14 July 2015, Başaran 245 & Eker (AIBU)!; Mengen, west of the Şirinyazı pond, marshes, 1095 m, 14 July 2015, Başaran 253 & Eker (AIBU)!; Mengen, Bürnük village-Şirinyazı pond road, 650 m to the pond, roadside wetlands, 1062 m, 14 July 2015, Başaran 258 & Eker (AIBU)!

Regional conservation assessment: During field studies, three populations were determined. The distribution of these populations is very limited. There is no significant threat for habitat of EPA245 population for now. However, the DIB252 population in Abant and the DIB597 population in the Şirinazı pond/Mengen are under human pressure and the threat of grazing. Thus, these two populations need conservation.

Figure 4.29. *Epipactis palustris* – a) Habit, b) Flower

4.1.27 *Epipactis persica* (Soó) Hausskn. ex Nannf.

Plant 13.8−58.9 cm, photosynthetic autotroph. Rhizome with long filiform roots. Stem glabrous or slightly pubescent above. Leaves 2−4, spreading, distributed especially middle of the stem, ovate to ovate-lanceolate, obtuse to acute, green without blotch, 2.8−7.1 × 1.1−2.9 cm. Inflorescence 3.7−21.4 cm long, loosely 6−22(−27) flowered. Bracts 19−56 × 6−28 mm, spreading to deflexed, ovate-lanceolate to lanceolate, the lowermost leaf-like, shortly acuminate, glabrous, green. Pedicel (including ovary) 7−17 × 2.5−11 mm, glabrous, green. Perianth segments connivent forming an open bell-shaped. Lateral sepals 6.5−11.5 × (2.5−)3−5.5 mm, ovate-lanceolate, acute, glabrous, green sometimes slightly suffused with reddish; dorsal sepal 6.5−11.5 × 3−5 mm, ovate-lanceolate, acute, glabrous, green sometimes slightly suffused with reddish. Petals 6−11 × (2−)2.5−5 mm, ovate, acute, glabrous, light green sometimes slightly suffused with reddish. Labellum divided into hypochile and epichile, 4.5−10 × 3.5−7 mm; hypochile 2.5−5 × 3.5−7 mm, cup-shaped, saccate, glabrous, glossy inside, containing nectar, olive-green outside, more or less purplish-tinged on the margin, brownish-green to reddish-brown inside; epichile 2−5 × 2−4 mm, straight, sometimes slightly deflexed at apex, triangular, acute, purplish, light green towards apex, with 2 purple protuberances at base. Column 3−4 × 1 mm.

Phenology: Flowering from middle of July to end of July.

Habitat and altitude: Glades, roadsides, *Fagus* forest and *Pinus* forest, 1280−1408 m.

Specimens examined: A3 Bolu: Aladağlar, Demirciler plateau east entrance, *Pinus* forest, 1379 m, 21 July 2015, Başaran 277 & Eker (AIBU)!; eastern entrance of Karacaagac Plateau, *Pinus* forest, 1408 m, 29 July 2015, Başaran 332 & Eker (AIBU)!; Yedigöller road, 8.25 km from Anatolian highway, *Pinus* forest, 1195 m, 3 August 2015, Başaran 338 & Eker (AIBU)!; 13 km from Yedigöller road crossroad to Çaltepe, between Çaltepe and Çeletepe, northern foothills, *Abies* forest, 1292 m, 3 August 2015, Başaran 346 & Eker (AIBU)!; Mudurnu, Davlumbaz plateau, glades, 1369 m, 7 August 2015, Başaran 354 & Eker (AIBU)!; southwest of Çaltepe, Kadıköy plateau-Merkeşler village road, 1.10 km from the plateau, roadsides, 1477

m, 9 August 2015, Başaran 358 & Eker (AIBU)!; Seben, Kesenözü village-Karakiriş summit road, north of the village, *Pinus* forest, 1280 m, 12 August 2015 (in fruit), Başaran 366 & Eker (AIBU)!; Abant Road, 5.5 km to Abant, between road and stream, *Fagus* forest, 1070 m, 14 July 2017, Başaran 600 & Eker (AIBU)!

Regional conservation assessment: During field studies, only three populations were determined. These populations show a very limited spread. However, there is no significant threat for their habitats for now.

Figure 4.30. *Epipactis persica* – a) Habit, b) Flower

4.1.28 ***Epipactis pontica*** Taubenheim

Plant 19.6−25.5(−35.8) cm, photosynthetic autotroph. Rhizome woody. Stem pubescent above. Leaves (2−)3−4, erect to slightly spreading, distributed especially middle of the stem, ovate-elliptic to lanceolate, the uppermost bractlike, obtuse to acuminate, green without blotch, 2.4−5.6 × 0.3−1 cm. Inflorescence 2−10.3 cm long, loosely 5−11(−16) flowered. Bracts 13.5−32.5 × 2.5−4.5 mm, spreading, ovate-elliptic to narrowly elliptic, acute, glabrous, green. Pedicel (including ovary) 7−10 × 2−3.5 mm, sparsely pubescent, green. Perianth segments connivent to form an open bell. Lateral sepals 6.5−7.5 × 3 mm, ovate-elliptic, acute, glabrous, green to olive-green; dorsal sepal 6−7.5 × 2.5−3.5 mm, ovate-elliptic, acute, glabrous, green to olive-green. Petals 5.5−6.5 × 2.5−3 mm, ovate-elliptic, obtuse to acute, glabrous, yellowish-green. Labellum divided into hypochile and epichile, 5−6.5 × 3−4 mm;

hypochile 3−4 × 3−4 mm, cup-shaped, saccate, glabrous, glossy inside, containing nectar, greenish-white outside, brownish-green to olive-green inside; epichile 2−2.5 × 2−2.5(−3.5) mm, slightly deflexed at apex, broadly ovate, obtuse to acute, whitish-green, with 2 darker green protuberances at base. Column 2.5−3 × 1 mm.

Phenology: Flowering from end of July to early August.

Habitat and altitude: *Fagus* forest, 550 m.

Specimens examined: A3 Bolu: Yedigöller-Mengen road, 3.5 km from Yedigöller, *Fagus* forest, 550 m, 3 August 2015, Başaran 340 & Eker (AIBU)!; Yedigöller, north of the big lake, *Fagus* forest, 803 m, 10 September 2015 (in fruit), Başaran 399 & Eker (AIBU)!; Yedigöller road, 4.5 km from Gurbettaşı, *Fagus* forest, 1604 m, 29 July 2017, Başaran 631 & Eker (AIBU)!

Regional conservation assessment: This taxon was only found in Yedigöller. This locality is around the picnic area and is under human pressure. Thus, this population needs immediate conservation.

Figure 4.31. *Epipactis pontica* – a) Habit, b) Flower

4.1.29 *Epipactis turcica* Kreutz

Plant 29.3−60.2(−68.8) cm, photosynthetic autotroph. Rhizome woody. Stem sparsely pubescent above, light green. Leaves (2−)3−9(−18), suberect to spreading, densely distributed especially bottom of the stem, clasping stem at base, broadly rounded to broadly ovate-lanceolate, acute to acuminate, light to dark green without blotch, 2.1−9.1 × 0.5−3.2 cm. Inflorescence 10.6−28.6(−31.2) cm long, densely or loosely 10−48 flowered. Flowers nodding, almost one-sided. Bracts 15−74(−93) × 3.5−16(−23) mm, deflexed to suberect, lanceolate to narrowly lanceolate, acuminate, glabrous, green. Pedicel (including ovary) 8−18 × 2−6 mm, sparsely pubescent, green. Perianth segments connivent to form an open bell. Lateral sepals 8−12.5 × 4.5−6 mm, ovate-lanceolate, acute, outer side slightly pubescent, olive-green, sometimes suffused with purplish; dorsal sepal 8−12 × 4−6 mm, ovate-lanceolate, acute, outer side slightly pubescent, olive-green, sometimes suffused with purplish. Petals 6.5−10.5 × 3.5−6 mm, shortly ovate-lanceolate, acute, glabrous, green, more or less suffused with purplish. Labellum divided into hypochile and epichile, 7−10.5 × 6−8 mm; hypochile 4−5.5 × 6−8 mm, cup-shaped, saccate, glabrous, glossy inside, greenish outside, mostly more or less whitish-tinged on the margin, reddish to dark yellowish-green inside; epichile 3−5 × 3.5−5.5 mm, mostly more or less deflexed at apex, cordate, subobtuse, with slightly crenulate margin, greenish-white or purplish to yellowish, with 2 protuberances at base. Column 4−5 × 1 mm.

Phenology: Flowering from middle of June to end of July.

Habitat and altitude: Roadside slopes and roadside glades, 668−1605 m.

Specimens examined: A3 Bolu: Bolu-Bilecik road, 12.6 km from BAİBÜ Central Campus crossroad, roadside slopes, 894 m, 7 July 2015, Başaran 192 & Eker (AIBU)!; ibid., Başaran 193 & Eker (AIBU)!; ibid., Başaran 195 & Eker (AIBU)!; 23 km from Kartalkaya-D100 crossroad to Kartalkaya, roadside glades, 1605 m, 21 July 2015, Başaran 268 & Eker (AIBU)!; Mengen, north of Afşar village, southeast foothills of Çaltepe, roadside glades, 1214 m, 23 July 2015, Başaran 291 & Eker (AIBU)!; ibid., Başaran 292 & Eker (AIBU)!; northeast of the Berk plateau pond, *Pinus* forest, 1415 m, 29 July 2015, Başaran 331 & Eker (AIBU)!; Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti , roadsides, 606 m, 7 August

2015 (in fruit), Başaran 350 & Eker (AIBU)!; Mudurnu, Abant-Taşkesti road, 3 km from Abant, around Ekizoluk crossroad, roadside glades, 1396 m, 7 August 2015, Başaran 356 & Eker (AIBU)!; 6.5 km from Kartalkaya-D100 crossroad to Kartalkaya, roadside slopes, 1190 m, 14 August 2015, Başaran 370 & Eker (AIBU)!; Mengen, 1 km from Küplüce village crossroad, roadside slopes, 668 m, 23 June 2016, Başaran 535 & Eker (AIBU)!; Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti , roadsides, 607 m, 29 June 2016 (in fruit), Başaran 541 & Eker (AIBU)!; Mengen, Güneygökçesu village-Turna village road, 1 km from Güneygökçesu village, roadsides, 811 m, 22 June 2017, Başaran 585 & Eker (AIBU)!; Seben, around Ellez waterfall, roadside slopes, 940 m, 13 July 2017, Başaran 593 & Eker (AIBU)!

Regional conservation assessment: During field studies, four populations were determined. These populations show a restricted spread. However, there is no significant threat for their habitats for now.

Figure 4.32. *Epipactis turcica* – a) Habit, b) Inflorescence

4.1.30 ***Epipogium aphyllum*** Sw.

Plant 8.9−29.2 cm, leafless saprophyte without chlorophyll. Rhizome coral-like branched. Stem glabrous, swollen above base, pale yellowish to pinkish with many short reddish streaks, with 2−4(−5) membranous brownish sheathing scales. Inflorescence 0.7−7.1 cm long, loosely 1−5 flowered, cylindrical. Flowers not

resupinate, nodding. Bracts 7−11(−13) × 2.5−8.5(−12) mm, spreading or bent downwards, linear-oblong to ovate, obtuse, glabrous, yellowish-brown, membranous. Pedicel (including ovary) 6−13 × 3−5 mm, glabrous, yellowish, sometimes with pinkish-purple blotches. Perianth segments pointing downwards, pale yellow, sometimes tinged with reddish at tip. Lateral sepals 15−17.5 × 2−2.5 mm, spreading, pointing downwards, more or less linear, with incurved margin, obtuse, glabrous; dorsal sepal 14.5−16.5 × 2−2.5(−3) mm, more or less linear, with incurved margin, obtuse, glabrous. Petals 14−16 × 2−2.5(−3) mm, ovate-lanceolate, with incurved margin, obtuse, glabrous. Labellum divided into hypochile and epichile, 14.5−17 × 10−11.5 mm; hypochile 4−5 × 10−11.5 mm, with oblong-rounded lateral lobes, glabrous, pale yellowish to light pinkish; epichile 10−12 × 7−10 mm, slightly concave, ovate-cordate, whitish to light pink with pinkish-purple papillae and crests. Spur 6.5−9 × 4−5(−5.5) mm, directed upwards, saccate, obtuse, slightly notched, light pink. Column 4−4.5 × 1.5−2 mm.

Phenology: Flowering from early July to middle of August.

Habitat and altitude: Damp shady places in *Abies* and *Fagus* forest, 1150−1638 m.

Specimens examined: A3 Bolu: Yedigöller, southeast of Yedigöller, *Abies* forest, 1150 m, 11 July 2015, Başaran 219 & Eker (AIBU)!; 3 km from Sarıalan forest warehouse to Kartalkaya, damp places in *Abies* forest, 1638 m, 21 July 2015, Başaran 276 & Eker (AIBU)!; Yedigöller road, between Gurbettaşı and Çaltepe road, 4.5 km from Gurbettaşı, *Abies* forest, 1229 m, 3 August 2015, Başaran 343 & Eker (AIBU)!; southwest of Çaltepe, Kadıköy plateau-Merkeşler village road, 1.10 km from the plateau, *Fagus* forest, 1477 m, 9 August 2015, Başaran 361 & Eker (AIBU)!; southwest of Çaltepe, Kadıköy plateau-Merkeşler village road, 1.10 km from the plateau, *Fagus* forest, 1458 m, 21 July 2017, Başaran 611 & Eker (AIBU)!

Regional conservation assessment: During field studies, only three populations were determined. These populations show a very limited spread. However, there is no significant threat for their habitats for now.

Figure 4.33. *Epipogium aphyllum* – a) Habit, b) Flower

4.1.31 ***Himantoglossum affine*** (Boiss.) Schltr.

Plant 75.1−77.8 cm, photosynthetic autotroph. Tubers ellipsoid. Stem glabrous. Leaves 4−5, erect to spreading, oblong-lanceolate to lanceolate, obtuse to acute, glabrous, green without blotch, 11.3−20 × 1.7−2.8 cm. Inflorescence 26.6−38.5 cm long, loosely 21−30 flowered, elongated. Bracts 49−59 × 3−4 mm, suberect, linear-lanceolate, acuminate, light green, more or less suffused with reddish-purple to reddish-brown towards tip. Pedicel (including ovary) 20−24 × 1.5−2.5 mm, glabrous, light green. Perianth segments united into a galea. Sepals whitish-green, more or less suffused with reddish-purple to reddish-brown, with reddish-purple to reddish-brown veins. Lateral sepals 12−14 × 4.5−5 mm, ovate-elliptic to ovate-lanceolate, obtuse, glabrous; dorsal sepal 12−14 × 4−5 mm, ovate-elliptic to ovate-lanceolate, with incurved margin, obtuse, glabrous. Petals 10−11 × 1.5−2 mm, linear-lanceolate, acute, glabrous, greenish with reddish-purple longitudinal stripes. Labellum 3-lobed, whitish and minutely papillose at center and base, without blotches or only faintly reddish-purple blotches near base, 58−68 × 10−11 mm; lateral lobes 3−6 × 2−2.5 mm, mostly deflexed, triangular-falcate, acuminate, glabrous, with undulate margin, reddish-purple to reddish-brown; middle lobe 45.5−51 × 1.5 mm, directed forwards, linear, strap-shaped, more or less twisted, glabrous, reddish-purple to reddish-brown; lobules 5.5−11 × 1 mm, directed forwards, linear, somewhat acuminate, slightly twisted to somewhat straight, glabrous, reddish-purple to reddish-brown. Spur 3−4.5

× 2−2.5 mm, horizontal to directed downwards, pyramidal-conical, obtuse, light green with whitish base. Column 3.5−4 × 0.5 mm.

Phenology: Flowering from early July.

Habitat and altitude: Macchie, 1452 m.

Specimens examined: A3 Bolu: Seben, around Korucuk plateau, macchie, 1452 m, 1 July 2016, Başaran 551 & Eker (AIBU)!

Regional conservation assessment: This taxon was only found at one locality and only 5 individuals were counted in the area. Morphological measurements were made during the field study and two individuals were sampled. This population shows very limited spread. However, there is no significant threat for its habitat for now.

Figure 4.34. *Himantoglossum affine* – a-b) Inflorescence

4.1.32 ***Himantoglossum caprinum*** (M.Bieb.) Spreng.

Plant (26.1−)40.5−100.7 cm, photosynthetic autotroph. Tubers ellipsoid. Stem glabrous. Leaves 3−10, erect to spreading, oblong-lanceolate to lanceolate or narrowly lanceolate, obtuse to acute, glabrous, green without blotch, (4−)6−19.2(−24.5) × (1−)1.4−3.2 cm. Inflorescence 10.1−50(−59.1) cm long, loosely 10−59(−81) flowered, elongated. Bracts 25−65(−78) × (1.5−)2−5(−7) mm, suberect,

linear-lanceolate, acuminate, light green, more or less suffused with reddish-purple to reddish-brown towards tip. Pedicel (including ovary) 10−25 × 1.5−2.5 mm, glabrous, light green. Perianth segments united into a galea. Sepals whitish-green, more or less suffused with reddish-purple to reddish-brown, with reddish-purple to reddish-brown veins. Lateral sepals 10−15 × (3.5−)4−7 mm, ovate-elliptic to ovate-lanceolate, obtuse, glabrous; dorsal sepal (8.5−)9−12(−15) × (3−)3.5−5(−5.5) mm, ovate-elliptic to ovate-lanceolate, with incurved margin, obtuse, glabrous. Petals 7−11(−11.5) × 1.5−2.5 mm, linear-lanceolate, acute, glabrous, greenish with reddish-purple longitudinal stripes. Labellum 3-lobed, whitish and minutely papillose at center and base with reddish-purple blotches, 37−100 × (8−)10−20(−32) mm; lateral lobes (4−)5−22(−31) × (1−)1.5−4 mm, mostly deflexed, linear to obliquely linear-falcate, acuminate, glabrous, with undulate margin, reddish-purple to reddish-brown; middle lobe 28−85 × (1−)1.5−2 mm, directed forwards, linear, strap-shaped, more or less twisted, glabrous, reddish-purple to reddish-brown; lobules 3−38(−52) × 0.5−1 mm, directed forwards, linear, somewhat acuminate, more or less twisted, glabrous, reddish-purple to reddish-brown. Spur (2−)2.5−5 × 1.5−2.5 mm, horizontal to directed downwards, conical, obtuse, light green with whitish base. Column 4−5.5 × 0.5−1.5 mm.

Phenology: Flowering from early June to end of July.

Habitat and altitude: Roadsides, macchie, grassy places, glades and *Quercus* forest, 457−1066 m.

Specimens examined: A3 Bolu: Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti , *Quercus* forest, 587 m, 24 June 2015, Başaran 141 & Eker (AIBU)!; Yedigöller road, 500 m from Anatolian highway, glades, 847 m, 26 June 2015, Başaran 150 & Eker (AIBU)!; Merkeşler-Çaltepe road, 840 m to Merkeşler, roadsides, 1027 m, 26 June 2015, Başaran 158 & Eker (AIBU)!; southwest of Banaz village, macchie, 895 m, 12 July 2015, Başaran 223 & Eker (AIBU)!; north of Merkeşler village, 160 m from Merkeşler village crossroad, glades, 975 m, 12 July 2015, Başaran 224 & Eker (AIBU)!; Merkeşler village, Çaltepe road, southern foothills of Çaltepe, glades, 1066 m, 12 July 2015, Başaran 227 & Eker (AIBU)!; Dere village, east of Merkeşler village, roadsides, 767 m, 12 July 2015, Başaran 231 & Eker (AIBU)!; Mengen, Bolu-Mengen road, 39 km from Bolu, near Kayışlar

village crossroad, macchie, 632 m, 14 July 2015, Başaran 232 & Eker (AIBU)!; ibid., 8 km to Mengen, around Sayar village, grassy places, 574 m, 14 July 2015, Başaran 240 & Eker (AIBU)!; Bolu-Bilecik road, Yenimahalle cemetery, grassy places, 730 m, 22 July 2015, Başaran 286 & Eker (AIBU)!; Abant road, 700 m from the crossroad of Akçaalan village to the village, grassy places, 928 m, 25 July 2015, Başaran 298 & Eker (AIBU)!; Banaz village-Çobankaya village road, 1.29 km from Banaz village crossroad to Çobankaya village, glades, 1054 m, 27 July 2015, Başaran 308 & Eker (AIBU)!; north of Tetemeçele village, 480 m towards the mountain road, glades, 1076 m, 27 July 2015, Başaran 310 & Eker (AIBU)!; Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti , *Quercus* forest, 606 m, 7 August 2015, Başaran 351 & Eker (AIBU)!; Hamzabey Village-Yedigöller road, north of Hamzabey village, 1.20 km from the village, grassy places, 1076 m, 11 August 2015 (in fruit), Başaran 365 & Eker (AIBU)!; around Bağışlar village, west of the village, glades, 976 m, 16 August 2015, Başaran 373 & Eker (AIBU)!; ibid., grassy places, 950 m, 16 August 2015, Başaran 375 & Eker (AIBU)!; north of Merkeşler village, 310 m from Merkeşler village crossroad, grassy places, 998 m, 4 June 2016, Başaran 497 & Eker (AIBU)!; Yedigöller road, 500 m from Anatolian highway, grassy places, 835 m, 16 June 2016, Başaran 514 & Eker (AIBU)!; Mengen, Gökçesu-Kayabükü road, around Karakaya village, grassy places, 457 m, 23 June 2016, Başaran 531 & Eker (AIBU)!; Banaz village-Değirmenderesi village road, 840 m from Banaz village , glades, 897 m, 25 June 2016, Başaran 537 & Eker (AIBU)!; Abant road, west of Akçaalan village, mountain road, 400 m from village, glades, 1013 m, 25 July 2015, Başaran 302 & Eker (AIBU)!; **A4 Bolu:** Mengen, east of Düzağaç village, 700 m to the village, glades, 978 m, 1 July 2015, Başaran 185 & Eker (AIBU)!; Yeniçağa, Yeniçağa-Mengen road, 4 km from Eskiçağa crossroad to Mengen , near Taş Değirmen Piknik-Restaurant, roadsides, 853 m, 8 July 2015, Başaran 212 & Eker (AIBU)!; Mengen, Mengen-Eskipazar road, 890 m from Sazlar village crossroad to the village, grassy places, 651 m, 14 July 2015, Başaran 242 & Eker (AIBU)!; Mengen, east of Düzağaç village, 700 m to the village, glades, 992 m, 1 September 2015 (in fruit), Başaran 390 & Eker (AIBU)!

Regional conservation assessment: During field studies, 11 populations were determined. These populations show a wide spread. There is no significant threat for habitats of seven populations for now. However, the the area where HCA141

population located in Taşkesti/Mudurnu is under grazing and human pressure and there is a risk that the area will be transformed into settlement or agricultural area. However, the ruins of *Himantoglossum caprinum* were observed in the area due to commercial harvesting of salep orchids in the following years after the first detection. There is a risk that the the area where the HCA223 population located around Banaz village and the area of HCA514 population on Yedigöller road are converted into agricultural area. The area where the HCA298 population located around Akçaalan village is under grazing pressure. Thus, these four population needs conservation.

Figure 4.35. *Himantoglossum caprinum* – a) Habit, b) Flower
(Lateral sepals was opened manually)

4.1.33 ***Himantoglossum comperianum*** (Steven) P.Delforge

Plant 26.7−57.4 cm, photosynthetic autotroph. Tubers ellipsoid. Stem glabrous. Leaves (2−)3−4, erect to spreading, ovate-lanceolate to oblong-lanceolate or lanceolate, obtuse to subobtuse, glabrous, green without blotch, 7−15.6 × 1.1−2.8 cm. Inflorescence 7.4−23.4 cm long, loosely 7−19(−25) flowered, elongated. Bracts 25−46(−53) × (2.5−)3−7.5 mm, erect to suberect, linear-lanceolate, acute, light green, more or less suffused with reddish-purple. Pedicel (including ovary) 16−24 × 1.5−2.5(−3) mm, glabrous, green, more or less suffused with reddish-purple. Perianth segments united into a galea. Sepals light green, more or less suffused with reddish-purple. Lateral sepals 13−20 × (5−)6−7.5 mm, ovate-lanceolate to oblong-ovate,

mostly deflexed at the apex, acute, glabrous; dorsal sepal 12−17.5 × 5−6 mm, oblong-ovate, mostly deflexed at the apex, acute, glabrous. Petals 10−16 × 1.5−2 mm, linear-lanceolate, acute, glabrous, greenish to purplish. Labellum 3-lobed, pinkish at the center with whitish base, 32−57(−68.5) × 9.5−22 mm; lateral lobes 13−41(−53) × 2−3(−5) mm, directed forwards to deflexed, pendulous, filiform lanceolate, glabrous, reddish-purple; middle lobe (17.5−)22−41(−52) × 2.5−4 mm, directed forwards to deflexed, pendulous, filiform lanceolate, glabrous, reddish-purple; lobules 15−40(−48) × 0.5 mm, pendulous, glabrous, reddish-purple. Column 4.5−5 × 0.5 mm.

Phenology: Flowering from end of May to early July.

Habitat and altitude: Grassy places, glades and *Pinus* forest, 696−1044 m.

Specimens examined: A3 Bolu: Göynük, Sünnet lake, southwest road of the lake, *Pinus* forest, 1075 m, 7 July 2015, Başaran 201 & Eker (AIBU)!; Göynük, Sünnet lake, Sünnet village road, *Pinus* forest, 1044 m, 7 July 2015, Başaran 203 & Eker (AIBU)!; Göynük, Sünnet lake, Sünnet village road, *Pinus* forest, 1061 m, 15 September 2015 (in fruit), Başaran 403 & Eker (AIBU)!; Mudurnu, Sülüklügöl road, 3 km to the lake, glades, 842 m, 29 June 2016, Başaran 543 & Eker (AIBU)!; Mudurnu, Taşkesti-Karamurat village road, 600 m to Karamurat lake crossroad, grassy places, 696 m, 27 May 2017, Başaran 575 & Eker (AIBU)!; Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti , glades, 606 m, 29 May 2015, Başaran 48 & Eker (AIBU)!; Mudurnu, Sülüklügöl, north of the lake, glades, 1071 m, 24 June 2015, Başaran 145 & Eker (AIBU)!

Regional conservation assessment: During field studies, only three populations were determined. These populations show a very limited spread. However, there is no significant threat for their habitats for now.

Figure 4.36. *Himantoglossum comperianum* – a) Habit, b) Inflorescence

4.1.34 ***Limodorum abortivum*** (L.) Sw. var. ***abortivum***

Plant (23.4−)27.5−71.7(−87.1) cm, leafless saprophyte with a little or without chlorophyll. Rhizome with numerous thick, fleshy roots. Stem glabrous, purple to purplish-green, covered with 4−10 bluish-purple sheaths. Inflorescence (5.3−)7−31.5 cm long, loosely 4−19(−27) flowered, elongated. Bracts 17−42 × 5−15 mm, erect, oblong-lanceolate to lanceolate, acute to acuminate, glabrous, bluish-green, mostly purple-tinged. Pedicel (including ovary) 17−42 × 2−5(−5.5) mm, glabrous, mostly bluish-green. Lateral sepals 16−25.5 × 5−7 mm, spreading to slightly deflexed, oblong-lanceolate, acute to subacute, glabrous, whitish-purple to light purple; dorsal sepal 19−27 × 8−12 mm, curving forwards, oblong-obovate, with incurved margin, obtuse, glabrous, light purple. Petals 16−20 × 3−4 mm, spreading to deflexed, linear-lanceolate, acuminate, glabrous, light purple. Labellum divided into hypochile and epichile, (10−)18.5−21 × 8−12 mm; hypochile 5−6 × (3.5−)4−5 mm, deltoid, with incurved margin, glabrous, whitish to light purple with longitudinally purple lines; epichile 13−15 × 8−12 mm, directed forwards, triangular-ovate, obtuse, with incurved and slightly crenulate-undulate margin, mostly purple with longitudinally arranged darker lines, whitish at the center. Spur (15−)16−23 × 1.5−2.5 mm, directed downwards, slender, cylindrical, obtuse, greenish to dark purple. Column 11−16 × 1.5−2 mm.

Phenology: Flowering early May to early July.

Habitat and altitude: Glades, *Pinus* forest, *Abies* forest, *Fagus* forest *Quercus* forest 635−1587 m.

Specimens examined: A3 Bolu: BAİBÜ central campus, north of Gölköy dam lake, *Quercus* forest, 811 m, 18 May 2014, Başaran 18 & Eker (AIBU)!; Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti , *Quercus* forest, 606 m, 29 May 2015, Başaran 51 & Eker (AIBU)!; Yedigöller, near waterfalls, *Fagus* forest, 855 m, 11 July 2015 (in fruit), Başaran 217 & Eker (AIBU)!; Aladağlar, Demirciler plateau east entrance, *Pinus* forest, 1379 m, 21 July 2015 (in fruit), Başaran 280 & Eker (AIBU)!; Bolu-Aladağlar road, upper side of Karacasu plateau, 20 km from Karacasu, glades, 1420 m, 29 July 2015 (in fruit), Başaran 322 & Eker (AIBU)!; between Çeletepe-Çaltepe, 2 km from Kaydıköy plateau to Çeletepe, glades, 1605 m, 9 August 2015 (in fruit), Başaran 357 & Eker (AIBU)!; Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti , *Quercus* forest, 635 m, 2 June 2016, Başaran 490 & Eker (AIBU)!; north of Merkeşler village, 310 m from Merkeşler village crossroad, *Pinus* forest, 998 m, 4 June 2016, Başaran 496 & Eker (AIBU)!; Seben, Kesenözü village-Çatak plateau road, 6.58 km from the village, glades, 830 m, 7 June 2016, Başaran 499 & Eker (AIBU)!; Seben, Haccağız village-Musasofular village road, 1.07 km to Musasofular village, *Pinus* forest, 940 m, 11 June 2016, Başaran 509 & Eker (AIBU)!; north of the Çelegölcük forest warehouse, *Pinus* forest, 1209 m, 16 June 2016, Başaran 519 & Eker (AIBU)!; Banaz village-Değirmenderesi village road, 840 m from Banaz village , glades, 897 m, 25 June 2016, Başaran 536 & Eker (AIBU)!; BAİBÜ central campus, north of Gölköy dam lake, *Quercus* forest, 799 m, 30 June 2016, Başaran 547 & Eker (AIBU)!; Seben, 3.74 km from Kizik village crossroad to the Kızık village, *Abies* forest, 1587 m, 1 July 2016, Başaran 549 & Eker (AIBU)!

Regional conservation assessment: During field studies, six populations were determined. These populations show an extensive spread and there is no significant threat for their habitats for now.

Figure 4.37. *Limodorum abortivum* var. *abortivum* – a) Habit, b) Flower

4.1.35 ***Limodorum abortivum*** (L.) Sw. var. ***rubrum*** H.Sund. ex Kreutz

Plant 36−86.7(−95.2) cm, leafless saprophyte with a little or without chlorophyll. Rhizome with numerous thick, fleshy roots. Stem glabrous, reddish to purplish, covered with (5−)6−11(−13) reddish-purple sheaths. Inflorescence 9.2−37.2 cm long, loosely (4−)7−25(−34) flowered, elongated. Bracts 26−48 × 7−13 cm, erect, oblong-lanceolate to lanceolate, acute to acuminate, glabrous, reddish-green, mostly reddish-tinged. Pedicel (including ovary) 20−38 × (1.5−)2−2.5 mm, glabrous, mostly reddish-green. Lateral sepals 18−25.5 × 5.5−7 mm, spreading to slightly deflexed, oblong-lanceolate, acute to subacute, glabrous, reddish-pink; dorsal sepal 22−28 × 10.5−13 mm, curving forwards, oblong-obovate, with incurved margin, obtuse, glabrous, reddish-pink. Petals 17−20 × 3.5−4 mm, spreading to deflexed, linear-lanceolate, acuminate, glabrous, reddish-pink. Labellum divided into hypochile and epichile, (19.5−)20−21 × (9−)10−11(−12) mm; hypochile 5.5−6 × 4.5−5 mm, deltoid, with incurved margin, glabrous, whitish to light pink with longitudinally pink lines; epichile 14−15 × (9−)10−11(−12) mm, directed forwards, triangular-ovate, obtuse, with incurved and slightly crenulate-undulate margin, mostly reddish-pink with longitudinally arranged darker lines, whitish at center. Spur 15−23 × 2−2.5 mm, directed downwards, slender, cylindrical, obtuse, greenish to purplish-red. Column 12−16 × 1.5−2 mm.

Phenology: Flowering from early June to middle of July.

Habitat and altitude: *Pinus* forest and *Abies* forest, 715−1591 m.

Specimens examined: A3 Bolu: Seben, 3.74 km from Kizik village crossroad to the Kızık village, *Abies* forest, 1587 m, 1 July 2016, Başaran 550 & Eker (AIBU)!; Göynük, between Kayabaşı village and Kürnüç, *Pinus* forest, 715 m, 1 June 2017, Başaran 580 & Eker (AIBU)!; Seben, east of Hıdırlar village, *Pinus* forest, 1117 m, 23 June 2017, Başaran 589 & Eker (AIBU)!; Seben, 1.60 km from Kizik village crossroad to the Kızık village, *Abies* forest, 1522 m, 13 July 2017, Başaran 591 & Eker (AIBU)!; Kıbrıscık, Argözü valley, 7.31 km from Bölücekkaya village, *Pinus* forest, 1591 m, 17 July 2017, Başaran 602 & Eker (AIBU)!

Regional conservation assessment: During field studies, four populations were determined. These populations show a restricted spread. However, there is no significant threat for their habitats for now.

Figure 4.38. *Limodorum abortivum* var. *rubrum*
a) Habit, b) Inflorescence

4.1.36 ***Neotinea tridentata*** (Scop.) R.M.Bateman, Pridgeon & M.W.Chase

Plant 14.5−39.6 cm, photosynthetic autotroph. Tubers subglobose or ellipsoid. Stem glabrous. Leaves 4−10, erect to spreading, ovate-lanceolate to oblong-lanceolate, obtuse to acute, glabrous, green without blotch, (3.5−)5.5−9.5(−12) × (0.8−)1−2(−2.4) cm. Inflorescence 1.8−5.3 cm long, densely 8−46 flowered, globose

to ovoid. Bracts (5−)7−13(−18) × 1−2.5(−3.5) mm, suberect, lanceolate, acuminate, glabrous, green, more or less suffused with pinkish-purple. Perianth segments united into a galea. Sepals light pinkish-purple with conspicuous dark reddish-purple veins, white with green veins in albino forms. Lateral sepals (6.5−)7−11 × 2.5−3(−4) mm, ovate-lanceolate, acuminate, glabrous; dorsal sepal 6−9(−9.5) × (1.5−)2−2.5 mm, ovate-lanceolate, acuminate, glabrous. Petals light pinkish-purple with conspicuous dark reddish-purple veins, white with green veins in albino forms, 5−6.5 × 1−1.5 mm, narrowly lanceolate, acute to acuminate, glabrous. Labellum 3-lobed, white to light pinkish-purple with purple dotted blotches, white without blotch in albino forms, (6−)7−10(−12) × 5−9 mm; lateral lobes (1−)1.5−4 × 1−2.5 mm, directed forwards, rhombic, obliquely oblong-ligulate, with dentate margin at apex, minutely papillose; middle lobe 2−5(−6) × 2−6(−8) mm, directed forwards, obcordate, with dentate margin at apex, shallowly notched or bilobed, sometimes with a minute tooth between lobules, minutely papillose. Spur 5−9 × 1−1.5(−2) mm, directed downwards, cylindrical, obtuse, white to light pinkish-purple, white in albino forms. Column 2−3 × 0.5(−1) mm.

Phenology: Flowering from early May to middle of June.

Habitat and altitude: Grassy places, glades and dry grassy places, 560−1510 m.

Specimens examined: A3 Bolu: East of Pirahmetler village, around Çakmaklar offroad racing area, grassy places, 1017 m, 12 May 2017, Başaran 566 & Eker (AIBU)!; Mengen road, Çaydurt-Mengen road, 8.60 km from Yeniçaydurt, grassy places, 667 m, 6 May 2016, Başaran 441 & Eker (AIBU)!; Mengen, Gökçesu-Mengen road, 1 km from Gökçesu, grassy places, 560 m, 6 May 2016, Başaran 445 & Eker (AIBU)!; BAİBÜ central campus, north of Gölköy dam lake, grassy places, 805 m, 13 May 2016, Başaran 459 & Eker (AIBU)!; Abant road, west of Akçaalan village, mountain road, 390 m from village, glades, 1015 m, 14 June 2015, Başaran 98 & Eker (AIBU)!; Abant road, 700 m from the crossroad of Akçaalan village to the village, grassy places, 906 m, 2 May 2016, Başaran 435 & Eker (AIBU)!; Karacasu-Gölcük road, 1.66 km from Karacasu, grassy places, 844 m, 18 May 2016, Başaran 472 & Eker (AIBU)!; around Kırık plateau, grassy places, 1510 m, 9 June 2017, Başaran 584 & Eker (AIBU)!; **A4 Bolu:** Yeniçağa, 950 m east of Çamlık village,

grassy places, 1241 m, 24 May 2017, Başaran 572 & Eker (AIBU)!; ibid., Başaran 574 & Eker (AIBU)!

Regional conservation assessment: During field studies, seven populations were determined. These populations show an extensive spread. There is no significant threat for habitats of four populations (NTR445, NTR441, NTR435, NTR584) for now. However, the NTR572 population around Çamlık village/Yeniçağa is under the threat of grazing. The NTR459 population located in Gölköy is also under the threat of both grazing and agricultural activities. The NTR566 population around of the Köroğlu Motorsports Center in Çakmaklar district is under human pressure. Thus, these three populations need conservation.

Figure 4.39. *Neotinea tridentata* – a) Habit, b) Inflorescence

4.1.37 *Neottia nidus-avis* (L.) Rich.

Plant (16.3−)18.5−43 cm, leafless saprophyte, without chlorophyll. Rhizome short with densely crowded fleshy roots. Stem minutely glandular-pubescent, stout and mostly thick, yellowish-brown to dark brown, with 4−5 surrounded by yellowish-brown to dark brown sheathing scales. Inflorescence 5.4−21.1 cm long, densely but rather loosely below, 10−38 flowered, cylindrical. Bracts 5−17 × (1−)1.5−2.5(−3) mm, spreading, lanceolate, acuminate, glabrous, yellowish-brown. Pedicel (including ovary) 6−12 × (1.5−)2−4(−4.5) mm, minutely glandular-pubescent, yellowish-brown to dark brown. Perianth segments united into a galea. Lateral sepals 5−7 × 3−4.5

mm, obovate, obtuse, glabrous, yellowish-brown to dark brown; dorsal sepal 5−6.5 × (2.5−)3−4 mm, obovate, obtuse, glabrous, yellowish-brown to dark brown. Petals 4−5.5 × 2−3 mm, obovate, obtuse, glabrous, yellowish-brown to dark brown. Labellum 2-lobed, yellowish-brown, greyish-brown at base, basal part cup shaped (lower side minutely glandular-pubescent), on the middle dividing into two spreading lobes, 7−11(−13) × 7−12 mm; lateral lobes 3.5−7 × 2−3.5 mm, spreading, directed forwards, cordate-oblong, obtuse, papillose. Column 4.5−5 × 1 mm.

Phenology: Flowering from middle of May to early July.

Habitat and altitude: *Abies* forest, *Fagus* forest, *Pinus* forest, and glades, 896−1514 m.

Specimens examined: A3 Bolu: BAİBÜ central campus, north of Gölköy dam lake, *Quercus* forest, 811 m, 26 May 2014, Başaran 20 & Eker (AIBU)!; Mudurnu, Sülüklügöl, west of the lake, glades, 1077 m, 31 May 2015, Başaran 53 & Eker (AIBU)!; Abant road, 4.3 km from Abant-Gökdere crossroad, *Abies* and *Fagus* forest, 1146 m, 14 June 2015, Başaran 95 & Eker (AIBU)!; Abant Road, 5.5 km to Abant, between road and stream, *Fagus* forest, 1076 m, 14 June 2015, Başaran 108 & Eker (AIBU)!; Abant Road, 5.5 km to Abant, between road and stream, *Fagus* forest, 1138 m, 14 June 2015, Başaran 110 & Eker (AIBU)!; Mudurnu, Abant, 1.3 km northeast of Örencik plateau, *Abies* forest, 1483 m, 19 June 2015, Başaran 118 & Eker (AIBU)!; Yedigöller road, 8.5 km from Anatolian highway, *Pinus* forest, 1325 m, 21 June 2015, Başaran 136 & Eker (AIBU)!; Yedigöller road, Yığılca crossroad, *Abies* and *Fagus* forest, 1184 m, 21 June 2015, Başaran 137 & Eker (AIBU)!; 13 km from Yedigöller road crossroad to Çaltepe, between Çaltepe and Çeletepe, northern foothills, *Abies* forest, 1295 m, 21 June 2015, Başaran 140 & Eker (AIBU)!; Çelegölcük forest warehouse-Banaz plateau road, 3.4 km from Çelegölcük forest warehouse, south of Çeletepe, glades, 1432 m, 26 June 2015, Başaran 154 & Eker (AIBU)!; Yedigöller, near waterfalls, *Fagus* forest, 855 m, 11 July 2015, Başaran 216 & Eker (AIBU)!; between Çaltepe and Çeletepe, 1.15 km from Kadıköy plateau to Çaltepe, *Abies* forest, 1519 m, 27 July 2015 (in fruit), Başaran 316 & Eker (AIBU)!; northeast of Sebenardı village, *Abies* forest, 1430 m, 29 July 2015 (in fruit), Başaran 329 & Eker (AIBU)!; Yedigöller-Mengen road, 3.5 km from Yedigöller, *Fagus* forest, 550 m, 3 August 2015(in fruit), Başaran 341 & Eker

(AIBU)!; Yedigöller road, between Gurbettaşı and Çaltepe road, 4.5 km from Gurbettaşı, *Abies* forest, 1229 m, 3 August 2015 (in fruit), Başaran 344 & Eker (AIBU)!; 13 km from Yedigöller road crossroad to Çaltepe, between Çaltepe and Çeletepe, northern foothills, *Abies* forest, 1292 m, 3 August 2015 (in fruit), Başaran 345 & Eker (AIBU)!; southwest of Çaltepe, Kadıköy plateau-Merkeşler village road, 1.10 km from the plateau, *Fagus* forest, 1477 m, 9 August 2015 (in fruit), Başaran 360 & Eker (AIBU)!; southwest of Çaltepe, Kadıköy plateau-Merkeşler village road, 2.17 km from the plateau, *Abies* forest, 1400 m, 16 October 2015 (in fruit), Başaran 411 & Eker (AIBU)!; Karacasu-Gölcük road, 1 km to Gölcük, *Abies* forest, 1121 m, 18 May 2016, Başaran 475 & Eker (AIBU)!; **A4 Bolu:** Mengen, northeast of Mengen, north of Gezginder plateau, *Abies* forest, 1514 m, 1 July 2015, Başaran 169 & Eker (AIBU)!

Regional conservation assessment: During field studies, six populations were determined. These populations show a wide spread and there is no significant threat for their habitats for now.

Figure 4.40. *Neottia nidus-avis* – a) Habit, b) Inflorescence

4.1.38 ***Ophrys apifera*** Huds.

Plant 18.8−50.8 cm, photosynthetic autotroph. Tubers globose or ellipsoid. Stem glabrous. Leaves 4−7, erect to spreading, ovate-lanceolate to oblong-lanceolate or lanceolate, glabrous, green without blotch, (4.2−)5.5−9.6(−11.5) × 1−2.4 cm.

Inflorescence 3.4−14.8(−20) cm long, loosely 2−9 flowered, elongated. Bracts 17−43(−66) × 3−11(−16) mm, suberect, lanceolate, acute, glabrous, pale green. Pedicel (including ovary) 17−35 × (1−)1.5−6 mm, glabrous, green. Lateral sepals 13−18 × 5.5−7.5 mm, spreading to deflexed, ovate-lanceolate to ovate-oblong, obtuse, glabrous, light pink to purplish-pink with green mid-vein; dorsal sepal 12.5−17.5 × 5.5−7.5 mm, spreading to deflexed, ovate-oblong, obtuse, mostly somewhat concave, glabrous, light pink to purplish-pink with green mid-vein. Petals 3−4 × 1.5−2 mm, triangular-ligulate, subobtuse, entire to revolute, whitish pubescent on both surface, light green to slightly pinkish. Labellum 3-lobed, 9.5−13 × 9.5−11 mm; lateral lobes 3−4 × (1.5−)2−2.5 mm, deflexed, obliquely triangular, papillose, minutely velutinous and villous, yellowish-greeen to brownish, each with 1−1.5 mm long obtuse hump; middle lobe 7−9 × 7.5−9.5 mm, convex, margin and front deflexed, obovate, papillose, minutely velutinous and villous, partly dark reddish-brown to greenish, ending with an appendix which is papillose, yellowish-green, deflexed, 3−3.5 × 1.5 mm; speculum covers almost all surface, scutelliform at the base extending laterally and apically, glabrous, violet or reddish-brown, yellowish-green on the margin. Column 6−8 × 1−1.5 mm, with 3 × 1−1.5 mm flexuous connective.

Phenology: Flowering from end of May to end of June.

Habitat and altitude: Grassy places and glades, 814−1071 m.

Specimens examined: A3 Bolu: BAİBÜ central campus, north of the FEF laboratories, grassy places, 867, 28 May 2014, Başaran 23 & Eker (AIBU)!; Yeniçağa, 200 m to Yeniçağa village, grassy places, 1066 m, 12 June 2015, Başaran 74 & Eker (AIBU)!; Abant road, 1.5 km from Abant crossroad to Abant, grassy places, 813 m, 14 June 2015, Başaran 84 & Eker (AIBU)!; Abant road, 3 km from Abant crossroad to Abant, glades, 851 m, 14 June 2015, Başaran 89 & Eker (AIBU)!; Abant road, west of Akçaalan village, mountain road, 390 m from village, grassy places, 1015 m, 14 June 2015, Başaran 100 & Eker (AIBU)!; Abant road, 700 m from the crossroad of Akçaalan village to the village, glades, 918 m, 14 June 2015, Başaran 103 & Eker (AIBU)!; Abant Road, 9.35 km to Abant, glades, 983 m, 14 June 2015, Başaran 104 & Eker (AIBU)!; Mudurnu, plateau in the south of Akyokuş village, grassy places, 1118 m, 24 June 2015, Başaran 148 & Eker (AIBU)!;

Merkeşler-Çaltepe road, 840 m to Merkeşler, glades, 1027 m, 26 June 2015, Başaran 160 & Eker (AIBU)!; BAİBÜ central campus, south of the FEF laboratories, glades, 876 m, 30 June 2015, Başaran 162 & Eker (AIBU)!; Bolu-Bilecik road, 12.6 km from BAİBÜ Central Campus crossroad, roadside slopes, 894 m, 7 July 2015, (in fruit) Başaran 199 & Eker (AIBU)!; southwest of Banaz village, grassy places, 895 m, 12 July 2015 (in fruit), Başaran 222 & Eker (AIBU)!; Abant road, 700 m from the crossroad of Akçaalan village to the village, grassy places, 928 m, 25 July 2015, (in fruit) Başaran 300 & Eker (AIBU)!; Hamzabey Village-Yedigöller road, north of Hamzabey village, 1.20 km from the village, grassy places, 1076 m, 11 August 2015, (in fruit) Başaran 364 & Eker (AIBU)!; BAİBÜ central campus, south of BESYO, grassy places, 862 m, 25 May 2016, Başaran 483 & Eker (AIBU)!; Mudurnu, Abant-Taşkesti road, between İğneciler and Elmacıkdere, 1.11 km from İğneciler, grassy places, 790 m, 2 June 2016, Başaran 488 & Eker (AIBU)!; Merkeşler-Hayranlar road, 2.22 km to Hayranlar, grassy places, 814 m, 4 June 2016, Başaran 493 & Eker (AIBU)!; Yedigöller road, 500 m from Anatolian highway, grassy places, 835 m, 16 June 2016, Başaran 511 & Eker (AIBU)!; **A4 Bolu:** Mengen, northeast of Mengen, east of Düzağaç village, glades, 1071 m, 1 July 2015, Başaran 179 & Eker (AIBU)!; Mengen, east of Düzağaç village, 700 m to the village, grassy places, 978 m, 1 July 2015, Başaran 183 & Eker (AIBU)!; Mengen, northwest of Bürnük village, glades, 1014 m, 14 July 2015, Başaran 246 & Eker (AIBU)!; Mengen, Bürnük village-Şirinyazı pond road, 650 m to the pond, grassy places, 1062 m, 14 July 2015, Başaran 261 & Eker (AIBU)!

Regional conservation assessment: During field studies, five populations were determined. These populations show an extensive spread. There is no significant threat for habitats of two populations (OAP179, OAP100) for now. However, there is a risk that the area where of the OAP511 population located on Yedigöller road is converted into agricultural area. The OAP493 population located around Dereköy/Mengen is also under the threat of agricultural activities. The population of OAP483, located on the central campus of BAİBÜ, is cut every year due to the lawn mowing activities carried out in certain periods. Thus, this situation prevents the seed propagation of individuals in population. These three populations need conservation.

Figure 4.41. *Ophrys apifera* – a) Habit, b) Inflorescence

4.1.39 ***Ophrys fusca*** Link subsp. ***thracica*** Kreutz

Plant 12.1−14.7 cm, photosynthetic autotroph. Tubers subglobose or ellipsoid. Stem glabrous. Leaves 4−5, erect to spreading, ovate to oblong-elliptic or lanceolate, obtuse to acute, glabrous, green without blotch, 3−4 × 1.1−1.9 cm. Inflorescence 2.5−4.7 cm long, loosely 1−2 flowered. Bracts 12−21 × 5−6 mm, erect, oblong-elliptic to oblong-obovate, obtuse, glabrous, pale green. Pedicel (including ovary) 16−22 × 4−6 mm, glabrous, green. Lateral sepals 8.5−12.5 × 4−5 mm, more or less curving forwards, ovate-lanceolate to broadly oblong, obtuse, more or less revolute, glabrous, light green to yellowish-green; dorsal sepal 8−9 × 4−5 mm, curving forwards converging with the petals, ovate-lanceolate to broadly oblong, obtuse, more or less revolute, glabrous, light green to yellowish-green. Petals 5−7 × 1.5−2 mm, linear-oblong, obtuse, with entire to undulate margin, glabrous, green with dark brownish margin. Labellum 3-lobed, 10−12 × 6.5−9 mm; lateral lobes 1.5−2 × 1.5−2 mm, directed forwards, oblong, papillose and velutinous, brownish, greenish margin; middle lobe 4.5−5 × 4−5 mm, directed forwards, obcordate, somewhat emarginate, papillose and velutinous, brownish, with greenish margin; speculum from base to middle, bipartite, W-shaped, slightly velutinous, greyish-blue, yellow on the margin. Column 3.5−4 × 1.5−2 mm.

Phenology: Flowering early May.

Habitat and altitude: *Pinus* forest, 558 m.

Specimens examined: A3 Bolu: Göynük, Ekinciler-Kılavuzlar road, 3.83 km from Ekinciler, *Pinus* forest, 558 m, 3.05.2017, Başaran 559 & Eker (AIBU)!; ibid., 5.46 km from Ekinciler, *Pinus* forest, 772 m, 3.05.2017, Başaran 560 & Eker (AIBU)!

Regional conservation assessment: This taxon was only found at one locality in Göynük. However, there is no significant threat for its habitat for now.

Figure 4.42. *Ophrys fusca* subsp. *thracica* – a) Habit, b) Flower

4.1.40 ***Ophrys oestrifera*** M.Bieb. subsp. ***oestrifera***

Plant (12.4−)18.2−36.3(45.6) cm, photosynthetic autotroph. Tubers subglobose to ellipsoid. Stem glabrous. Leaves 4−7(−9), erect to spreading, ovate-lanceolate to oblong-lanceolate or lanceolate, glabrous, green without blotch, 4−10 × 1−2.8 cm. Inflorescence (2.8−)4−22.4(−27.5) cm long, loosely 2−13 flowered, elongated. Bracts 17−42(−55) × 3−11 mm, erect to suberect, acute, glabrous, pale green. Pedicel (including ovary) 12−27 × 1−2(−2.5) mm, glabrous, green. Lateral sepals 8−14 × 4−6 mm, spreading or deflexed, ovate-lanceolate to ovate-oblong or ovate-elliptic, obtuse, glabrous, light pink to purplish-pink with green mid-vein; dorsal sepal 8−13 × 3−4.5 mm, curving forwards to deflexed, ovate-oblong, obtuse, mostly somewhat concave, glabrous, light pink to purplish-pink with green mid-vein. Petals (2.5−)3−5 × 1−2.5 mm, triangular to lanceolate, subobtuse, entire, pubescent on both surface,

light pink to purplish-pink. Labellum 3-lobed, 8−12(−13) × 7−11(−11.5) mm; lateral lobes (2−)2.5−3.5 × 2−2.5 mm, deflexed, triangular, papillose, minutely velutinous and villous, yellowish-greeen to brownish, each with (4−)5−7 mm long obtuse horn; middle lobe 6−9 × 7−11(−11.5) mm, margin deflexed, strongly convex, ovate, papillose, minutely velutinous and villous, partly dark reddish-brown to greenish, ending with an appendix which is papillose, yellowish-green, directed upwards, (0.5−)1−1.5 × 1−2 mm; speculum occupying most of middle lobe, scutelliform, H-shaped, glabrous, bluish-brown, yellowish to greyish-blue lines on the margin. Column (4−)4.5−6 × 1 mm, with 0.5−2 × 0.5−1 mm apiculate connective.

Phenology: Flowering from early May to middle of July.

Habitat and altitude: Grassy places, roadsides, glades, *Pinus* forest, *Quercus* forest and macchie, 635−998 m.

Specimens examined: A3 Bolu: BAİBÜ central campus, north of Gölköy dam lake, macchie, 813 m, 12 June 2014, Başaran 25 & Eker (AIBU)!; Abant road, 3 km from Abant crossroad to Abant, glades, 851 m, 14 June 2015, Başaran 91 & Eker (AIBU)!; Abant road, west of Akçaalan village, mountain road, 390 m from village, grassy places, 1015 m, 14 June 2015, Başaran 99 & Eker (AIBU)!; Abant road, 700 m from the crossroad of Akçaalan village to the village, glades, 918 m, 14 June 2015, Başaran 102 & Eker (AIBU)!; Mengen, Gökçesu-Mengen yolu, Gökçesu'dan 2.27 km sonra, *Pinus* forest, 632 m, 14 July 2015 (in fruit), Başaran 239 & Eker (AIBU)!; Abant road, 700 m from the crossroad of Akçaalan village to the village, grassy places, 928 m, 25 July 2015 (in fruit), Başaran 301 & Eker (AIBU)!; ibid., 906 m, 2 May 2016, Başaran 433 & Eker (AIBU)!; BAİBÜ central campus, north of Gölköy dam lake, grassy places, 805 m, 13 May 2016, Başaran 455 & Eker (AIBU)!; Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti , *Quercus* forest, 635 m, 2 June 2016, Başaran 491 & Eker (AIBU)!; north of Merkeşler village, 310 m from Merkeşler village crossroad, grassy places, 998 m, 4 June 2016, Başaran 495 & Eker (AIBU)!; Mengen, east of Düzağaç village, 700 m to the village, grassy places, 981 m, 23 June 2016, Başaran 533 & Eker (AIBU)!; Merkeşler-Hayranlar road, 1.45 km to Hayranlar, grassy places, 730 m, 25 June 2016, Başaran 539 & Eker (AIBU)!; Göynük, Göynük-Sarıcalar village road, 620 m from crossroad, *Pinus* forest, 870 m, 1 June 2017, Başaran 578 & Eker (AIBU)!; **A4 Bolu:** Mengen, east of Düzağaç

village, 700 m to the village, grassy places, 978 m, 1 July 2015, Başaran 184 & Eker (AIBU)!; Mengen, Bürnük village-Şirinyazı pond road, 650 m to the pond, grassy places, 1062 m, 14 July 2015, Başaran 260 & Eker (AIBU)!

Regional conservation assessment: During field studies, five populations were determined. These populations show an extensive spread. There is no significant threat for habitats of two populations (OOE184, OOE495) for now. However, the area where located OOE491 population in Taşkesti/Mudurnu is under grazing and human pressure and there is a risk that the area will be transformed into settlement or agricultural area. The area where the OOE433 population located around Akçaalan village is under grazing pressure. The OOE455 population located in Gölköy is also under the threat of both grazing and agricultural activities. These three populations need conservation.

Figure 4.43. *Ophrys oestrifera* subsp. *oestrifera* – a) Habit, b) Flower

4.1.41 ***Ophrys transhyrcana*** Czerniak. subsp. ***paphlagonica*** Kreutz

Plant 15.8−52.2(−69.5) cm, photosynthetic autotroph. Tubers subglobose. Stem glabrous. Leaves (4−)5−8(−10), erect to spreading, oblong-lanceolate, acute, glabrous, green without blotch, 5.1−8.7(−11) × 1.1−2.4(−3.4) cm. Inflorescence 3.6−24.5(−29.8) cm long, loosely 3−14 flowered, elongated. Bracts 17−44 × (3.5−)4−10(−12) mm, suberect, lanceolate, acute, glabrous, pale green. Pedicel (including ovary) 14−30 × 1−3(−9) mm, glabrous, green. Lateral sepals 10−14 ×

4−6.5 mm, slightly curving forwards to slightly deflexed, ovate-lanceolate to ovate-oblong, obtuse, more or less revolute, glabrous, green, sometimes lower half more or less suffused with reddish-purple; dorsal sepal (9.5−)10−13 × 3.5−5.5 mm, slightly curving forwards to slightly deflexed, oblong-lanceolate, obtuse, entire to revolute, glabrous, green. Petals 5−7(−7.5) × 1.5−2 mm, lanceolate to ovate-lanceolate, subacute, slightly undulate to somewhat revolute margin, minutely pubescent on both surface, yellowish-green to with slightly reddish at base and/or on margin. Labellum undivided or 3-lobed, 10−12(−15) × (−7)8−11(−13) mm; lateral lobes absent or (1−)1.5−2.5 × 1−2(−2.5) mm, spreading to strongly deflexed, oblong-triangular, papillose, minutely velutinous and pilose, dark brownish to greenish-brown, each with 1−2 mm long obtuse hump; middle lobes absent or 4−6(−7) × 7.5−9(−10) mm, margin spreading to strongly deflexed, mostly convex, nearly round, papillose, minutely velutinous and pilose, dark brownish to greenish-brown, ending with an appendix which is papillose, yellowish-green to reddish, directed forwards, 0.5−1 × 0.5−1.5 mm; speculum from base to near apex, H-shaped, glabrous, dull bluish-purple, whitish-blue on the margin. Column (4.5−)5−6 × 1 mm, with 0.5−1 × 0.5−1 mm apiculate connective.

Phenology: Flowering from middle of April to middle of June.

Habitat and altitude: Macchie, glades, *Pinus* forest, roadsides and grassy places, 555−901 m.

Specimens examined: A3 Bolu: BAİBÜ central campus, north of the FEF laboratories, grassy places, 867 m, 21 April 2014, Başaran 1 & Eker (AIBU)!; ibid., 12 May 2015, Başaran 27 & Eker (AIBU)!; Göynük, Sünnet Lake road, 1.5 km from Bolu-Bilecik road crossroad, roadsides, 872 m, 16 April 2016, Başaran 416 & Eker (AIBU)!; Mudurnu, Tosunlar village-Taşkesti road, 580 m from Tosunlar village, grassy places, 555 m, 16 April 2016, Başaran 417 & Eker (AIBU)!; Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti , glades, 597 m, 16 April 2016, Başaran 419 & Eker (AIBU)!; BAİBÜ central campus, north of the FEF laboratories, grassy places, 858 m, 23 April 2016, Başaran 428 & Eker (AIBU)!; Mengen, Gökçesu-Mengen road, 1 km from Gökçesu, grassy places, 560 m, 6 May 2016, Başaran 446 & Eker (AIBU)!; BAİBÜ central campus, north of Gölköy dam lake, grassy places, 805 m, 13 May 2016, Başaran 456 & Eker (AIBU)!; Göynük, Sünnet

Lake road, 1.5 km from Bolu-Bilecik road crossroad, roadsides, 881 m, 16 May 2016, Başaran 463 & Eker (AIBU)!; ibid., Başaran 464 & Eker (AIBU)!; Göynük, Sünnet Lake road, 1.7 km from Bolu-Bilecik road crossroad, roadsides, 910 m, 16 May 2016, Başaran 465 & Eker (AIBU)!; Göynük, 3 km from Sünnet village, glades, 1253 m, 16 May 2016, Başaran 467 & Eker (AIBU)!; Seben, Kesenözü village-Çatak plateau road, 6.58 km from the village, *Pinus* forest, 830 m, 7 June 2016, Başaran 500 & Eker (AIBU)!; Seben, east of Güneyce village, Karayanık stream, glades, 901 m, 11 June 2016, Başaran 507 & Eker (AIBU)!; ibid., Başaran 508 & Eker (AIBU)!; Yedigöller road, 2.08 km from Anatolian highway, *Pinus* forest, 944 m, 16 June 2016, Başaran 515 & Eker (AIBU)!; Göynük, northern slopes of Mustanlar village, grassy places, 681 m, 3 May 2017, Başaran 562 & Eker (AIBU)!; ibid., Başaran 563 & Eker (AIBU)!; Bolu-Yeniçağa road, around Afşar village cemetery, *Pinus* forest, 966 m, 24 May 2017, Başaran 568 & Eker (AIBU)!; Göynük, Göynük-Sarıcalar village road, 620 m from crossroad, *Pinus* forest, 870 m, 1 June 2017, Başaran 579 & Eker (AIBU)!

Regional conservation assessment: During field studies, seven populations were determined. These populations show an extensive spread. There is no significant threat for habitats of six populations for now. However, the population of OTP428, located on the central campus of BAİBÜ is under human pressure. Thus, this population needs conservation.

Figure 4.44. *Ophrys transhyrcana*. subsp. *paphlagonica*
a) Habit, b) Flower

4.1.42 *Ophrys tremoris* Gämperle & Gölz

Plant (8.3−)24.1−32.2 cm, photosynthetic autotroph. Tubers rounded. Stem glabrous. Leaves 4−7, erect to spreading, oblong-lanceolate to ovate-lanceolate, acute, glabrous, green without blotch, 7.6−11.2 × (0.7−)1.4−1.5 cm. Inflorescence (2.7−)6−12 cm long, loosely (3−)6−8 flowered, elongated. Bracts 23−46 × 6−10 mm, erect to suberect, lanceolate, acute, glabrous, pale green. Pedicel (including ovary) 16−21 × 1−2 mm, glabrous, green. Lateral sepals 13.5−17 × 5.5−6.5 mm, slightly spreading to slightly deflexed, ovate-lanceolate to ovate-oblong, obtuse, more or less revolute, glabrous, green, mostly lower half more or less suffused with dark reddish; dorsal sepal 13−14 × 5−6 mm, slightly curving forwards to deflexed, oblong-lanceolate, obtuse, entire to revolute, glabrous, green. Petals 8−10 × 2−3 mm, lanceolate, acute to subacute, with slightly undulate to revolute margin, minutely pubescent on both surface, light greenish to mostly suffused with reddish-brown. Labellum undivided, 13−15(−17) × 10−15.5 mm, margin spreading to slightly deflexed, convex at center, nearly round to somewhat triangular, minutely velutinous and pilose, dark reddish to dark brownish, each with 0.5−1 mm long obtuse hump, ending with an appendix which is papillose, yellowish-green to reddish-yellow, directed forwards, 0.5−1 × 0.5−1.5 mm; speculum from base to near apex, H-shaped, mostly with lateral blotches, glabrous, dull bluish-brown to dull bluish-purple, whitish-blue on the margin. Column 5−6 × 1 mm, with 1−1.5 × 1 mm somewhat apiculate-flexuous connective.

Phenology: Flowering early of June.

Habitat and altitude: On the edge of sparse *Pinus* forests, 830 m.

Specimens examined: A3 Bolu: Seben, south of Kesenözü village, 2 km from the village, on the edge of sparse *Pinus* forests, 894 m, 30 May 2016, Başaran 487 & Eker (AIBU)!

Regional conservation assessment: This taxon was only found at one locality near Kesenözü village/Seben and five individuals were counted and sampled. However, there is no significant threat for its habitat for now.

Figure 4.45. *Ophrys tremoris* – a) Habit, b) Flower

4.1.43 *Orchis anatolica* Boiss.

Plant (9.6−)14−27.3 cm, photosynthetic autotroph. Tubers subglobose or ovoid. Stem glabrous. Leaves 3−5(−8), erect to spreading, lanceolate to oblong-lanceolate, obtuse to acute, glabrous, green with prominent or unclear blotch, (3.8−)5−12 × 0.6−1.8 cm. Inflorescence 2.5−9.5(−11.5) cm long, loosely 2−13(−17) flowered, cylindrical to ovoid. Bracts 6−18(−23) × 1−2(−2.5) mm, suberect, lanceolate to linear-lanceolate, acute to acuminate, glabrous, purplish-pink. Pedicel (including ovary) 10−21 × 1−2 mm, glabrous, purple. Lateral sepals 6−9 × 2.5−3.5(−4) mm, slightly deflexed to spreading, oblong-ovate to ovate-lanceolate, obtuse to acute, glabrous, purple to light pink; dorsal sepal 6−8 × 2−3 mm, spreading to curving forwards converging with the petals, oblong-lanceolate, cucullate, glabrous, purple to light pink. Petals 5.5−6.5 × (1.5−)2−2.5(−3) mm, obliquely oblong-ovate, obtuse, glabrous, purple to light pink. Labellum 3-lobed, whitish at center with purple blotches, 9−13(−15) × (5−)7−10(−13) mm, lateral lobes 1−2(−4) × 2−3.5(−4.5) mm, directed forwards to deflexed, rounded or rhombic, entire to slightly crenulate margin towards the apex, glabrous, purple to light pink; middle lobe 1−3.5(−4) × (2−)3−5(−6) mm, deflexed to directed upwards, slightly emarginate in front, glabrous, purple to light pink. Spur 11−23 × 1−2(−2.5) mm, horizontal to directed upwards, linear-cylindrical, dilated towards base, obtuse, purple to pink. Column 2.5−3.5 × 0.5 mm.

Phenology: Flowering from middle of April to early May.

Habitat and altitude: *Pinus* forest, 672−973 m.

Specimens examined: A3 Bolu: Göynük, Yeniköy-Dedeler village road, 1.80 km from Yeniköy, *Pinus* forest, 820 m, 20 April 2016, Başaran 423 & Eker (AIBU)!; Göynük, between Dedeler village and Susuz village, 1.50 km from Dedeler village, *Pinus* forest, 783 m, 26 April 2017, Başaran 553 & Eker (AIBU)!; Göynük, Sarıcalar-Köybaşı road, 2.93 km from Sarıcalar, *Pinus* forest, 932 m, 3 May 2017, Başaran 555 & Eker (AIBU)!; Göynük, Sarıcalar-Köybaşı road, 4 km from Sarıcalar, *Pinus* forest, 973 m, 3 May 2017, Başaran 556 & Eker (AIBU)!; Göynük, Köybaşı-Narzanlar road, 1.12 km from Köybaşı , *Pinus* forest, 927 m, 3 May 2017, Başaran 557 & Eker (AIBU)!; Göynük, southwest of Karacalar village, north of Gerişler village, *Pinus* forest, 672 m, 3 May 2017, Başaran 558 & Eker (AIBU)!; Göynük, Ekinciler-Kılavuzlar road, 5.46 km from Ekinciler, *Pinus* forest, 772 m, 3 May 2017, Başaran 561 & Eker (AIBU)!; Göynük, northern slopes of Mustanlar village, *Pinus* forest, 681 m, 3 May 2017, Başaran 564 & Eker (AIBU)!

Regional conservation assessment: During field studies, four populations were determined. These populations show a restricted spread. However, there is no significant threat for their habitats for now.

Figure 4.46. *Orchis anatolica* – a) Habit, b) Flower

4.1.44 *Orchis* × *angusticruris* Franch.

[***Orchis purpurea*** Huds. subsp. ***purpurea* × *Orchis simia*** Lam.]

Plant 39.5 cm, photosynthetic autotroph. Tubers ellipsoid. Stem glabrous. Leaves 8, erect to spreading, oblong-lanceolate to ovate-lanceolate, obtuse to acute, glabrous, green without blotch, 12.3 × 2.8 cm. Inflorescence 5.4 cm long, densely 34 flowered, ovoid. Bracts 2.5 × 2 mm, erect, ovate-lanceolate, acute to acuminate, purplish-white, purple at base. Pedicel (including ovary) 11 × 1 mm, green to suffused with purple. Perianth segments united into a dense or loose galea with free tips. Sepals greenish, with conspicuous pinkish-purple blotch and veins. Lateral sepals 10.5 × 4.5 mm, ovate-lanceolate, acuminate, glabrous; dorsal sepal 11 × 4 mm, ovate-lanceolate, acuminate, glabrous. Petals 8 × 1 mm, linear to linear-lanceolate, acuminate, glabrous, light pink, with pinkish-purple blotch and veins. Labellum 3-lobed, light pink to white at center and near base, with papillose and tuft of long papillae and/or hairs, 14.5 × 14.5 mm, lateral lobes 7.5 × 1.5 mm, upcurved, narrowly oblong-linear, truncate margin at apex, papillose, light pink to white at base, purple towards apex; middle lobe 9 × 9 mm, directed forwards with upcurved lobules, narrowly obcordate, light pink to white at base, purple towards apex, divided into 2 lobules with prominent tooth between; lobules 7 × 2.5 mm, upcurved, broadly oblong-linear, irregularly crenulate margin at apex; tooth 1.5 × 1 mm. Spur 5.5 × 2 mm, directed downwards, cylindrical, obtuse to slightly emarginate, light pink to purplish-green. Column 2.5 × 1 mm.

Phenology: Flowering middle of May.

Habitat and altitude: *Quercus* forest, 895 m.

Specimens examined: A3 Bolu: BAİBÜ central campus, north of Gölköy dam lake, *Quercus* forest, 820 m, 12 May 2015, Başaran 29 & Eker (AIBU)!

Regional conservation assessment: This hybrid taxon was only found at one locality in Gölköy and one individual was counted and sampled. However, there is no significant threat for its habitat for now.

Figure 4.47. *Orchis* × *angusticruris* – a) Habit, b) Inflorescence

4.1.45 ***Orchis mascula*** (L.) L. subsp. ***pinetorum*** (Boiss. & Kotschy) E.G.Camus

Plant (17.5−)20−52.5 cm, photosynthetic autotroph. Tubers subglobose or ellipsoid. Stem glabrous. Leaves 3−7(−9), spreading, obovate to oblong-lanceolate, acute, glabrous, green with or without blotch, (4.3−)6−12 × (0.6−)1−2(−2.3) cm. Inflorescence (3.5−)6−20 cm long, densely or somewhat loosely 10−40(−51) flowered, cylindrical. Bracts (8−)10−17(−22) × (1−)1.5−4 mm, suberect, lanceolate to linear-lanceolate, acuminate, glabrous, purple to light pink. Pedicel (including ovary) 10−22 × 1−4 mm, glabrous, green to suffused with purple. Lateral sepals 6−12 × (2−)2.5−4.5(−5) mm, deflexed to spreading, ovate to ovate-lanceolate, obtuse to acute, glabrous, purple to light pink; dorsal sepal 5−9(−10) × (1.5−)2−4 mm, more or less erect, ovate to oblong-lanceolate, obtuse to acute, glabrous, purple to light pink. Petals (4.5−)5−8(−9) × (1.5−)2−4.5 mm, obliquely ovate-lanceolate, obtuse, glabrous, purple to light pink. Labellum 3-lobed, whitish at center with purple blotches near base, (6.5−)8−12(−15) × (6−)7−11(−12) mm, lateral lobes 1−3(−4) × 1.5−3(−4) mm, directed forwards to deflexed, semiovate, rounded or rhombic, crenulate towards the apex, glabrous, purple to light pink; middle lobe (1.5−)2.5−5(−6) × (1.5−)3−6(−7) mm, directed forwards, subquadrate, emarginate or erose-truncate in front, glabrous, purple to light pink. Spur (6−)7−15(−16) × (1−)1.5−3(−3.5) mm, horizontal to directed upwards, cylindrical, dilated at tip, obtuse or mostly notched, purple to light pink. Column (1−)2−4 × 1−1.5 mm.

Phenology: Flowering from end of April to middle of June.

Habitat and altitude: Coniferous forest, *Abies* forest, *Fagus* forest, *Quercus* forest, *Pinus* forest and glades, 802−1443 m.

Specimens examined: A3 Bolu: BAİBÜ central campus, north of Gölköy dam lake, *Fagus* forest, 803 m, 1 May 2014, Başaran 2 & Eker (AIBU)!; ibid., Başaran 15 & Eker (AIBU)!; ibid., 1 May 2014, Başaran 16 & Eker (AIBU)!; Bolu-Aladağlar road, upper side of Karacasu plateau, 20 km from Karacasu, glades, 1404 m, 24 May 2015, Başaran 32 & Eker (AIBU)!; Seben, Bolu-Kıbrıscık road, 16 km from Bolu-Seben road, glades, 1318 m , 24 May 2015, Başaran 35 & Eker (AIBU)!; Seben, Bolu-Seben road, 1 km from Kıbrıscık crossroad to Seben, *Pinus* forest, 1443 m, 24 May 2015, Başaran 34 & Eker (AIBU)!; Yedigöller road, 4.3 km to Yedigöller, *Pinus* forest, 1268 m, 27 May 2015, Başaran 37 & Eker (AIBU)!; Seben, Aladağlar, Berk plateau, 2 km from Berk plateau crossroad, *Pinus* forest, 1361 m, 28 May 2015, Başaran 39 & Eker (AIBU)!; Seben, 2.30 km from Kizik village crossroad to the Kızık village, *Abies* forest, 1512 m, 28 May 2015, Başaran 40 & Eker (AIBU)!; Mudurnu, Abant-Taşkesti road, 3 km from Abant, Ekizoluk crossroad, *Abies* forest, 1407 m, 29 May 2015, Başaran 42 & Eker (AIBU)!; ibid., Başaran 43 & Eker (AIBU)!; Mudurnu, Sülüklügöl, northwest of the lake, glades, 1089 m, 31 May 2015, Başaran 54 & Eker (AIBU)!; north of Merkeşler village, 2 km from Merkeşler village crossroad, *Quercus* forest, 1048 m, 2 June 2015, Başaran 65 & Eker (AIBU)!; north of Merkeşler village, 5 km from Merkeşler village crossroad, glades, 1165 m, 2 June 2015, Başaran 66 & Eker (AIBU)!; north of Merkeşler village, 8 km from Merkeşler village crossroad, glades, 1204 m, 2 June 2015, Başaran 69 & Eker (AIBU)!; Mudurnu, Abant, 1.3 km northeast of Örencik plateau, glades, 1483 m, 19 June 2015, Başaran 116 & Eker (AIBU)!; Yedigöller road, Yığılca crossroad, *Abie*s and *Fagus* forest, 1184 m, 21 June 2015, Başaran 138 & Eker (AIBU)!; ibid., 1202 m, 3 August 2015 (in fruit), Başaran 339 & Eker (AIBU)!; Mudurnu, Abant-Taşkesti road, 3 km from Abant, around Ekizoluk crossroad, glades, 1396 m, 7 August 2015, Başaran 355 & Eker (AIBU)!; Yeniçağa-Bolu road, 7.30 km from Yeniçağa, *Quercus* forest, 1059 m, 22 April 2016, Başaran 425 & Eker (AIBU)!; **A4 Bolu:** Gerede, Koçumlar village, glades, 1352 m, 8 July 2015, Başaran 208 & Eker (AIBU)!

Regional conservation assessment: During field studies, 10 populations were determined. These populations show extensive spread and there is no significant threat for their habitats for now.

Figure 4.48. *Orchis mascula* subsp. *pinetorum*
a) Habit, b) Inflorescence

4.1.46 *Orchis pallens* L.

Plant 18−38.5(−49) cm, photosynthetic autotroph. Tubers subglobose or ovoid. Stem glabrous. Leaves (3−)4−6(−7), erect to spreading, ovate- lanceolate to oblong-ovate, obtuse to acute, glabrous, green without blotch, (7−)8−12(−13.5) × (1.2−)1.6−3.4 cm. Inflorescence (3.6−)4.3−11.5(−19.5) cm long, densely 13−29(−40) flowered, ovoid or oblong. Bracts (11.5−)13−22(−25) × 2−4(−5) mm, erect to suberect, lanceolate, acute, glabrous, green more or less yellowish-tinged on the margin. Pedicel (including ovary) (11−)12−22 × 1.5−2.5(−3) mm, glabrous, green. Lateral sepals (5−)6−9(−10) × (2.5−)3−5(−6.5) mm, deflexed to spreading, oblong-ovate, obtuse, glabrous, pale yellow; dorsal sepal 5−8(−8.5) × (2−)2.5−4(−5) mm, curving forwards converging with the petals, oblong-elliptic, obtuse, glabrous, pale yellow. Petals (3−)5−7(−7.5) × (2−)2.5−4(−5) mm, obliquely oblong-ovate, obtuse, glabrous, pale yellow. Labellum 3-lobed, pale yellow, yellow at center and near base, (6−)8−10(−12) × (6−)8−10(−12.5) mm; lateral lobes 1−2(−3) × (1−)1.5−2(−3.5) mm, directed forwards, orbiculate, with entire margin, minutely papillose, pale yellow;

middle lobe (1.5−)2−3(−4.5) × (2.5−)3.5−6(−7) mm, directed forwards, subquadrate, emarginate or erose-truncate in front, minutely papillose, pale yellow. Spur (7−)8−12(−14) × 1.5−2.5(−3) mm, directed upwards, cylindrical, obtuse, pale yellow. Column (1−)1.5−2(−3) × 1−2 mm.

Phenology: Flowering from middle of April to end of May.

Habitat and altitude: Coniferous forest, *Pinus* forest, *Abies* forest, glades and meadows, 847−1786 m.

Specimens examined: A3 Bolu: Yedigöller road, 1 km to Yığılca crossroad, coniferous forest, 867 m, 9 May 2015, Başaran 26 & Eker (AIBU)!; Kartalkaya, 2.3 km from Gökpınar plateau crossroad, on the Hıra plateau road, coniferous forest, 1531 m, 15 May 2015, Başaran 30 & Eker (AIBU)!; Bolu-Aladağlar road, 18 km from Karacasu, around Mühendisin Çeşmesi, glades, 1503 m, 24 May 2015, Başaran 31 & Eker (AIBU)!; Seben, Bolu-Seben road, 1 km from Kıbrıscık crossroad to Seben, *Pinus* forest, 1443 m, 24 May 2015, Başaran 33 & Eker (AIBU)!; Çaltepe, Merkeşler plateau, meadows, 1786 m, 27 May 2015, Başaran 38 & Eker (AIBU)!; Seben, 2.30 km from Kizik village crossroad to the Kızık village, *Abies* forest, 1512 m, 28 May 2015, Başaran 41 & Eker (AIBU)!; Mudurnu, Abant-Taşkesti road, 3 km from Abant, Ekizoluk crossroad, *Abies* forest, 1407 m, 29 May 2015, Başaran 44 & Eker (AIBU)!; Mudurnu, upper side of Örencik plateau, 1 km from the plateau, *Pinus* forest, 1476 m, 31 May 2015, Başaran 63 & Eker (AIBU)!; Aladağlar, around Beşpınarlar Nature Park, *Pinus* forest, 1380 m, 21 July 2015, Başaran 283 & Eker (AIBU)!; Çaltepe, Merkeşler plateau, meadows, 1824 m, 27 July 2015 (in fruit), Başaran 317 & Eker (AIBU)!; Bolu-Aladağlar road, 18 km from Karacasu, around Mühendisin Çeşmesi, glades, 1487 m, 29 July 2015 (in fruit), Başaran 318 & Eker (AIBU)!; Mudurnu, upper side of Örencik plateau, 1 km from the plateau, *Pinus* forest, 1473 m, 18 August 2015, Başaran 382 & Eker (AIBU)!; Göynük, Çubuk village plateau, north of Çubuk lake, meadows, 1417 m, 20 April 2016, Başaran 422 & Eker (AIBU)!; 11 km from Yedigöller road crossroad to Çaltepe, between Çaltepe and Çeletepe, northern foothills, *Abies* forest, 1329 m, 27 April 2016, Başaran 429 & Eker (AIBU)!; Seben, south of the Kızık village pond, glades, 1519 m, 9 June 2016, Başaran 504 & Eker (AIBU)!; Yedigöller road, 8.25 km from Anatolian highway, *Fagus* and *Pinus* forest, 1176 m, 16 June 2016 (in fruit), Başaran 517 & Eker

(AIBU)!; Mudurnu, Abant-Taşkesti road, 3 km from Abant, around Ekizoluk crossroad, glades, 1402 m, 21 June 2016, Başaran 527 & Eker (AIBU)!

Regional conservation assessment: During field studies, nine populations were determined. These populations show a wide spread and there is no significant threat for their habitats for now.

Figure 4.49. *Orchis pallens* – a) Habit, b) Flower

4.1.47 ***Orchis purpurea*** Huds. subsp. ***purpurea***

Plant (20−)30−66.5 cm, photosynthetic autotroph. Tubers subglobose or ellipsoid. Stem glabrous. Leaves 5−6(−8), erect to spreading, oblong-ovate to elliptic-lanceolate, obtuse, glabrous, green without blotch, (9−)12−17(−22) × (2−)2.5−4(−6) cm. Inflorescence (3.5−)4−14.5(−23.5) cm long, densely 21−71 flowered, cylindrical. Bracts 1.5−4(−25) × (1−)1.5−2.5(−4) mm, erect, ovate-lanceolate, obtuse to acute, whitish to purple. Pedicel (including ovary) (8.5−)9−18(−20) × 1−2 mm, glabrous, green to suffused with purple. Perianth segments united into a galea. Sepals greenish, with conspicuous dense blackish-purple or dark reddish-brown blotch. Lateral sepals 8−12(−14) × (3−)4−5(−6) mm, ovate, subobtuse to acute, glabrous; dorsal sepal 7.5−11.5(−13) × (3−)4−5.5(−9) mm, ovate, subobtuse to acute, glabrous. Petals (5−)6−9.5(−13) × 1−1.5(−2) mm, linear-lanceolate, subobtuse to acute, glabrous, pale pink or greenish with reddish-brown blotch. Labellum 3-lobed, reddish-purple papillose and tuft of long papillae and/or hairs, 9.5−18(−19) ×

12−22(−23) mm; lateral lobes (5−)6.5−10(−11.5) × 1.5−2.5 mm, directed forwards, oblong-linear, truncate margin at apex, white or light pink; middle lobe (6−)7−14(−18) × 7−14(−16) mm, directed forwards, obcordate, white or light pink , divided into 2 lobules with prominent tooth in between; lobules (2−)3.5−7.5 × 2.5−6 mm, directed forwards, broadly oblong-rhombic, irregularly crenulate margin at apex; tooth 1−2.5(−4) × 0.5 mm. Spur 4−6(−6.5) × 1.5−2(−2.5) mm, directed downwards, cylindrical, obtuse, greenish-white, more or less suffused with purple blotches. Column (1−)1.5−2(−2.5) × 1−1.5(−2) mm.

Phenology: Flowering from middle of April to end of May.

Habitat and altitude: *Quercus* forest, *Fagus* forest, grassy places and glades, 593−1515 m.

Specimens examined: A3 Bolu: BAİBÜ Central Campus, south of BAİBÜ social facilities, *Quercus* forest, 895 m, 12 May 2015, Başaran 28 & Eker (AIBU)!; Mudurnu, Sülüklügöl road, 3 km to the lake, glades, 816 m, 31 May 2015, Başaran 60 & Eker (AIBU)!; Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti, *Quercus* forest, 587 m, 24 June 2015 (in fruit), Başaran 144 & Eker (AIBU)!; Mengen, north of Afşar village, southeast foothills of Çaltepe, glades, 1043 m, 23 July 2015 (in fruit), Başaran 288 & Eker (AIBU)!; Seben, north of the Kızık village pond, glades, 1513 m, 5 August 2015 (in fruit), Başaran 347 & Eker (AIBU)!; Mudurnu, Taşkesti-Sülüklügöl road, northern slopes of Taşkesti, *Quercus* forest, 597 m, 16 April 2016, Başaran 421 & Eker (AIBU)!; Yeniçağa-Bolu road, 11.90 km from Yeniçağa, grassy places, 1099 m, 22 April 2016, Başaran 426 & Eker (AIBU)!; Abant road, 700 m from the crossroad of Akçaalan village to the village, grassy places, 906 m, 2 May 2016, Başaran 434 & Eker (AIBU)!; Karacasu-Gölcük road, 3 km to Gölcük, *Fagus* forest, 940 m, 5 May 2016, Başaran 439 & Eker (AIBU)!; north of Merkeşler village, 198 m from Merkeşler village crossroad, grassy places, 1005 m, 6 May 2016, Başaran 443 & Eker (AIBU)!; Mengen, Gökçesu-Mengen yolu, Gökçesu'dan 2.27 km sonra, glades, 593 m, 6 May 2016, Başaran 447 & Eker (AIBU)!; BAİBÜ central campus, north of Gölköy dam lake, *Quercus* forest, 817 m, 13 May 2016, Başaran 460 & Eker (AIBU)!; Seben, north of the Kızık village pond, glades, 1522 m, 14 May 2016, Başaran 461 & Eker (AIBU)!; Karacasu-Gölcük road, 1.66 km from Karacasu, *Fagus* forest, 844 m, 18 May 2016, Başaran 471 & Eker

(AIBU)!; Seben, north of the Kızık village pond, glades, 1515 m, 30 May 2016, Başaran 486 & Eker (AIBU)!; Gölcük village road, 480 m from Taşkesti-Abant road crossroad, glades, 725 m, 27 May 2017, Başaran 577 & Eker (AIBU)!; **A4 Bolu:** Yeniçağa, 950 m east of Çamlık village, grassy places, 1241 m, 24 May 2017, Başaran 573 & Eker (AIBU)!

Regional conservation assessment: During field studies, seven populations were determined. These populations show an extensive spread. There is no significant threat for habitats of five populations for now. However, the OPU573 population around Çamlık village/Yeniçağa is under the threat of grazing. The area where the OPU434 population located around Akçaalan village is also under grazing pressure. Thus, these populations need conservation.

Figure 4.50. *Orchis purpurea* subsp. *purpurea*
a) Habit, b) Inflorescence

4.1.48 ***Orchis simia*** Lam.

Plant (17.6−)19−37(−40.5) cm, photosynthetic autotroph. Tubers ovoid or ellipsoid. Stem glabrous. Leaves 5−6(−7), erect to spreading, oblong-lanceolate to ovate-lanceolate, obtuse to acute, glabrous, green without blotch, 7−12.5(−19) × 1.6−3.4 cm. Inflorescence 3−6.5(−10) cm long, densely (17−)20−42(−47) flowered, ovoid or broadly cylindrical, terminal flowers bloom first. Bracts 1−3(−12) × 1−2(−2.5) mm, erect, ovate-lanceolate, acuminate, white, greenish at base. Pedicel (including ovary)

(7−)8−11(−12) × (0.5−)1−1.5 mm, green to suffused with reddish-purple. Perianth segments united into a dense or loose galea with free tips. Sepals white to greyish-pink with pinkish-purple blotch and veins, suffused with greenish at base. Lateral sepals (8.5−)10−12(−14) × (2.5−)3−4(−4.5) mm, ovate-lanceolate, acuminate, glabrous; dorsal sepal (7.5−)10−11(−14) × 3−4(−4.5) mm, ovate-lanceolate, acuminate, glabrous. Petals (6−)7−10(−11) × 0.5−1 mm, linear to linear-lanceolate, acuminate, glabrous, white to greyish-pink with pinkish-purple blotch. Labellum 3-lobed, light pink to white at center and near base, with papillose and tuft of long papillae and/or hairs, (9−)11−14(−16) × (6−)8−14(−15) mm, lateral lobes (4−)5−7(−9) × 0.5−1 mm, upcurved, narrowly linear, obtuse, with entire margin, papillose, light pink to white at base, purple towards apex; middle lobe (6−)8−11(−12) × (3−)5−10(−11) mm, directed forwards with upcurved lobules, ligulate, light pink to white at base, purple towards apex, divided into 2 lobules with prominent tooth between; lobules (3−)4.5−6.5(−8) × 0.5−1(−1.5) mm, upcurved, narrowly linear, with entire margin, papillose, light pink to white at base, purple towards apex; tooth (0.5−)1−2(−4) × 0.5−1 mm. Spur 4−6 × 1−2 mm, directed downwards, narrowly cylindrical, obtuse to slightly emarginate, light pink to white. Column 1−2 × 0.5−1 mm.

Phenology: Flowering from end of April to end of May.

Habitat and altitude: *Quercus* forest, *Fagus* forest, *Pinus* forest, coniferous forest and glades, 802−1280 m.

Specimens examined: A3 Bolu: BAİBÜ central campus, north of Gölköy dam lake, *Quercus* forest, 803 m, 23 April 2014, Başaran 14 & Eker (AIBU)!; ibid., 26 May 2014, Başaran 19 & Eker (AIBU)!; north of Merkeşler village, 5 km from Merkeşler village crossroad, *Fagus* forest, 1165 m, 2 June 2015, Başaran 67 & Eker (AIBU)!; north of Merkeşler village, 198 m from Merkeşler village crossroad, *Quercus* forest, 1005 m, 6 May 2016, Başaran 442 & Eker (AIBU)!; Mengen, Gökçesu-Mengen yolu, Gökçesu'dan 2.27 km sonra, glades, 593 m, 6 May 2016, Başaran 448 & Eker (AIBU)!; BAİBÜ central campus, north of Gölköy dam lake, *Quercus* forest, 802 m, 13 May 2016, Başaran 452 & Eker (AIBU)!; Seben, Seben pond-Kuzgölcük village road, 5.81 km from Seben road crossroad, east of Kuzgölcük village, glades, 1280 m, 14 May 2016, Başaran 462 & Eker (AIBU)!; Göynük, Sünnet village-Alanköy road,

3.08 km from Sünnet village, *Pinus* forest, 1253 m, 16 May 2016, Başaran 466 & Eker (AIBU)!

Regional conservation assessment: During field studies, five populations were determined. These populations show a restricted spread. However, there is no significant threat for their habitats for now.

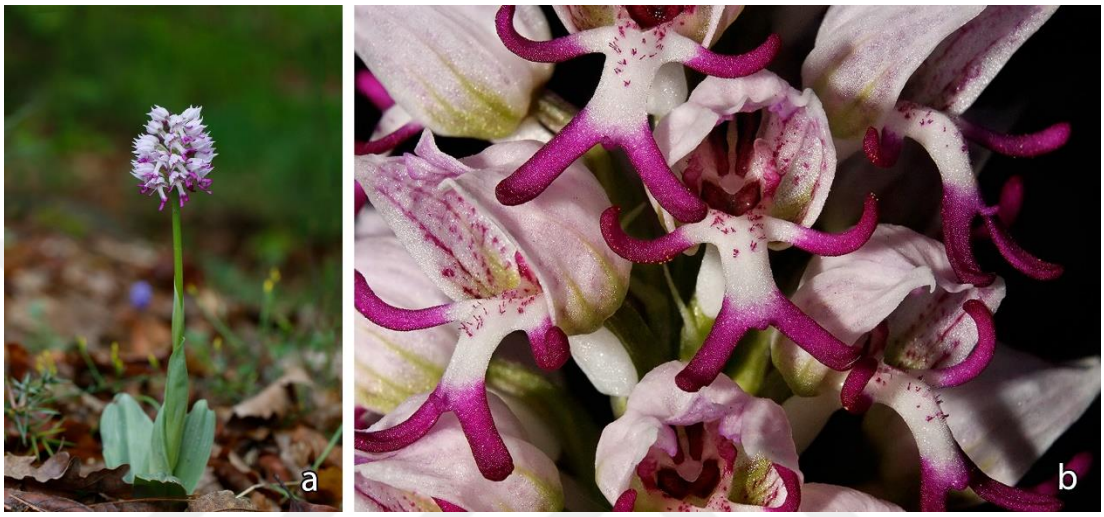


Figure 4.51. *Orchis simia* – a) Habit, b) Inflorescence

4.1.49 ***Orchis spitzelii*** Saut. ex W.D.J.Koch

Plant 19.5−28(−34) cm, photosynthetic autotroph. Tubers ovoid. Stem glabrous. Leaves 3−4(−5), spreading, oblong-lanceolate, obtuse, glabrous, green without blotch, (4.7−)5−10 × 1−1.7(−2) cm. Inflorescence 4.6−7.6(−9) cm long, densely or loosely (9−)10−14(−16) flowered, shortly cylindrical. Bracts 10−16(−19) × 1.5−2(−4) mm, erect to suberect, linear-lanceolate, acuminate, glabrous, brownish-purple. Pedicel (including ovary) 12−18 × 1.5−2 mm, glabrous, brownish-purple. Lateral sepals 7−8.5 × (2.5−)3−4 mm, deflexed to spreading, oblong-ovate, obtuse, glabrous, purplish to brownish green, inside mostly with red dots; dorsal sepal 6.5−8(−8.5) × 2.5−3 mm, curving forwards converging with the petals, oblong-ovate, obtuse, glabrous, purplish to brownish green. Petals 6−7(−9) × 2−2.5 mm, ovate-lanceolate, obtuse, glabrous, purplish to brownish green. Labellum 3-lobed, with pinkish-purple blotches at center and near base, 10−14 × 7−12 mm; lateral lobes (1−)2−3.5(−5.5) × 2.5−3 mm, deflexed, ovate, obtuse, entire to irregularly crenulate

margin at apex, glabrous, pinkish-purple; middle lobe (1.5−)2−3.5(−5) × 3.5−6 mm, directed forwards to deflexed, obovate, emarginate, crenulate margin at apex, minutely papillose, pinkish-purple. Spur (7.5−)8−10 × (2−)2.5−3(−3.5) mm, directed downwards, broadly conical, obtuse to acute, pinkish-purple. Column 4−5 × 0.5 mm.

Phenology: Flowering early June.

Habitat and altitude: Glades, 1519 m.

Specimens examined: A3 Bolu: Seben, south of the Kızık village pond, glades, 1519 m, 9 June 2016, Başaran 503 & Eker (AIBU)!; ibid., 3 June 2017, Başaran 581 & Eker (AIBU)!; ibid., 3 June 2017, Başaran 582 & Eker (AIBU)!

Regional conservation assessment: This taxon was only found at one locality in Seben. However, there is no significant threat for its habitat for now.

Figure 4.52. *Orchis spitzelii* – a) Habit, b) Inflorescence

4.1.50 ***Platanthera chlorantha*** (Custer) Rchb.

Plant (21.5−)27.4−50(−56) cm, photosynthetic autotroph. Tubers ovoid. Stem glabrous. Leaves 2−3, subopposite, suberect to spreading, oblong-obovate to elliptic, obtuse, glabrous, green without blotch, (5.3−)8−19 × 2.2−6.6 cm. Inflorescence 7.5−20.5(−23) cm long, densely or loosely (8−)10−25(−31) flowered, cylindrical. Bracts 11−25 × 2.5−5(−8) mm, suberect, lanceolate to narrowly lanceolate, acute,

glabrous, green. Pedicel (including ovary) (12−)13−18(−19) × 1−2 mm, glabrous, green. Lateral sepals 7−12 × 3.5−4.5(−5) mm, spreading, obliquely ovate-lanceolate, obtuse, more or less slightly undulate, glabrous, white at base, greenish towards apex; dorsal sepal 5−6(−6.5) × 5.5−7 mm, curving forwards converging with the petals, forming a shield over the petals, broadly cordate-ovate, obtuse, glabrous, green with slightly white-tinged on the margin. Petals 5−7 × 2−2.5 mm, linear-lanceolate, obtuse to acute, glabrous, pale green. Labellum undivided, 9−14(−17) × (1−)1.5−2.5 mm, more or less deflexed, linear, strap-shaped, with entire margin, glabrous, darker greenish, pale green or whitish at base. Spur 16−28 × 1−2 mm, horizontal to directed upwards, filiform, slightly inflated towards apex, obtuse to acute, pale green or whitish at base, darker green towards apex. Column 1.5−2 × 2 mm. Anther-cells convergent above and widely separated below.

Phenology: Flowering from middle of May to middle of July.

Habitat and altitude: Glades, *Quercus* forest, *Fagus* forest, *Pinus* forest, *Abies* forest and meadows, 862−1615 m.

Specimens examined: A3 Bolu: north of Merkeşler village, 2 km from Merkeşler village crossroad, *Quercus* forest, 1048 m, 2 June 2015, Başaran 64 & Eker (AIBU)!; Yeniçağa, Dereköy, *Pinus* forest, 1121 m, 12 June 2015, Başaran 78 & Eker (AIBU)!; Abant road, 1.5 km from Abant crossroad to Abant, *Quercus* forest, 813 m, 14 June 2015, Başaran 81 & Eker (AIBU)!; Çaltepe summit, meadows, 1884 m, 21 June 2015, Başaran 139 & Eker (AIBU)!; Yedigöller road, 2.5 km from Çelegölcük forest warehouse crossroad to Çelegölcük forest warehouse, *Quercus* forest, 1142 m, 26 June 2015, Başaran 152 & Eker (AIBU)!; Yedigöller, southeast of Yedigöller, *Quercus* forest, 1144 m, 11 July 2015, Başaran 218 & Eker (AIBU)!; Merkeşler village, Çaltepe road, southern foothills of Çaltepe, *Quercus* and *Pinus* forest, 1030 m, 12 July 2015 (in fruit), Başaran 229 & Eker (AIBU)!; 23 km from Kartalkaya-D100 crossroad to Kartalkaya, glades, 1605 m, 21 July 2015, Başaran 267 & Eker (AIBU)!; 22.5 km from Kartalkaya-D100 crossroad to Kartalkaya, glades, 1615 m, 21 July 2015, Başaran 270 & Eker (AIBU)!; beginning of Abant road, Bolu city forest, *Pinus* forest, 827 m, 25 July 2015 (in fruit), Başaran 294 & Eker (AIBU)!; northern foothills of Çaltepe-Çeletepe, *Quercus* and *Pinus* forest, 1315 m, 27 July 2015 (in fruit), Başaran 314 & Eker (AIBU)!; Bolu-Aladağlar road, upper side of

Karacasu plateau, 20 km from Karacasu, *Pinus* forest, 1420 m, 29 July 2015, (in fruit) Başaran 323 & Eker (AIBU)!; east of the Berk plateau pond, glades, 1419 m, 29 July 2015, Başaran 325A & Eker (AIBU)!; Mudurnu, Tavşansuyu-Taşkesti road, 1 km from Tavşansuyu, near the Akyokuş village crossroad, *Quercus* forest, 406 m, 7 August 2015 (in fruit), Başaran 353 & Eker (AIBU)!; Mengen, Gökçesu-Mengen road, 1 km from Gökçesu, *Pinus* forest, 567 m, 16 October 2015 (in fruit), Başaran 407 & Eker (AIBU)!; north of Merkeşler village, 2 km from Merkeşler village crossroad, *Quercus* forest, 1046 m, 16 October 2015 (in fruit), Başaran 410 & Eker (AIBU)!; Karacasu-Gölcük road, 1.66 km from Karacasu, *Fagus* forest, 844 m, 18 May 2016, Başaran 469 & Eker (AIBU)!; BAİBÜ central campus, between İzzet Baysal Arboretum and BAİBÜ social facilities, *Quercus* forest, 862 m, 25 May 2016, Başaran 482 & Eker (AIBU)!; north of Merkeşler village, 310 m from Merkeşler village crossroad, *Pinus* forest, 998 m, 4 June 2016, Başaran 494 & Eker (AIBU)!; Yedigöller road, 2.45 km from upper Çelegölcük forest warehouse crossroad to Çelegölcük forest warehouse, *Quercus* forest, 1196 m, 16 June 2016, Başaran 518 & Eker (AIBU)!; **A4 Bolu:** Yeniçağa, northeast of Yamanlar village, mountain road, glades, 1246 m, 24 May 2017, Başaran 571 & Eker (AIBU)!; Gerede, north of Gerede, 3 km from the Gerede traffic lights, plateau district, around Vahdettin Beyin fountain, *Pinus* forest, 1605 m, 1 July 2015, Başaran 163 & Eker (AIBU)!; Mengen, northeast of Mengen, east of Düzağaç village, *Fagus* forest, 1071 m, 1 July 2015, Başaran 178 & Eker (AIBU)!; Mengen, Bürnük village-Şirinyazı pond road, 650 m to the pond, *Pinus* forest, 1062 m, 14 July 2015 (in fruit), Başaran 263 & Eker (AIBU)!

Regional conservation assessment: During field studies, seven populations were determined. These populations show an extensive spread and there is no significant threat for their habitats for now.

Figure 4.53. *Platanthera chlorantha* – a) Habit, b) Inflorescence

4.1.51 ***Serapias bergonii*** E.G.Camus

Plant 22.6−39.6 cm, photosynthetic autotroph. Tubers ovoid. Stem glabrous, reddish-green. Leaves 3−6, erect to spreading, lanceolate, acute, glabrous, green without blotch, upper ones reddish tip, 7.3−11.6 0.7−1.6 cm. Inflorescence 4.6−14.6 cm long, loosely 2−9 flowered, elongate or condensed. Bracts 30−47 × 7−11 mm, erect, lanceolate, acuminate, glabrous, more or less greyish-pale red, with darker veins. Pedicel (including ovary) 12−15(−18) × 2−3.5 mm, glabrous, green and slightly suffused with reddish. Perianth segments straight, united into a galea with free tips. Lateral sepals 16−18 × 3.5−4 mm, lanceolate, acuminate, glabrous, more or less greyish-pale red; dorsal sepal 15.5−17.5 × 3.5−4.5 mm, lanceolate, acuminate, glabrous, more or less greyish-pale red. Petals 14−16 × 3−4.5 mm, ovate-lanceolate, acuminate, glabrous, slightly greyish-red. Labellum divided into hypochile and epichile, 18.5−23 × 8−12 mm; hypochile 7−9 × 8−12 mm, with involute parallel lateral lobes, partly hidden by galea, glabrous or slightly hairy, blackish-red; epichile 11−14 × 3.5−4.5 mm, strongly or slightly deflexed, narrowly lanceolate to oblong-lanceolate, brownish-red, hairy near base. Column 4.5−5 × 1 mm.

Phenology: Flowering from middle of May to middle of June.

Habitat and altitude: Grassland, 813−815 m.

Specimens examined: A3 Bolu: BAİBÜ central campus, north of Gölköy dam lake, grassland, 811 m, 26 May 2014, Başaran 22 & Eker (AIBU)!; Abant road, 1.5 km from Abant crossroad to Abant, grassland, 813 m, 14 June 2015, Başaran 82 & Eker (AIBU)!; ibid., 819 m, 25 July 2015 (in fruit), Başaran 295 & Eker (AIBU)!; Abant road, 1.5 km from Abant crossroad to Abant, grassland, 819 m, 20 May 2016, Başaran 481A & Eker (AIBU)!

Regional conservation assessment: During field studies, two populations were determined. The distribution of these populations is very limited. The area where the SBE82 population located on the Abant road, under grazing and human pressure, and there is a risk that the area will be transformed into settlement or agricultural area. The SBE22 population located in Gölköy is also under the threat of both grazing and agricultural activities. These populations need conservation.

Figure 4.54. *Serapias bergonii* – a) Habit, b) Inflorescence

4.1.52 ***Spiranthes spiralis*** (L.) Chevall.

Plant (10.5−)13−27.1 cm, photosynthetic autotroph. Tubers oblong-ellipsoid. Stem glandular-pubescent. Leaves 3−8(−9), erect to spreading, rosulate, basal leaves dying off before flowering, ovate-elliptical to lanceolate, acute, glabrous, green without blotch, 2.1−5 × 0.7−2 cm. Inflorescence 2−11.5 cm long, densely 6−28 flowered in one spiral row. Bracts 6−13 × 1.5−5 mm, erect, ovate-lanceolate, acuminate, glandular-pubescent, green and more or less white-tinged on the margin. Pedicel

(including ovary) 5−7 × 1.5−2.5 mm, glandular-pubescent, green. Lateral sepals 5−6 × 1.5−2 mm, spreading, ovate-lanceolate to oblong-lanceolate, obtuse, outer side slightly glandular-pubescent, white, greenish at base; dorsal sepal (4−)4.5−5(−6) × 1−2 mm, curving forwards to labellum converging with the petals, ovate-lanceolate to oblong-lanceolate, obtuse, outer side slightly glandular-pubescent, white, greenish at base. Petals 5−5.5 × 1 mm, linear lanceolate to oblong-lanceolate, obtuse, white, greenish at base. Labellum undivided, 4−6 × 2.5−4(−5) mm, directed forwards, slightly bent downwards in front, oblong-ovate, with upwardly curved, with irregularly crenulate-undulate margin, glabrous, white, yelowish-green at base. Column 1.5−2 × 0.5−1 mm.

Phenology: Flowering from end of August to end of September.

Habitat and altitude: Grassy places and glades, 595−1133 m.

Specimens examined: A3 Bolu: BAİBÜ central campus, north of the FEF laboratories, grassy places, 867 m, 16 September 2014, Başaran 24 & Eker (AIBU)!; Yedigöller road, 7.75 km from Anatolian highway, *Pinus* forest, 1133 m, 10 September 2015, Başaran 397 & Eker (AIBU)!; Mesciçele Village entrance, northwest of the village, grassy places, 1127 m, 17 September 2015, Başaran 404 & Eker (AIBU)!; north of Tetemeçele village, 480 m towards the mountain road, grassy places, 1079 m, 17 September 2015, Başaran 405 & Eker (AIBU)!; Mengen, Gökçesu-Mengen yolu, Gökçesu'dan 2.27 km sonra, glades, 595 m, 16 October 2015, Başaran 408 & Eker (AIBU)!; west of BAİBÜ central campus, grassy places, 839 m, 16 September 2015, Başaran 413 & Eker (AIBU)!; BAİBÜ central campus, north of the FEF laboratories, grassy places, 867 m, 18 September 2015 (in fruit), Başaran 414 & Eker (AIBU)!; **A4 Bolu:** Mengen, east of Düzağaç village, 700 m to the village, grassy places, 992 m, 1 September 2015, Başaran 388 & Eker (AIBU)!

Regional conservation assessment: During field studies, five populations were determined. The taxon has a restricted spread. There is no significant threat for habitat of one population for now. However, habitats of the SSP397 population on the Yedigöller road, the SSP404 around Mesciçele village and the SSP405 population around Tetemeçele village are under grazing pressure. The population of SSP413, located on the central campus of BAİBÜ, is also cut every year due to the

lawn mowing activities carried out in certain periods. Thus, this situation prevents the seed propagation of individuals in population. These four populations need conservation.

Figure 4.55. *Spiranthes spiralis* – a) Habit, b) Inflorescence

4.1.53 ***Steveniella satyrioides*** (Spreng.) Schltr.

Plant 15.3−43 cm, photosynthetic autotroph. Tubers oblong-ovate. Stem glabrous. Leaf 1 (with a single leaf at the base), spreading, oblong-lanceolate to ovate-lanceolate, acute, glabrous, dark olive-green, longitudinally striped above with brownish-purple, flushed beneath with purple, (6.5−)9−14.2(−16.5) × 1.7−5.3 cm. Inflorescence 3.1−13 cm long, densely 8−21 flowered, cylindrical. Bracts 1.5−10 × 1−2.5 mm, erect to suberect, lanceolate to ovate, acuminate, glabrous, whitish to reddish-brown. Pedicel (including ovary) 7−10(−14.5) × (1−)1.5−4 mm, glabrous, green to dusty reddish-brown. Sepals united into a hood with free tip; lateral sepals 6−10 mm long, looks like ovate, acute, glabrous, green to dusty reddish-brown; dorsal sepal 5.5−9.5 mm long, looks like oblong-ovate, glabrous, green to dusty reddish-brown. Petals 2−4.5 × 0.5 mm, linear, obtuse to acute, glabrous, green to reddish-brown. Labellum 3-lobed, yellowish-green to brownish-green, reddish-brown at base, 5−7(−8) × 3−6 mm; lateral lobes 1−2 × 1−2 mm, directed forwards, rhombic, with entire margin, papillose; middle lobe (1.5−)2−4.5(−5) × 1−2.5 mm, directed forwards, oblong, ligulate, rotund, with entire margin, papillose, yellowish-

green to brownish-green. Spur 1.5−3.5 × 1.5−4 mm, broadly conical, notched at apex and mostly distinctly biconical, dusty reddish-brown, lighter at tip. Column 2−3.5 × 0.5−1 mm.

Phenology: Flowering from end of April to end of May.

Habitat and altitude: Grassy places, *Pinus* forest and glades, 725−1028 m.

Specimens examined: A3 Bolu: Göynük, between Dedeler village and Susuz village, 1.50 km from Dedeler village, *Pinus* forest, 791 m, 26 April 2017, Başaran 554 & Eker (AIBU)!; BAİBÜ central campus, north of Gölköy dam lake, *Quercus* forest, 800 m, 5 May 2017, Başaran 565 & Eker (AIBU)!; Bolu-Yeniçağa road, around Afşar village cemetery, *Pinus* forest, 966 m, 24 May 2017, Başaran 569 & Eker (AIBU)!; Gölcük village road, 480 m from Taşkesti-Abant road crossroad, glades, 725 m, 27 May 2017, Başaran 576 & Eker (AIBU)!; Mudurnu, Abant-Taşkesti road, 6 km from Gölcük village crossroad, İğneciler village, glades, 869 m, 29 May 2015, Başaran 47 & Eker (AIBU)!; Mudurnu, Sülüklügöl road, 3 km to the lake, glades, 816 m, 31 May 2015, Başaran 59 & Eker (AIBU)!; Abant road, west of Akçaalan village, mountain road, 410 m from village, glades, 1028 m, 2 May 2016, Başaran 436 & Eker (AIBU)!

Regional conservation assessment: During field studies, four populations were determined. These populations show a restricted spread. However, there is no significant threat for their habitats for now.

Figure 4.56. *Steveniella satyrioides* – a) Habit, b) Inflorescence

4.2 Results of Numerical Analyses

In the numerical evaluation of all taxa, principle component and cluster analyses were used to analyse the variation of 43 morphological characters measured for 57 OTUs. The character states are listed in (Appendix B.1).

In PCA analyses, the first two components gave a result which contained 42.9% of the variations (Appendix C.1). Therefore, first and second components are graphed as a result of PCA (Figure 4.57) and it was interpreted. In PCA graph, the taxa of *Cephalanthera* Rich., *Corallorhiza* Gagnebin, *Epipactis* Zinn, *Epipogium* Borkh., *Himantoglossum* Spreng., *Limodorum* Boehm., *Neottia* Guett., *Ophrys* L., *Platanthera* Rich., *Serapias* L. and *Spiranthes* Rich. were clearly separated from taxa belonging to other genera which constitute a "complex group (*Anacamptis* Rich., *Coeloglossum* Hartm., *Dactylorhiza* Neck. ex Nevski, *Neotinea* Rchb.f., *Orchis* Tourn. ex L.)" (Figure 4.57). However *Steveniella satyrioides* and *Ophrys fusca* took place around the complex group. The taxa which were separated from the complex group, were divided into small subgroups close to or distant. The *Limodorum* taxa were located as the furthest subgroup from the other taxa. *Epipogium aphyllum, Corallorhiza trifida* and *Spiranthes spiralis* followed them. The *Cephalanthera* and *Epipactis* species, which formed two distinct subgroups and were distinctly separated from the complex group, were located close to *Serapias bergonii* and *Neottia nidus-avis*, respectively. *Platenthera chlorantha* was also separated from the complex group, but was located as close to *O. fusca*. *Anacamptis papilionacea* subsp. *papilionacea* also took place quite far from other *Anacamptis* taxa found in the complex group. *Himantoglossum* and *Ophrys* taxa were quite distant from the other taxa, but close to each other. The *Ophrys* taxa were conspicuously distant from each other. *Orchis simia*, *O. purpurea* subsp. *purpurea* and their hybrid taxon were seperated from the other taxa and not included in complex group unlike other *Orchis* taxa. The complex group including *S. satyrioides* and *O. fusca* were run for PCA analysis separately from the other taxa (Figure 4.58). In PCA analysis of complex group, the first two components gave a result which contained 40.5% of the variations (Appendix C.2). In this situation, *S. satyrioides* and *O. fusca* were clearly separated from the compex group. The taxa belonging to *Anacamptis* (except for *A. papilionacea* subsp. *papilionacea*), *Coeloglossum*, *Dactylorhiza*, *Neotinea* and

Orchis genera still constituted this complex group. However, taxa of *Dactylorhiza* were relatively isolated than *Orchis* and *Neotinea* taxa and classified as two subgroups under the complex group. The *Anacamptis* taxa were divided into two subgroups. On the other hand, *Anacamptis laxiflora* subsp. *laxiflora* and *A. palustris* subsp. *palustris* mixed to *Dactylorhiza* taxa while *A. morio* subsp. *morio*, *A. coriophora* subsp. *coriophora*, *A. pyramidalis* and *A. x parvifolia* mixed to *Orchis* and *Neotinea* taxa. In addition to this, *Coeloglossum viride* took place between two subgroup, but nearer to *Orchis-Neotinea* group.

The results of cluster analysis can be explained as follows (Figure 4.67): All clusters were generated in two main groups at the similarity levels of 22.95–94.21% (MG-I & MG-II). In MG-I and MG-II OTUs showed heterogenous and homogenous clusters. In MGI, eleven small clusters were generated. Subgroup-I (SG-I) contained heterogenous two subclusters (including *Coeloglossum viride*, *Neotinea tridentata*, *Dactylorhiza romana* subsp. *romana*, *D. iberica*, all *Anacamptis* taxa except *A. palustris* subsp. *palustris* and *A. papilionacea* subsp. *papilionacea*, all *Orchis* taxa except *Orchis simia*, *O. purpurea* subsp. *purpurea* and *O.* × *angusticruris*). At 87.06% similarity level (SL), ACO–NTR were combined with DIB and then the CVI linked to this group at 82.97% SL. The second subcluster in SG-I, OMA–OPA were combined with ALA at 87.08% SL, and then AMO–ALAC and OSP was joined to this group at 84.38% SL. After that, DRO–OAN linked to this group at 82.27% SL, but the APY showed some differences and was joined to second subcluster in SG-I at 79.61% SL. And then, these two subclusters linked to each other at 78.85% in SG-I. Another subgroup (SG-II) contained homogenous clusters except *A. palustris*. DIBNC–DINN and DNI–DUR were combined at 89.61% SL and DIBI joined them at 87.00% SL. DIBNB–DSA were combined with DIN at 85.10% SL. This subcluster was linked to the DIBNC–DINN–DNI–DUR–DIBI at 83.55% SL and then APA was joined to this group at 80.93% SL. After that DIBNA–DIBND linked to the above mentioned subclusters at 78.32% SL. And then, DIBUA–DIBUB was joined to this group at 77.87% SL. Thus, SG-I merged with SG-II at 75.05%. The other subgroup (SG-III) included only STR which was joined the clusters of subgroups SG-I and SG-II at 63.83% SL. And then, APP (SG-IV) joined to previous three groups at 60.87% SL. Later, OSI linked to OPU and OPUS at 75.87% SL, and these three OTUs which constituted SG-V were joined to first four SGs at 60.18%

SL. In the other subgroup (SG-VI), OTP and OTR were combined at 81.25% and then OFU was joined to this group at 68.10% SL. After that, OAP and OOE was joined to the OFU–OTP–OTR group at 64.44% SL. Then, SG-VI and firts five subgroups were combined at 55.99% SL. Both SG-V and SG-VI contained homogenous clusters. All *Ophrys* taxa were placed in the SG-VI. The other heterogenous cluster (SG-VII) including CTR–SSP–NNI was linked to firts six subgroups at 53.16% SL. After that, homogenous cluster SG-VIII including HAF–HCA–HCO was joined to the previous subgroups at 50.82%. SG-IX including only PCH joined to the clusters of eight subgroups at 46.42% SL. CRU–SBE and CLA–CEP–CLO combined at 71.41% SL and formed the SG-X. EMI–EPO then linked to EHE–ETU–EPA–EPE group at 98.33% SL and constituted a homogenous cluster (SG-XI). That is, all *Epipactis* OTUs placed in the same cluster. Then, these two clusters (SG-X and SG-XI) linked to each other at 63.30% SL. Finally, SG-X and SG-XI were linked to the above mentioned SGs at 45.77% SL. This formed the first major group (MG-I). In the second major group (MG-II), two small clusters were generated. At 87.06% SL, LAB–LRU (SG-XIII) were combined and then EAP (SG-XII) linked to this group at 54.45% SL. This formed the second major group (MG-II). As a final result of the cluster analysis, MG-I and MG-II combined at 22.95% SL.

4.2.1 The genus *Anacamptis*

In the numerical evaluation of taxa belonging the genus *Anacamptis*, principle component and cluster analyses were used to analyse the variation of 24 morphological characters measured for 28 OTUs which were at the population level. The character states are listed in Appendix B.2.

In PCA analyses, the first two components gave a result which contained 51.6% of the variations (Appendix C.3). Therefore, first and second components are graphed as a result of PCA (Figure 4.59) and it was interpreted. The populations of *Anacamptis* taxa were divided into five groups close to or distant. *Anacamptis papilionacea* subsp. *papilionacea* was located in the furthest distance than other taxa. The populations of *A. coriophora* subsp. *coriophora* were also settled

homogeneously and far from the remain taxa. *Anacamptis morio* subsp. *morio* populations formed a relatively homogeneous group, but were located as close to *A.* × *parvifolia*. The populations of *A. pyramidalis* which formed a distinct group, were located as close to the heterogeneous group of *A. laxiflora* subsp. *laxiflora-A. palustris* subsp. *palustris*. In the heterogeneous group, the APA70 population was located a bit away from the populations of *A. laxiflora* subsp. *laxiflora,* while APA73 was mixed to populations of *A. laxiflora* subsp. *laxiflora*.

In cluster analyses, populations belonging to the genus *Anacamptis* were clustered as follows (Figure 4.68): All clusters were generated in two main groups at the similarity levels of 20.96–100.00% (MG-I & MG-II). Above 66.17% SL, six SGs appeared under MG-I. In SG-I, ACO83–ACO130–ACO506–ACO505 populations were combined to each other at 100.00% SL while ACO77–ACO167 populations were combined to each other at 100.00% SL. Howewer, these two subclusters showed some differences and was joined to each other at 89.52% SL. Then, ALAC87 (SG-II) linked to SG-I at 64.72% SL. In SG-III, all *Anacamptis morio* subsp. *morio* populations were combined at 100.00% SL and then linked to SG-I and SG-II at 56.14% SL. On the other hand, ALA80–ALA120–ALA454 populations (SG-IV) and APA70–APA73 populations (SG-V) were combined at 66.17% SL. Then, APY populations (SG-VI) merged with SG-IV and SG-V at 63.45% SL. In SG-VI, APY147–APY182–APY191–APY225–APY221 populations were combined highly similar to each other at 100.00% SL and APY237–APY548 populations also were combined to each other at 100.00% SL. Finally, SG-IV–SG-V–SG-VI were linked to the above mentioned SGs (SG-I–SG-I–SG-III) at 63.45% SL. As a final result of the cluster analysis, MG-I and MG-II (APP418) combined at 20.96% SL.

4.2.2 The genus *Cephalanthera*

In the numerical evaluation of taxa belonging the genus *Cephalanthera*, principle component and cluster analyses were used to analyse the variation of 24 morphological characters measured for 28 OTUs which were at the population level. The character states are listed in Appendix B.3.

In PCA analyses, the first two components gave a result which contained 66.4% of the variations (Appendix C.4). Therefore, first and second components are graphed as a result of PCA (Figure 4.60) and it was interpreted. The populations of *Cephalanthera* taxa were divided into three groups quite distant. *Cephalanthera rubra* was located in the furthest distance than other taxa and its populations formed a homogeneous group. The populations of *C. epipactoides* were also settled homogeneously and far from the remain taxa, but the CEP85 population was located a bit away from the other *C. epipactoides* populations. The last group which was contain two different taxa of populations. This heterogeneous group composed of *C. damasonium* and *C. longifolia populations.* The CDA501 and CLO46 populations were located a bit away from the populations in this group.

In cluster analyses, populations belonging to the genus *Cephalanthera* were clustered as follows (Figure 4.69): All clusters were generated in two main groups at the similarity levels of 6.23–100.00% (MG-I & MG-II). Above 60.62% SL, three SGs appeared under MG-I. In SG-I, CDA502–CDA45–CDA468 populations were highly similar to each other at 100.00% SL and CDA167–CDA207 populations linked to this group at 83.42% SL. Later, CDA170 were combined at 78.10% SL and then, CDA528 at 75.79% SL. After that, CDA501 merged with this group at 72.29% SL. In SG-II, CLO451–CLO431 were combined at 100.00% SL and CLO440–CLO36 were linked to this subcluster at 83.42% SL. Then, CLO46 added to this group at 82.01% SL. After that, SG-I merged with SG-II at 60.62% SL. Finally, the last cluster in MG-I which contain CEP populations (SG-III) were linked to SG-I and SG-II at 38.54% SL. Also, CEP444 and CEP49 were highly similar to each other at 100.00% SL in SG-III. MG-II contained only *Cephalanthera rubra* populations. At 100.00% SL, CRU19–CRU190–CRU146–CRU200–CRU489–CRU94–CRU220 were highly similar to each other, but the CRU250–CRU13 populations showed some differences and were joined to this group at 83.42% SL. As a final result of the cluster analysis, MG-I and MG-II combined at 6.23% SL.

4.2.3 The genus *Dactylorhiza*

In the numerical evaluation of taxa belonging the genus *Dactylorhiza*, principle component and cluster analyses were used to analyse the variation of 19 morphological characters measured for 41 OTUs which were at the population level. The character states are listed in Appendix B.4.

In PCA analyses, the first two components gave a result which contained 47.4% of the variations (Appendix C.5). Therefore, first and second components are graphed as a result of PCA (Figure 4.61) and it was interpreted. The populations of *Dactylorhiza* taxa were divided into ten groups. *Dactylorhiza romana* subsp. *romana* was located in the furthest distance than other taxa and its populations formed a homogeneous group. The populations of *D. iberica and D. saccifera* subsp. *bithynica* were also settled homogeneously and far from the remain taxa. *Dactylorhiza incarnata* subsp. *incarnata* populations formed a homogeneous group and were located to abovementioned two groups equidistant. *Dactylorhiza urvilleana* subsp. *ilgazica* which formed a distinct homogeneous group, were located as close to the heterogeneous group of *D. nieschalkiorum-D.* × *abantiana-D.* × *balabaniana.* The other *D.* × *balabaniana* population (DIBU619B) was located away from that heterogeneous group. Another *D.* × *abantiana* population (DIBN596B) was also located away from the other *D.* × *abantiana* hybrid groups in the heterogeneous group. *Dactylorhiza* × *vogtiana* (DIBI599) and *D* × *renzii* (DINN595) were formed distinct groups away from the other taxa and relatively located in the center of all taxa.

In cluster analyses, populations belonging to the genus *Dactylorhiza* were clustered as follows (Figure 4.70): All clusters were generated in two main groups at the similarity levels of 20.95–100.00% (MG-I & MG-II). In MG-I, eight SGs were generated. In SG-I, DIB597–DIB612–DIB592–DIB146–DIB206–DIB252 were highly similar to each other at 100.00% SL, but DIB210 population showed some differences and was joined to this group at 85.86% SL. In SG-II, DRO424 was linked to DRO567 at 100.00% SL and DRO484 population was joined to them at 80.01% SL. After that, SG-I and SG-II linked to each other at 46.14% SL. In SG-IV, DSA601–DSA590–DSA326–DSA273 populations were 100.00% similar and

DSA324 was linked to them at 85.86% SL. Then, 100.00% similar DSA255–DSA123 populations were added at 84.69% SL. After that, DSA176 was joined to this group at 78.08% SL. Finally, SG-IV merged with SG-III (DINN595) at 58.51% SL. After that, SG-I–SG-II was joined to SG-III–SG-IV at 40.92% SL. In the other cluster, all DIBN OTUs (DIBN594A–DIBN623C–DIBN623D–DIBN596B) were placed in the same subgroup (SG-V). Then, SGVI including DIBU618A–DIBU619B was joined to SG-V at 57.12% SL. In SG-VII, DNI598–DNI628–DNI213–DNI187–DNI157 were combined at 100.00% SL. Then, 100.00% similar DNI622 and DNI627 populations were joined to this group at 85.86% SL. After that, DNI155 was added at 84.19% SL. In the last SG of MG-I (SG-VIII), DUR608–DUR621–DUR624 were combined at 100.00% SL and DUR626 was joined to them at 85.86% SL. Then, SG-VII merged with SG-VIII at 69.25% SL. Thus, SG-V and SG-VI with SG-VII and SG-VIII combined at 69.25% SL. Finally, SG-V–SG-VI–SG-VII–SG-VIII were linked to the above mentioned SGs (SG-I–SG-I–SG-III–SG-IV) at 37.93% SL. In MG-II, two SGs were generated. In SG-X, DIN111 and DIN171 were 100.00% similar each other. Then, DIN625 was added to this group at 85.86% SL. After that, DIBI599 (SG-IX) was linked to SG-X at 58.38%. As a final result of the cluster analysis, MG-I and MG-II combined at 20.95% SL.

4.2.4 The genus *Epipactis*

In the numerical evaluation of taxa belonging the genus *Epipactis*, principle component and cluster analyses were used to analyse the variation of 19 morphological characters measured for 23 OTUs which were at the population level. The character states are listed in Appendix B.5.

In PCA analyses, the first two components gave a result which contained 70.6% of the variations (Appendix C.6). Therefore, first and second components are graphed as a result of PCA (Figure 4.62) and it was interpreted. The populations of *Epipactis* taxa were divided into five groups. *Epipactis palustris* and *E. microphylla* were located in the furthest distance than other taxa and their populations were settled homogeneously. The populations of *E. pontica* also formed a homogeneous group and far from the remain taxa. *Epipactis persica* populations also formed a

homogeneous group and were located as close to *E. helleborine-E. turcica* heterogeneous group. However, EPE332 population was located a bit away from the other two population in its group.

In cluster analyses, populations belonging to the genus *Epipactis* were clustered as follows (Figure 4.71): All clusters were generated in two main groups at the similarity levels of 16.16–100.00% (MG-I & MG-II). Above 61.72% SL, five SGs appeared under MG-I. In SG-I, EHE281–EHE285–EHE330–EHE204 populations were combined at 100.00% SL and EHE236 joined to this group at at 82.10% SL. Then, EHE287 and EHE311 linked to this group at 71.95% SL. The SG-II including *E. turcica* populations (ETU535–ETU195–ETU268–ETU331) was linked to SG-I at 61.72% SL. ETU195–ETU268–ETU331 merged at 100.00% SL in this SG. Then, SG-III including EPE populations (EPE346–EPE366–EPE332) joined to SG-I and SG-II at 54.16% SL. After that, SG-IV (EPO340) was linked to them at 40.44% SL. Later, *E. palustris* populations constituted SG-V. EPA253 merged with EPA245 at 100.00% SL in this SG and EPA304 was linked to them at 76.10% SL. In MG-II contained only *E. microphylla* populations. At 100.00% SL, EMI278 and EMI588 were highly similar to each other, but the EMI305 population showed some differences and was joined to this group at 83.10% SL. After that, EMI194 was linked to them at 80.76% SL. As a final result of the cluster analysis, MG-I and MG-II combined at 16.16% SL.

4.2.5 The genus *Himantoglossum*

In the numerical evaluation of taxa belonging the genus *Himantoglossum*, principle component and cluster analyses were used to analyse the variation of 19 morphological characters measured for 14 OTUs which were at the population level. The character states are listed in Appendix B.6.

In PCA analyses, the first two components gave a result which contained 87.8% of the variations (Appendix C.7). Therefore, first and second components are graphed as a result of PCA (Figure 4.63) and it was interpreted. The populations of *Himantoglossum* taxa were divided into three groups quite distant and all taxa were settled homogeneously. HCA514 and HCA141 populations were located a bit away

from the other populations of *H. caprinum* group. The third homogeneous group, *H. comperianum,* which located quite distance from the other two taxa, was consists of three populations a bit away from each other.

In cluster analyses, populations belonging to the genus *Himantoglossum* were clustered as follows (Figure 4.72): All clusters were generated in two main groups at the similarity levels of 4.61–100.00% (MG-I & MG-II). Above 68.20% SL, two SGs appeared under MG-I. In SG-II, HCA185–HCA298–HCA223–HCA227 populations were highly similar to each other at 100.00% SL and 100% similar HCA231–HCA531–HCA232–HCA240 populations linked to this group at 84.58% SL. Then, 100% similar HCA141 and HCA514 populations was joined at 81.38% SL. After that, HAF551 (SG-I) merged with SG-II at 68.51% SL. In MG-II contained only *H. comperianum* populations. HCO575 and HCO543 were combined at 78.19% SL and HCO203 linked to this group at 73.28% SL. As a final result of the cluster analysis, MG-I and MG-II combined at 4.61% SL.

4.2.6 The genus *Limodorum*

In the numerical evaluation of taxa belonging the genus *Limodorum*, principle component and cluster analyses were used to analyse the variation of 4 morphological characters measured for 9 OTUs which were at the population level. The character states are listed in Appendix B.7.

In PCA analyses, the first two components gave a result which contained 76.1% of the variations (Appendix C.8). Therefore, first and second components are graphed as a result of PCA (Figure 4.64) and it was interpreted. The populations of *Limodorum* taxa were divided into seven groups distant. The populations of *Limodorum abortivum* var. *abortivum*, consisted of four distinct groups that one of them composed of three populations. LAB549 population was quite far from the other populations of this taxon. The three populations of *Limodorum abortivum* var. *rubrum* were formed three distinct groups. On the other hand, the LAB499 and LRU591 populations belonging to infraspesific taxa were located closer to each other than the other populations.

In cluster analyses, populations belonging to the genus *Limodorum* were clustered as follows (Figure 4.73): All clusters were generated in two main groups at the similarity levels of 20.26–100.00% (MG-I & MG-II). In MG-I, contained only *Limodorum abortivum* var. *abortivum* populations. At 100.00% SL, LAB519–LAB547–LAB490 were highly similar to each other, but the LAB499–LAB509 populations showed some differences and was joined to this group at 50.00% SL. Then, LAB549 merged with this group at 26.12% SL. In MG-II, LRU602 joined to LRU591 at 83.10% SL. After that, LRU580 was linked to them at 39.65% SL. As a final result of the cluster analysis, MG-I and MG-II combined at 20.06% SL.

4.2.7 The genus *Ophrys*

In the numerical evaluation of taxa belonging the genus *Ophrys*, principle component and cluster analyses were used to analyse the variation of 31 morphological characters measured for 19 OTUs which were at the population level. The character states are listed in Appendix B.8.

In PCA analyses, the first two components gave a result which contained 67.7% of the variations (Appendix C.9). Therefore, first and second components are graphed as a result of PCA (Figure 4.65) and it was interpreted. The populations of *Ophrys* taxa were divided into five groups. The populations of all taxa were settled homogeneously. *Ophrys fusca* subsp. *thracica* was located in the furthest distance than other taxa. *Ophrys transhyrcana* subsp. *paphlagonica* group were located as close to *O. tremoris* group. One of the *O. transhyrcana* subsp. *paphlagonica* population (OTP563) was located a bit away from populations in its group. On the other hand, *O. apifera* and *O. oestrifera* subsp. *oestrifera* populations which formed two distinct homogeneous groups, were located to above mentioned two groups quite distant.

In cluster analyses, populations belonging to the genus *Ophrys* were clustered as follows (Figure 4.74): All clusters were generated in two main groups at the similarity levels of 13.14–100.00% (MG-I & MG-II). Above 52.28% SL, four SGs appeared under MG-I. In SG-I, all *O. apifera* populations (OAP511–OAP483–OAP179–OAP100–OAP493) were combined at 100.00% SL. In SG-II, OOE433–

OOE455–OOE495 were combined at 100.00% and OOE184–OOE491 was linked to them at 91.92%. *Ophrys oestrifera* subsp. *oestrifera* populations (SG-II) joined to SG-I at 52.28% SL. In SG-III, OTP464–OTP507–OTP500 were combined at 100.00% SL and OTP428 and OOE446 were linked to them at 93.31%. Then, OTP417 joined to them at 91.09% SL and OTP563 merged with this group at 84.04% SL. The last SG of MG-I (SG-IV), contained only *O. fusca* subsp. *thracica* population (OFU559). SG-IV combined with SG-I–SG-II and SGIII at 34.28% SL. In MG-II contained only *O. tremoris* population (OTR487). As a final result of the cluster analysis, MG-I and MG-II combined at 13.14% SL.

4.2.8 The genus *Orchis*

In the numerical evaluation of taxa belonging the genus *Anacamptis*, principle component and cluster analyses were used to analyse the variation of 24 morphological characters measured for 36 OTUs which were at the population level. The character states are listed in Appendix B.9.

In PCA analyses, the first two components gave a result which contained 69.3% of the variations (Appendix C.10). Therefore, first and second components are graphed as a result of PCA (Figure 4.66) and it was interpreted. The populations of *Orchis* taxa were divided into eight groups close to or distant. The populations of all taxa were settled homogeneously. *Orchis spitzelii* was located in the furthest distance than other taxa. *Orchis mascula* subsp. *pinetorum* and *O. pallens* groups were placed very close to each other, but homogeneously. The populations of *Orchis anatolica* were located away from the *O. spitzelii* group, but close to these above mentioned two groups. The populations of *Orchis purpurea* subsp. *purpurea* were formed two distinct group which contained three populations in each. The hybrid taxon *O.* × *angusticruris* (OPUS29) was settled between *Orchis purpurea* subsp. *purpurea* and *Orchis simia* homogenous groups.

In cluster analyses, populations belonging to the genus *Orchis* were clustered as follows (Figure 4.75): All clusters were generated in two main groups at the similarity levels of 15.74–100.00% (MG-I & MG-II). Above 78.84% SL, seven clusters appeared under MGs. In MG-I, four SGs were generated. In SG-I, all *O.*

anatolica populations (OAN423–OAN564–OAN558–OAN556) were combined at 100.00% SL. In SG-II, OPA26–OPA30–OPA31 merged at 100.00% SL and the other subcluster in this SG, OPA33–OPA38–OPA41–OPA44–OPA63–OPA104 were also combined at 100.00% SL. After that, these two subclusters merged at 92.22% SL. Then, SG-II joined to SG-I at 73.08% SL. In SG-III, OMA32–OMA37–OMA42–OMA69–OMA34–OMA138–OMA453–OMA425–OMA80–OMA645 were highly similar to each other at 100.00% SL and this subgroup combined with SG-I and SG-II at 70.97% SL. The last SG of MG-I (SG-IV), contained only *O. spitzelii* population (OSP581). SG-IV combined with SG-I–SG-II–SGIII at 62.59% SL. In MG-II, three SGs were generated. In SG-V, OPU434–OPU447–OPU426 combined at 100.00% SL. In the other subcluster in this SG, OPU486–OPU439–OPU460 also were combined at 100.00% SL. After that, these two clusters merged at 88.99% SL. In SG-VII, OSI452 and OSI462 combined at 100.00% SL while OSI442 and OSI29 were combined at 100.00% SL. After that, these two subclusters merged at 92.22% SL. Then, OSI466 joined to them at 90.61% SL. SG-VI contained only *O.* × *angusticruris* (OPUS29) was linked to SG-VII at 78.84% SL. Finally, SG-V was linked to SG-VI and SG-VII at 49.71% SL in MG-II. As a final result of the cluster analysis, MG-I and MG-II combined at 15.74% SL.

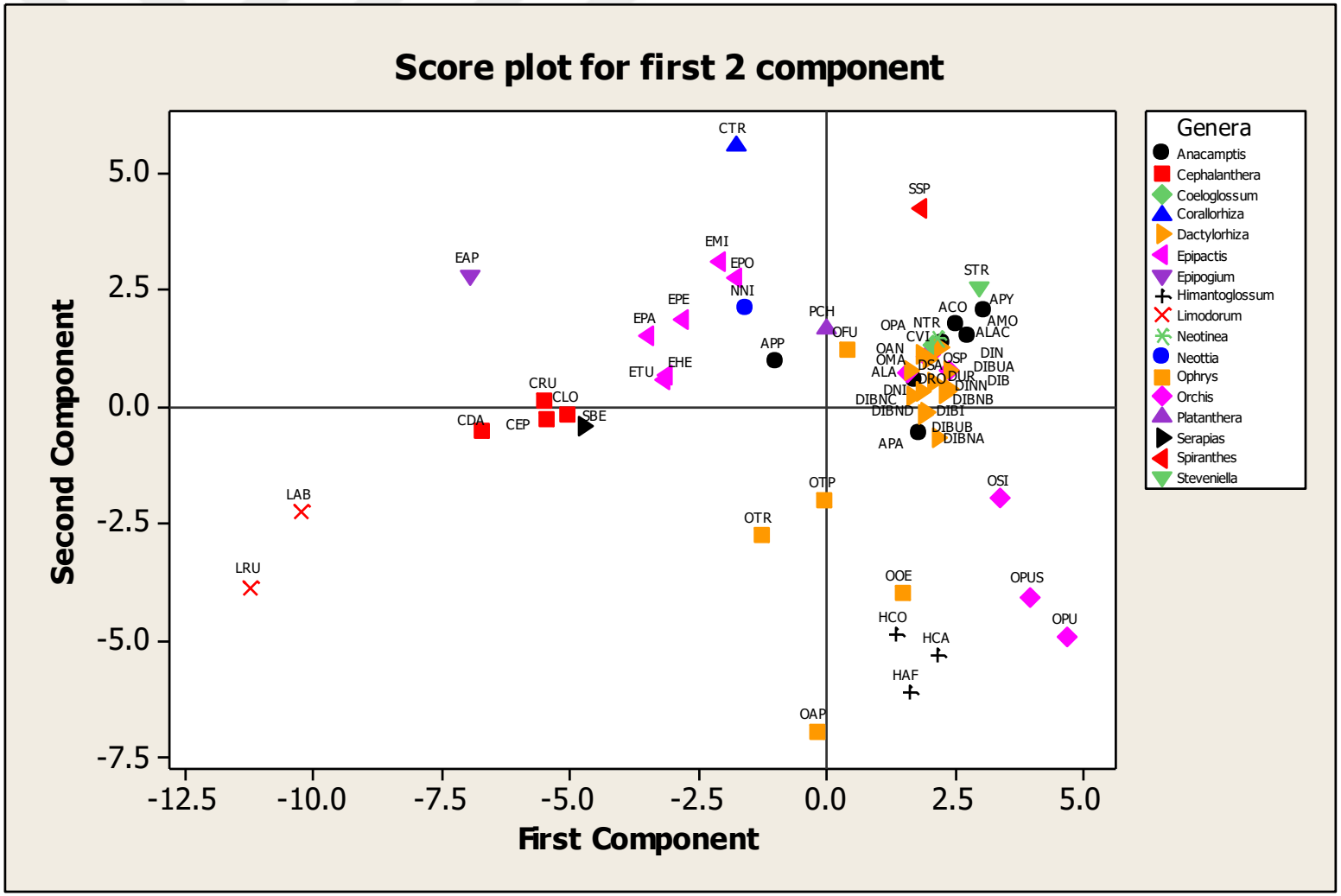


Figure 4.57. The results of principle component analysis of all OTUs.

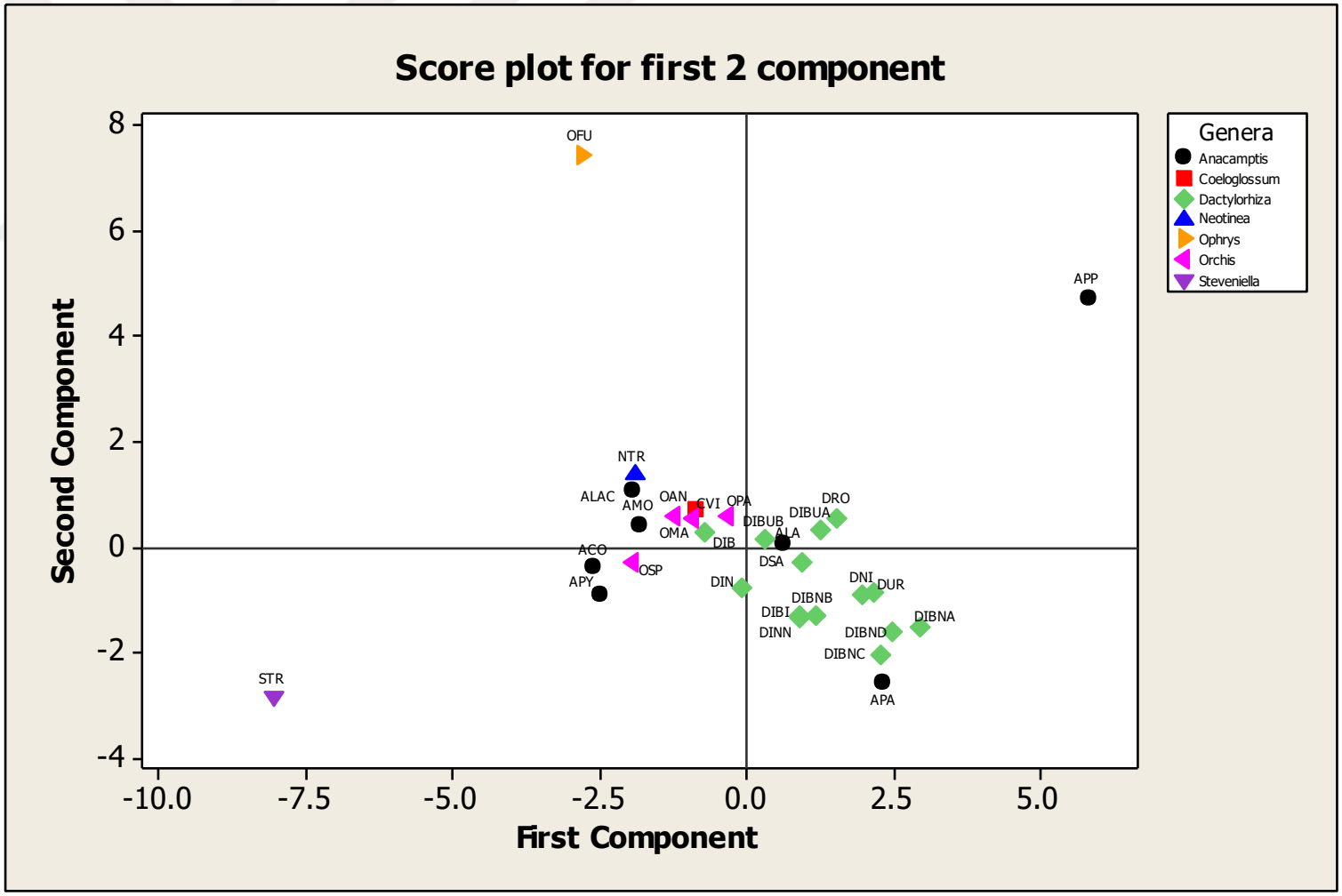


Figure 4.58. The results of principle component analysis of the complex group.

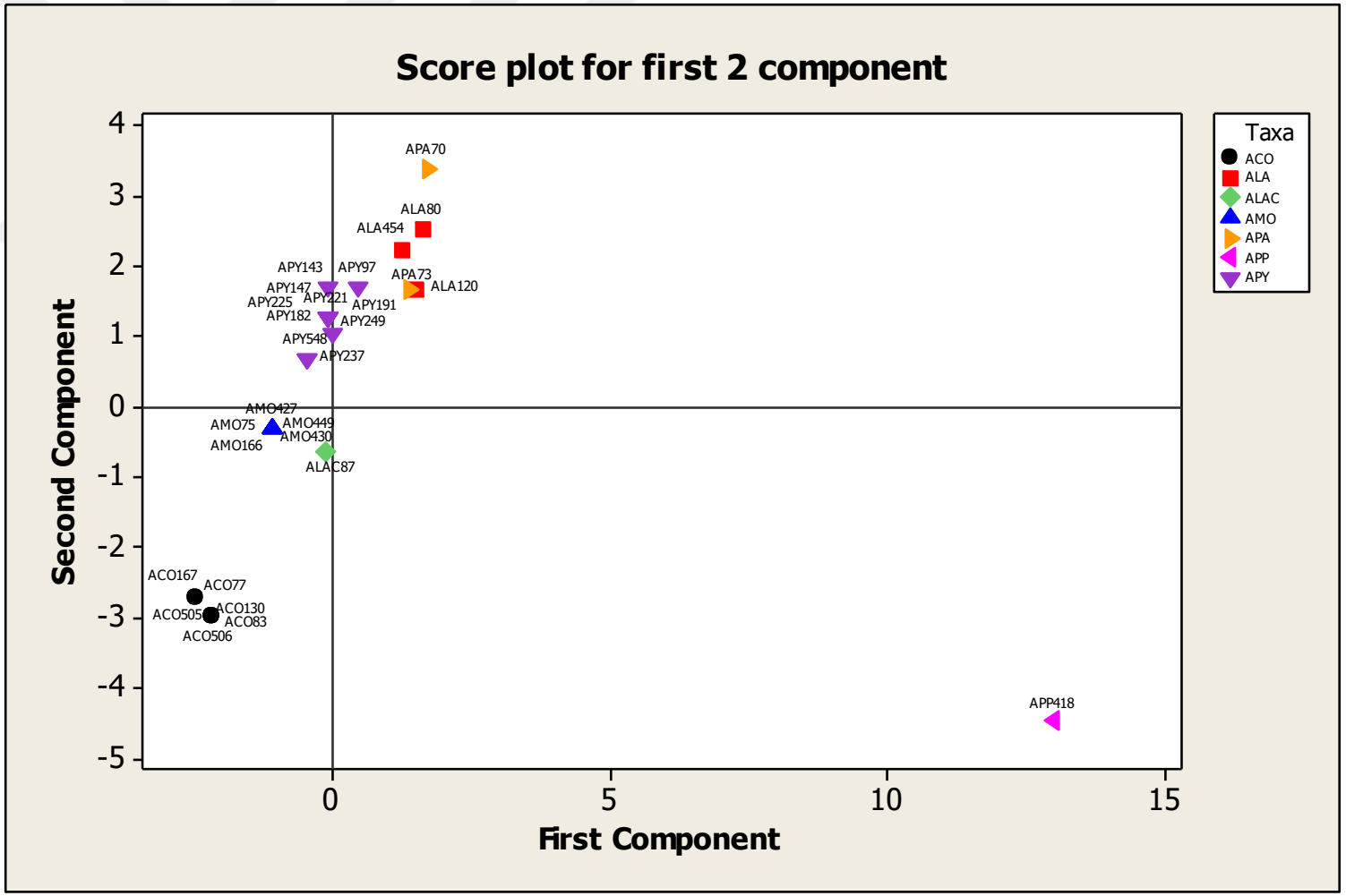


Figure 4.59. The results of principle component analysis of *Anacamptis* populations.

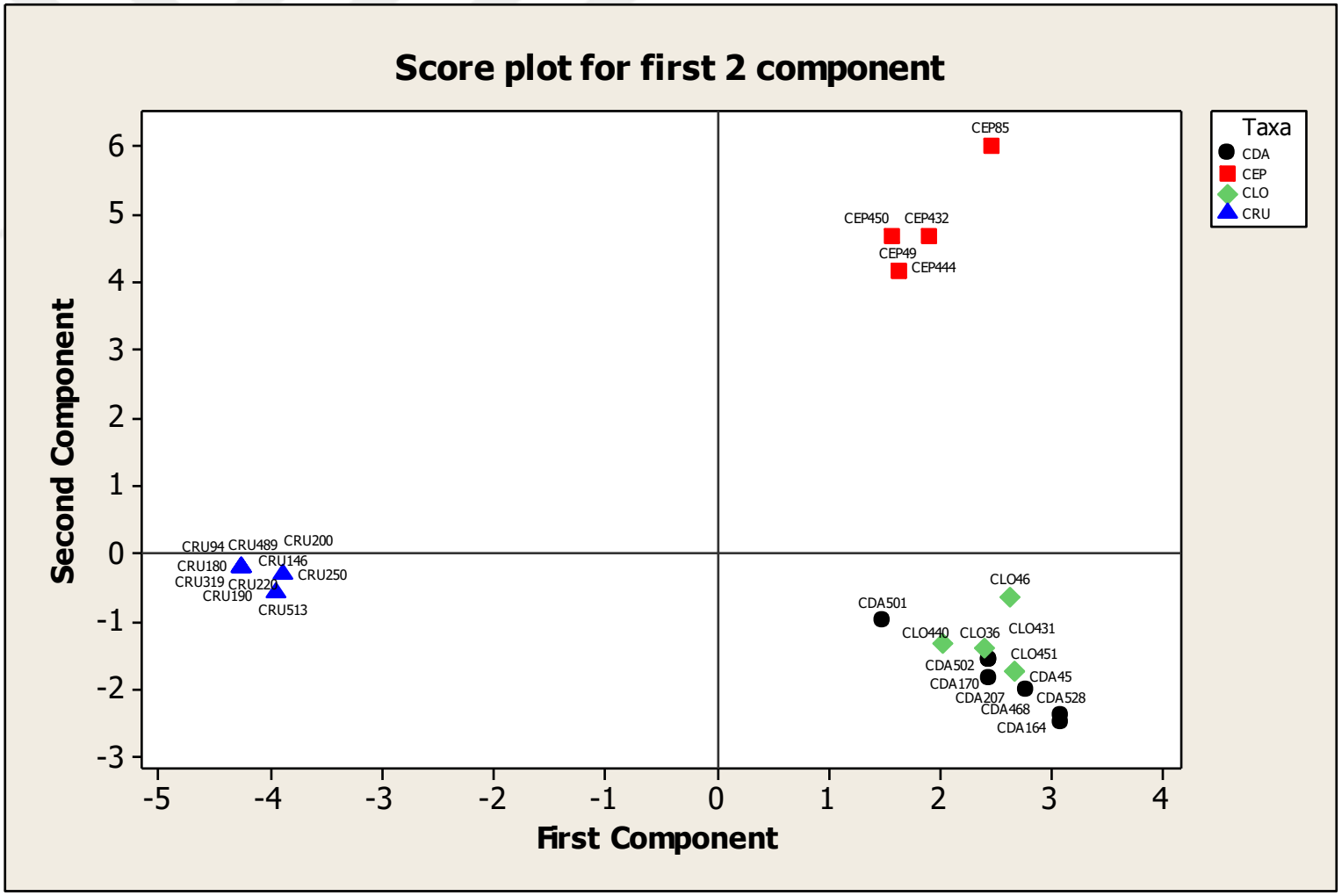


Figure 4.60. The results of principle component analysis of *Cephalanthera* populations.

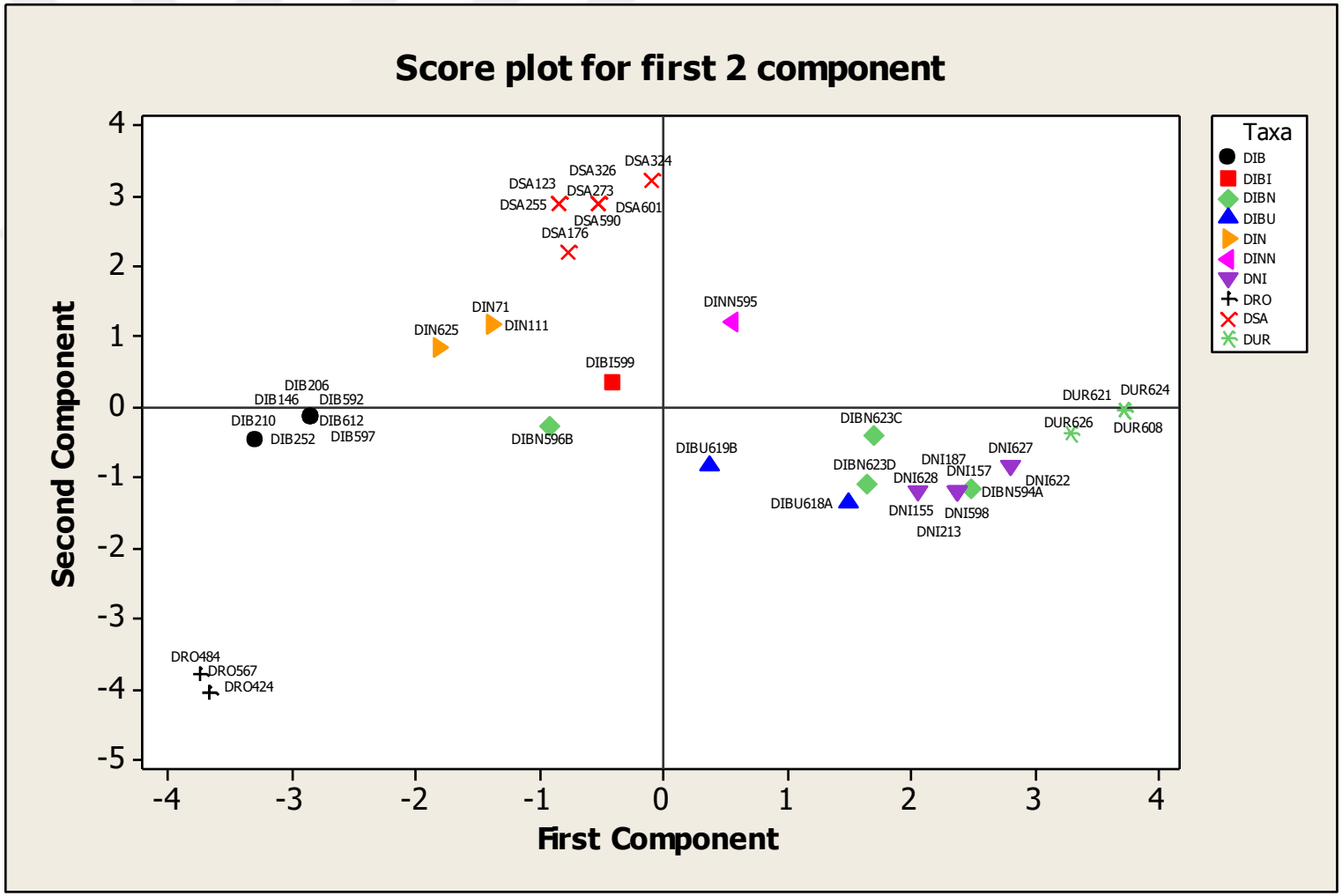


Figure 4.61. The results of principle component analysis of *Dactylorhiza* populations.

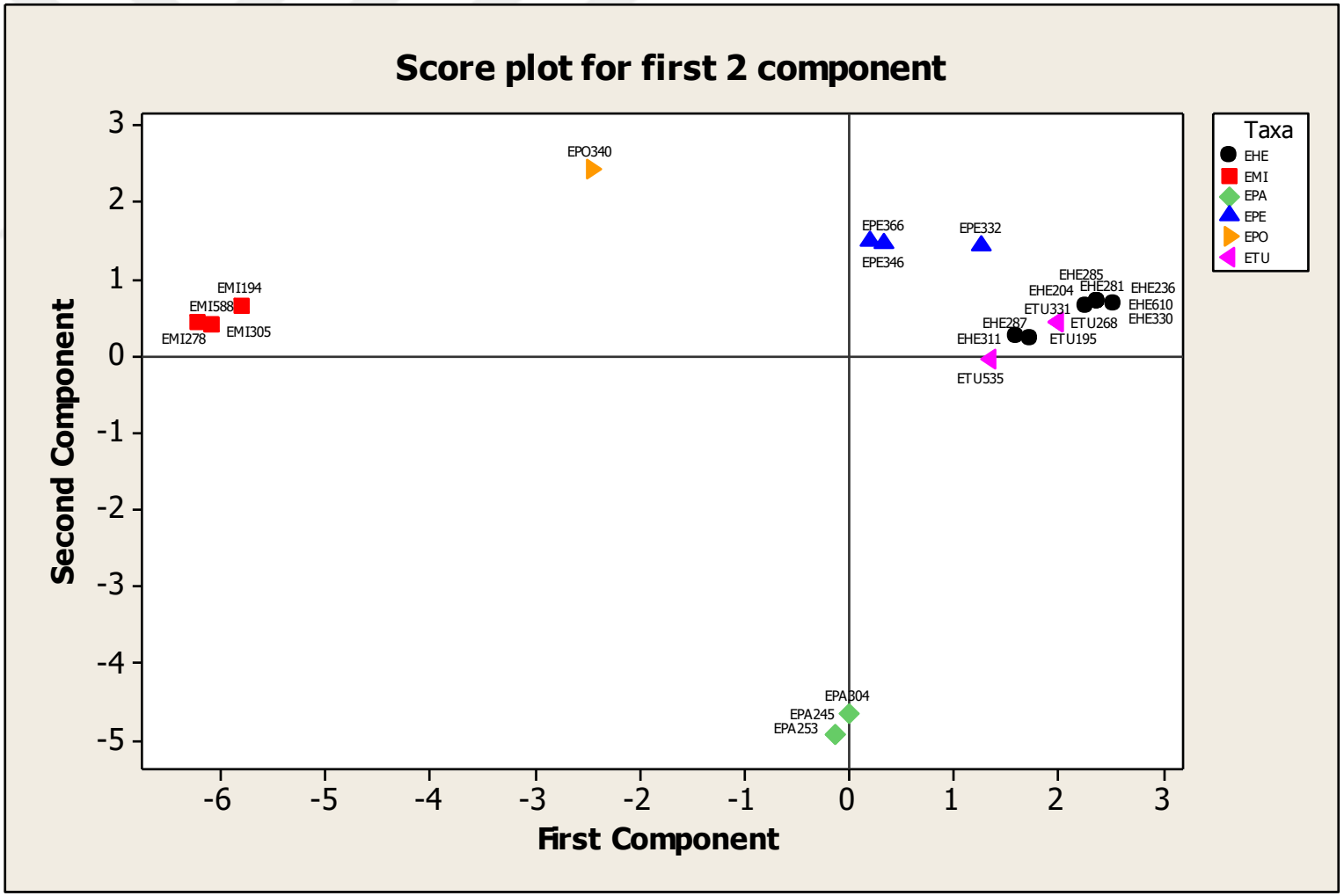


Figure 4.62. The results of principle component analysis of *Epipactis* populations.

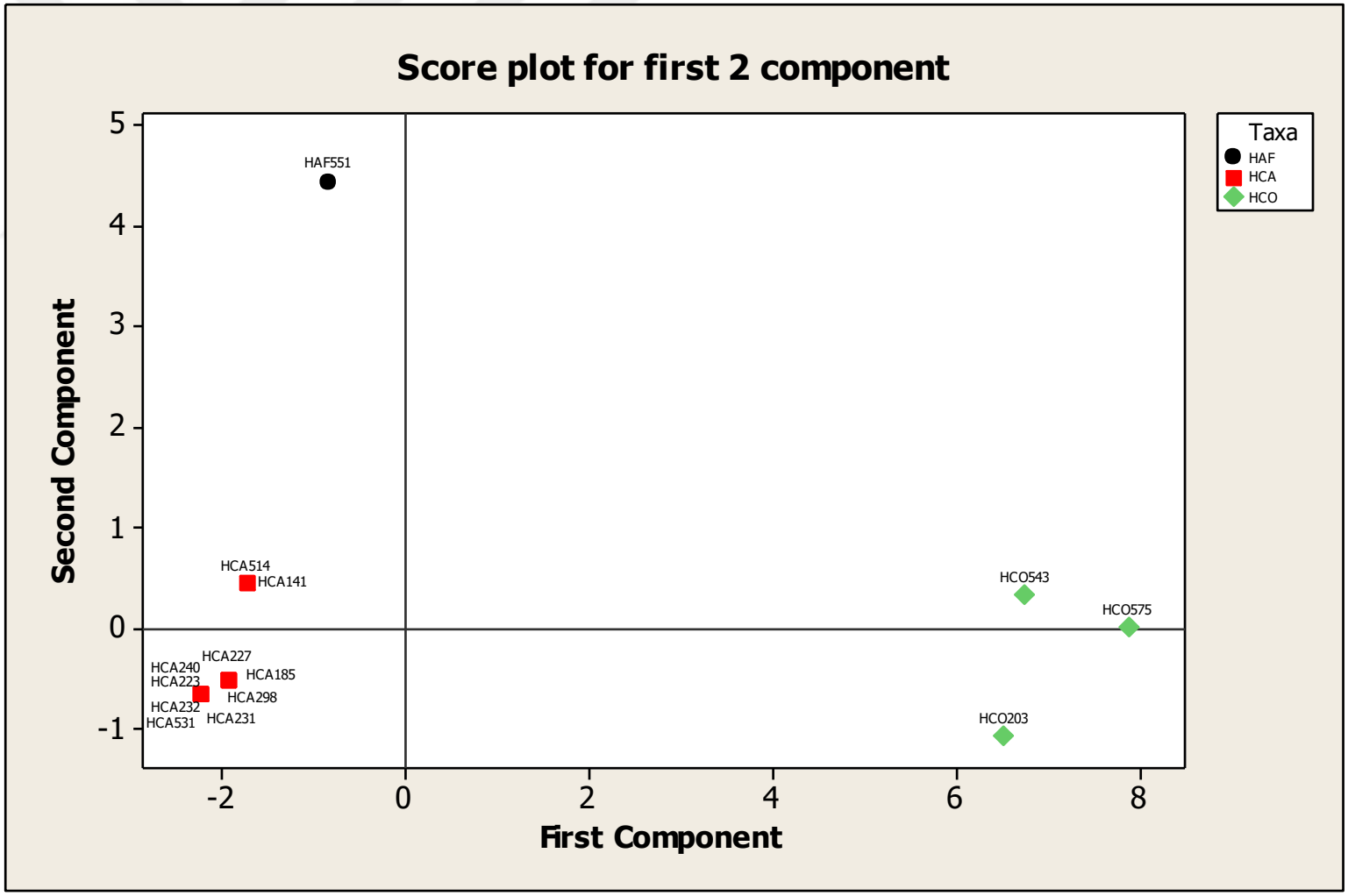


Figure 4.63. The results of principle component analysis of *Himantoglossum* populations.

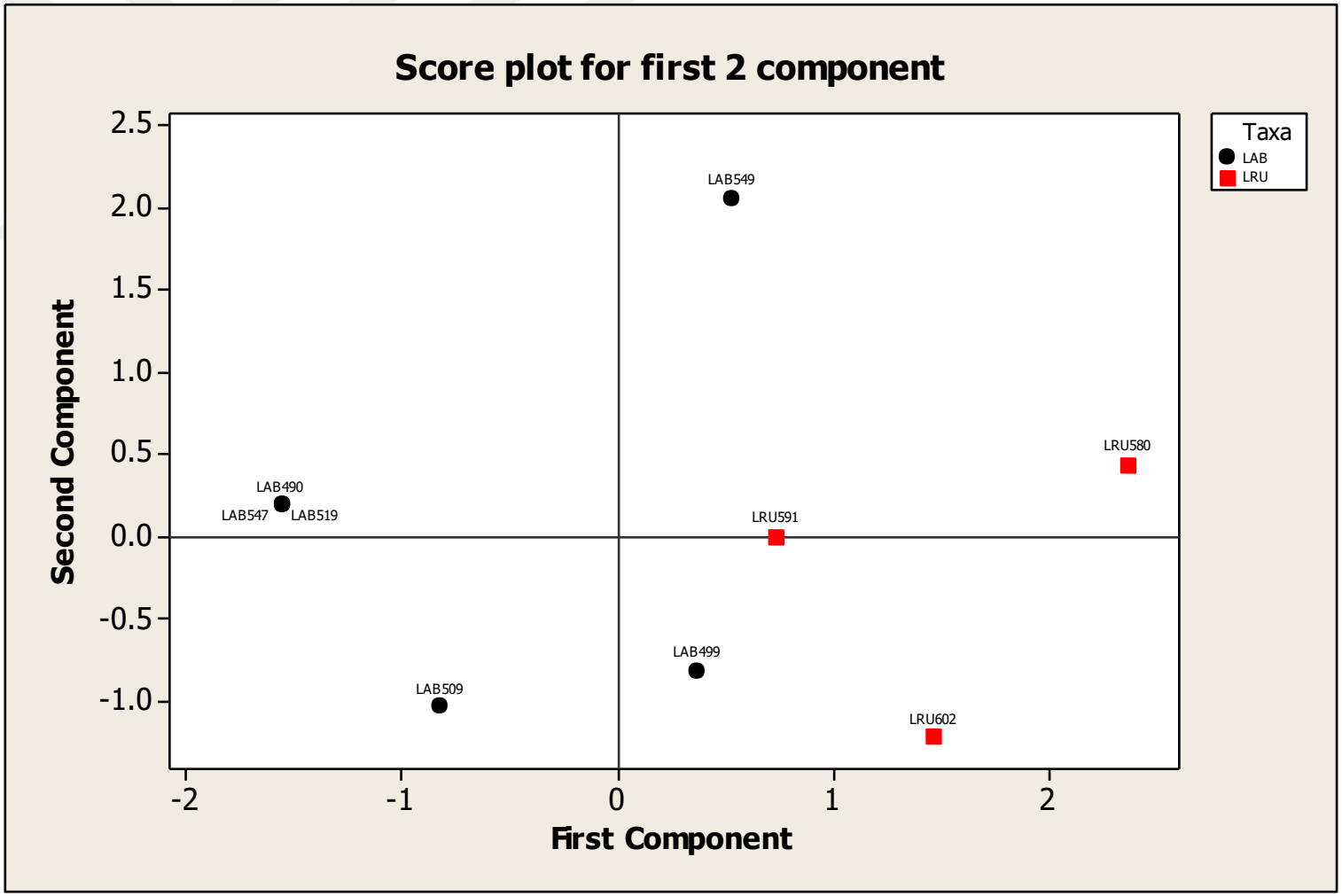


Figure 4.64. The results of principle component analysis of *Limodorum* populations.

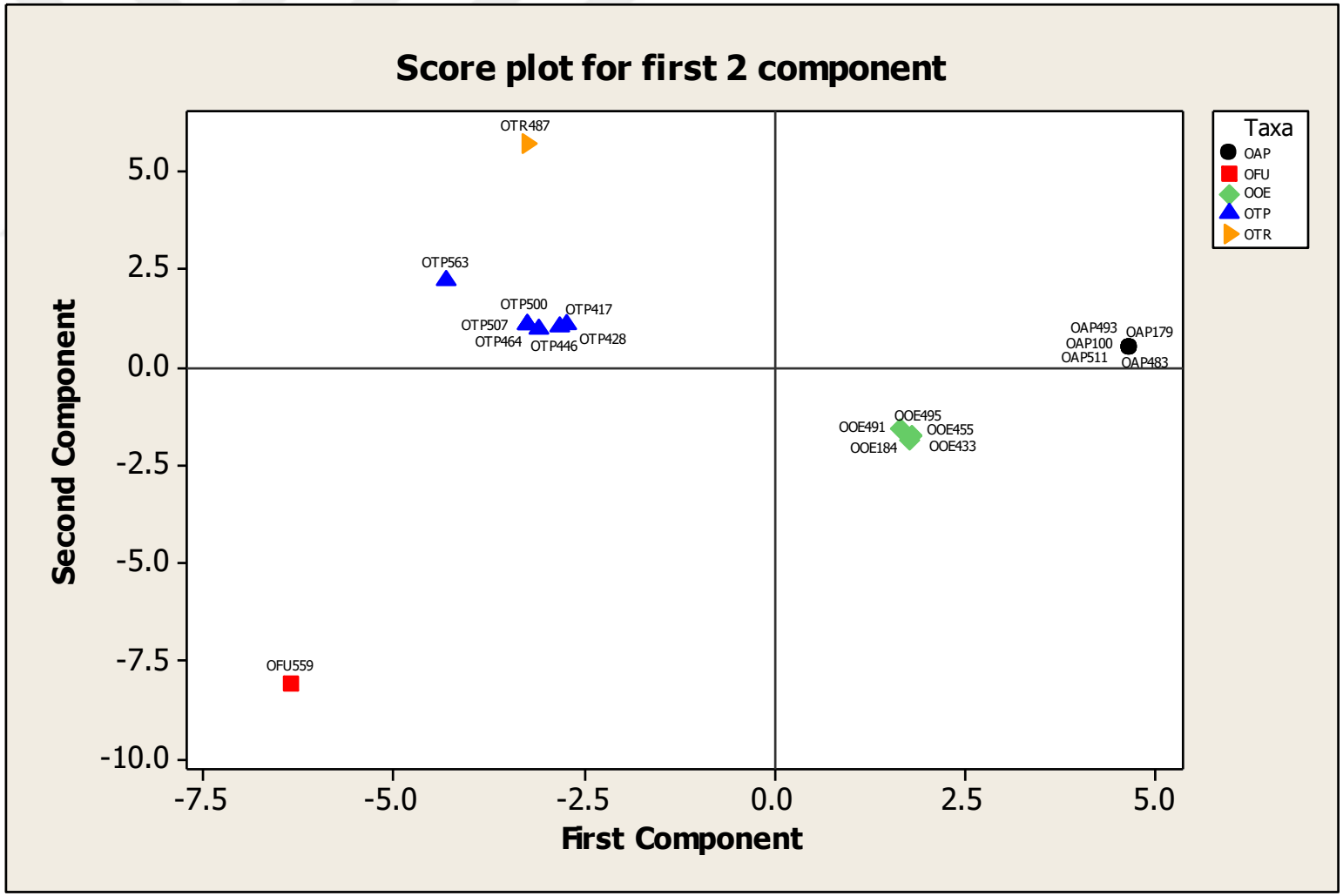


Figure 4.65. The results of principle component analysis of *Ophrys* populations.

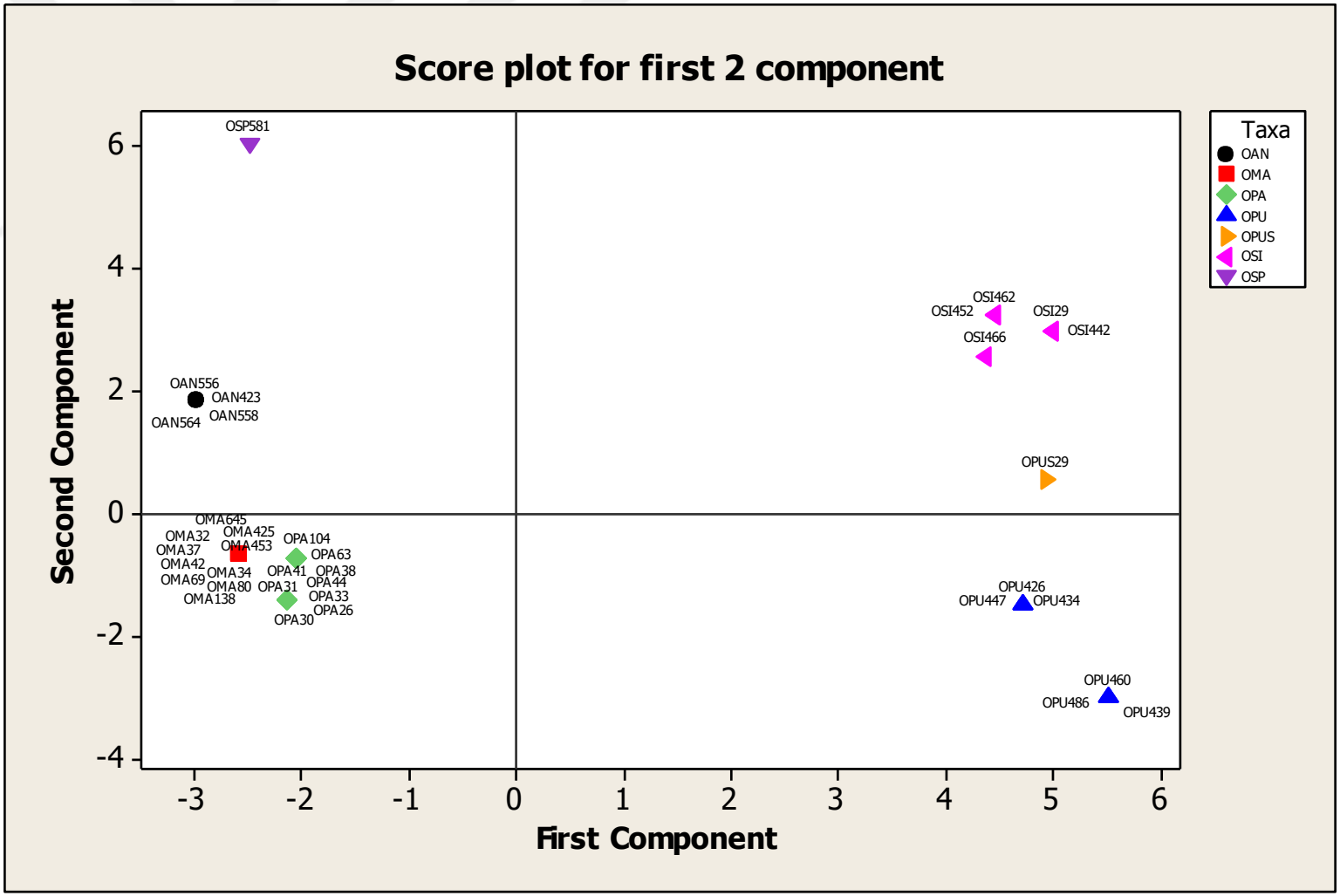


Figure 4.66. The results of principle component analysis of *Orchis* populations.

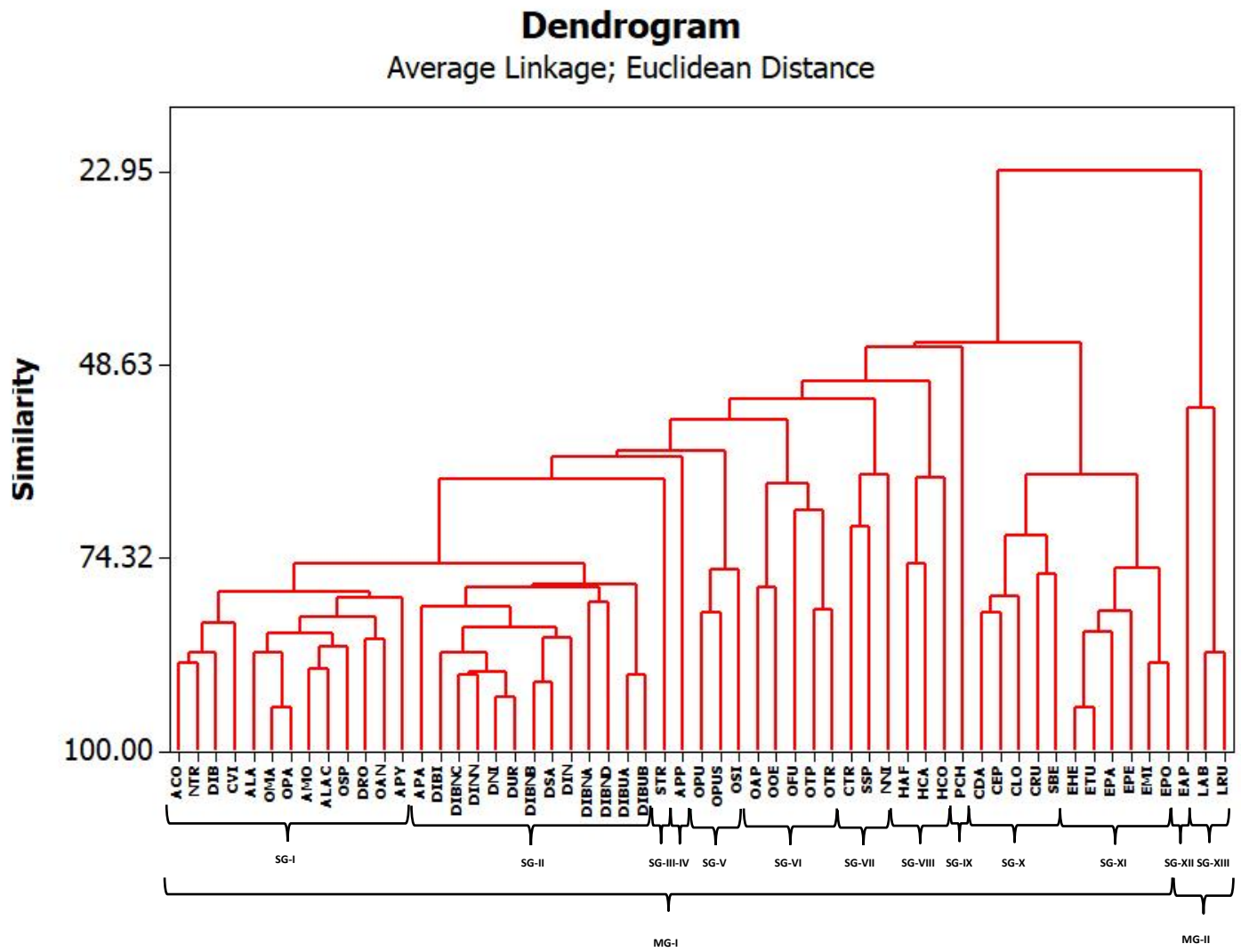


Figure 4.67. Cluster analysis of all OTUs.

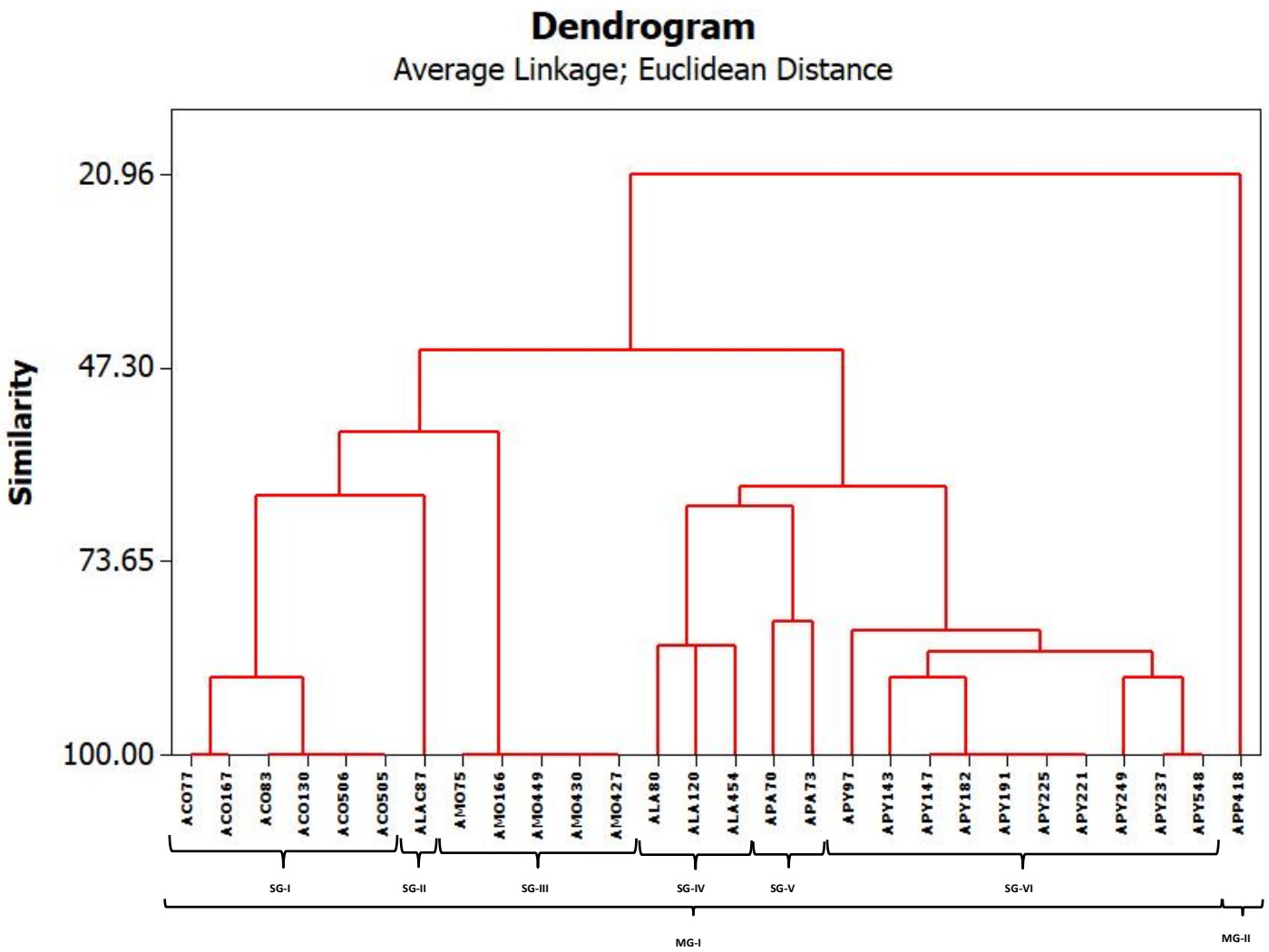


Figure 4.68. Cluster analysis of *Anacamptis* populations.

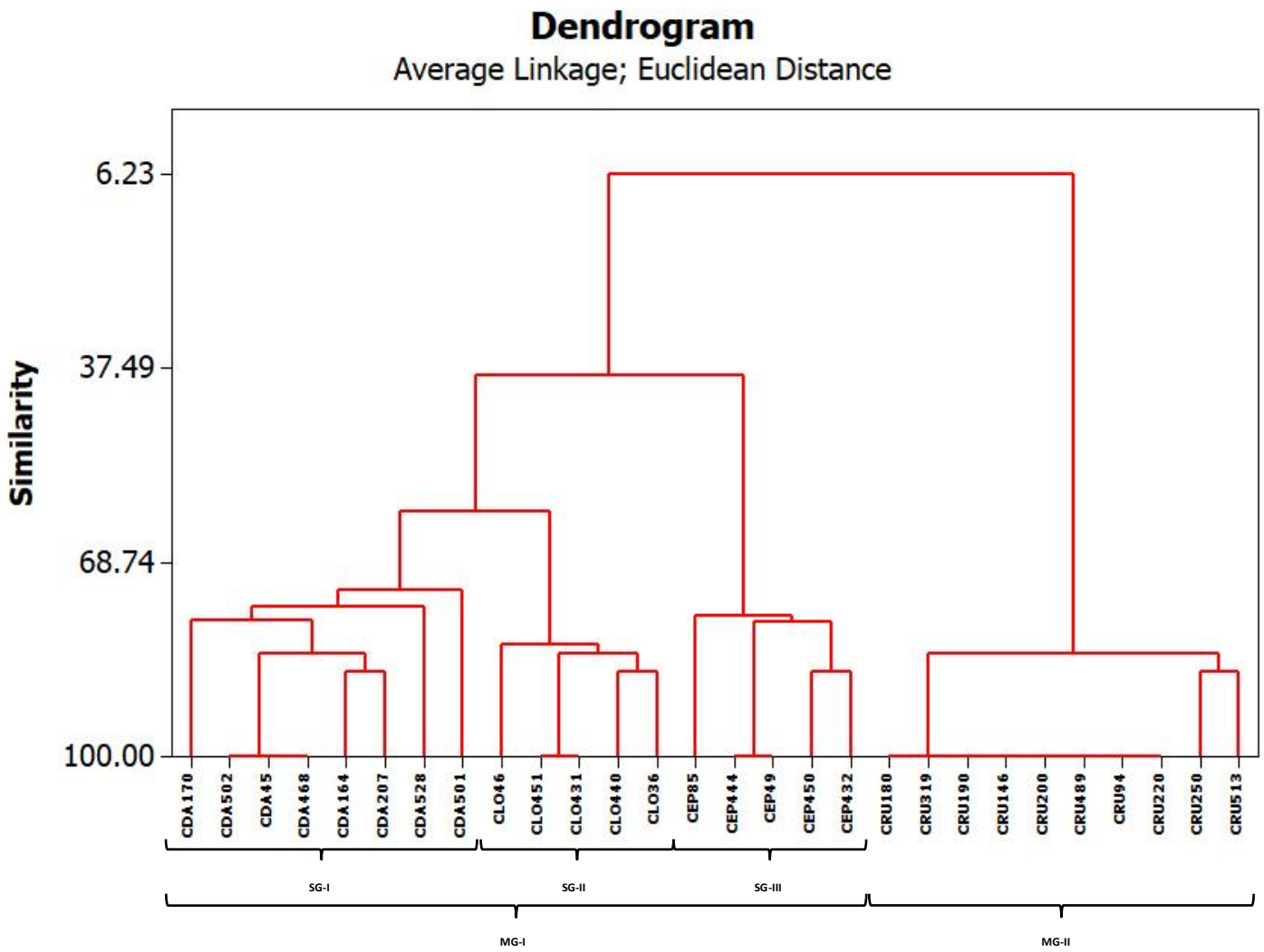


Figure 4.69. Cluster analysis of *Cephalanthera* populations.

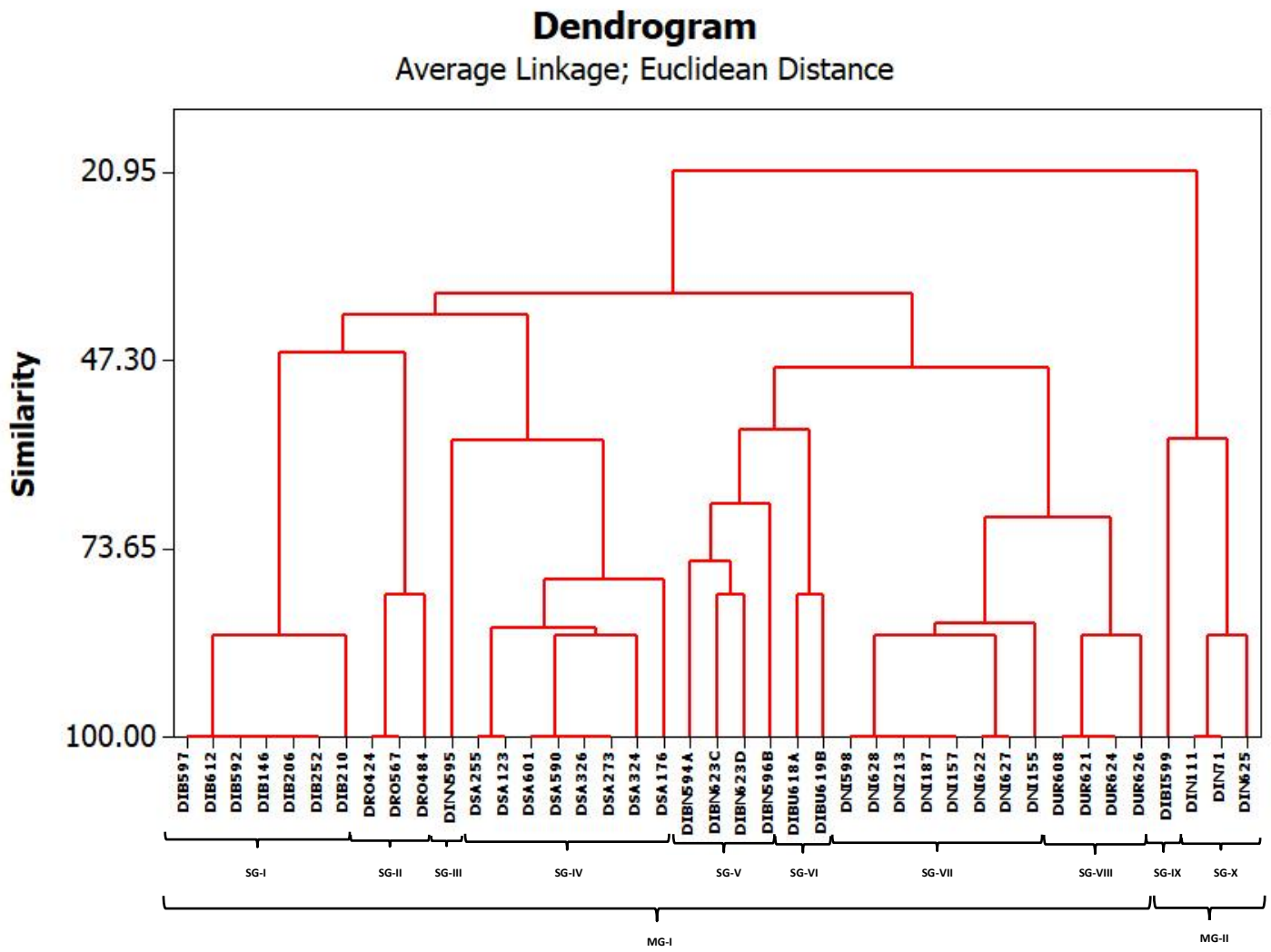


Figure 4.70. Cluster analysis of *Dactylorhiza* populations.

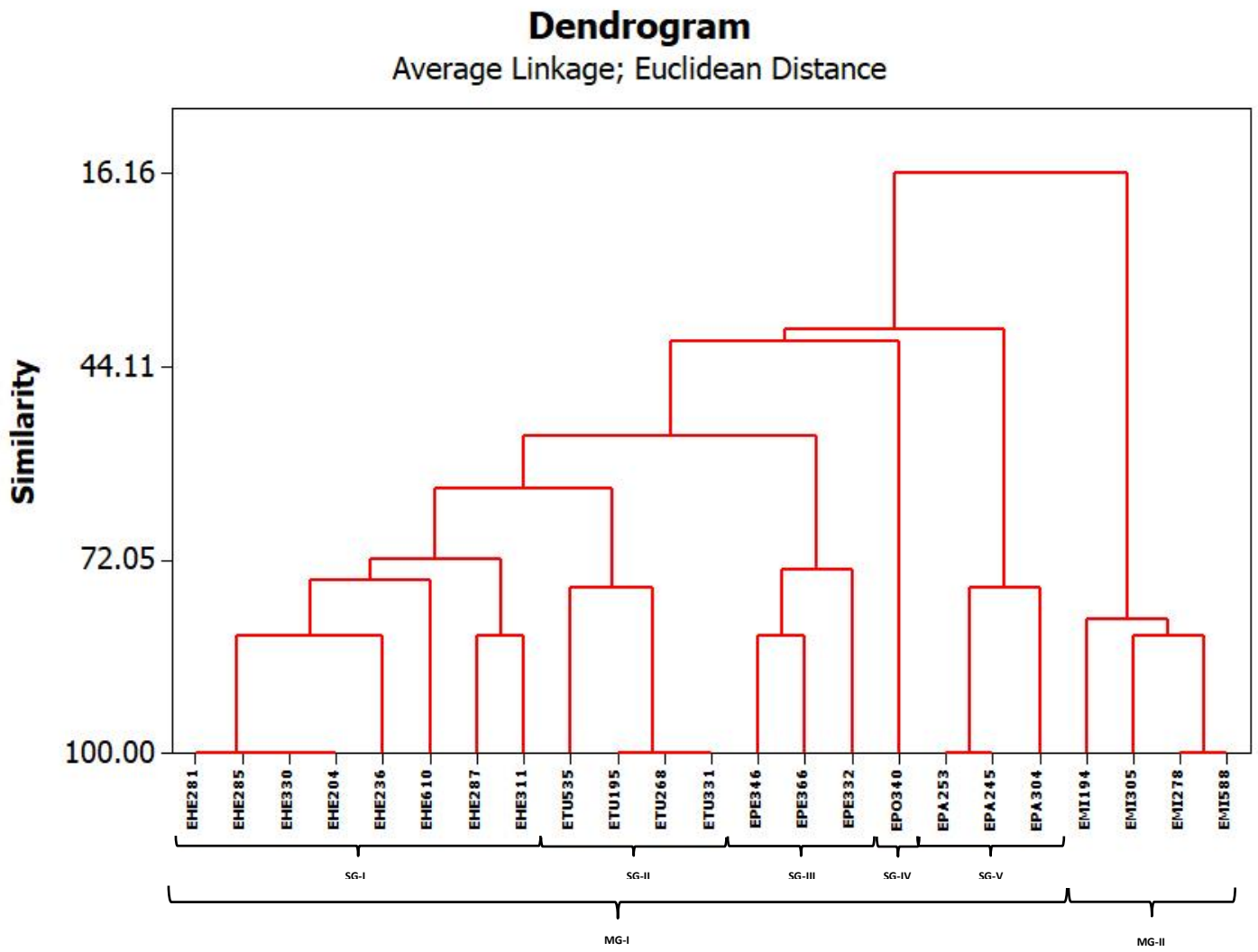


Figure 4.71. Cluster analysis of *Epipactis* populations.

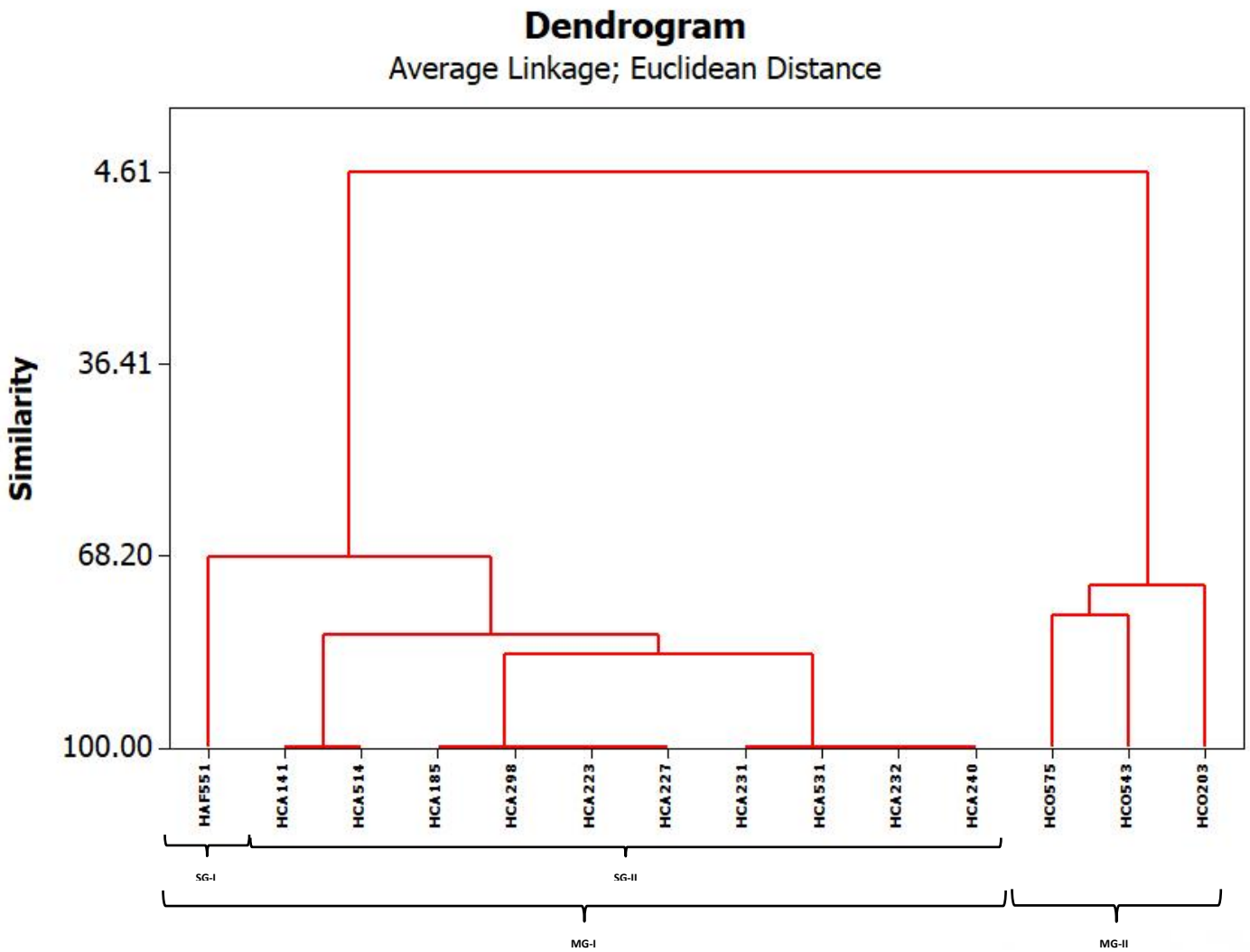


Figure 4.72. Cluster analysis of *Himantoglossum* populations.

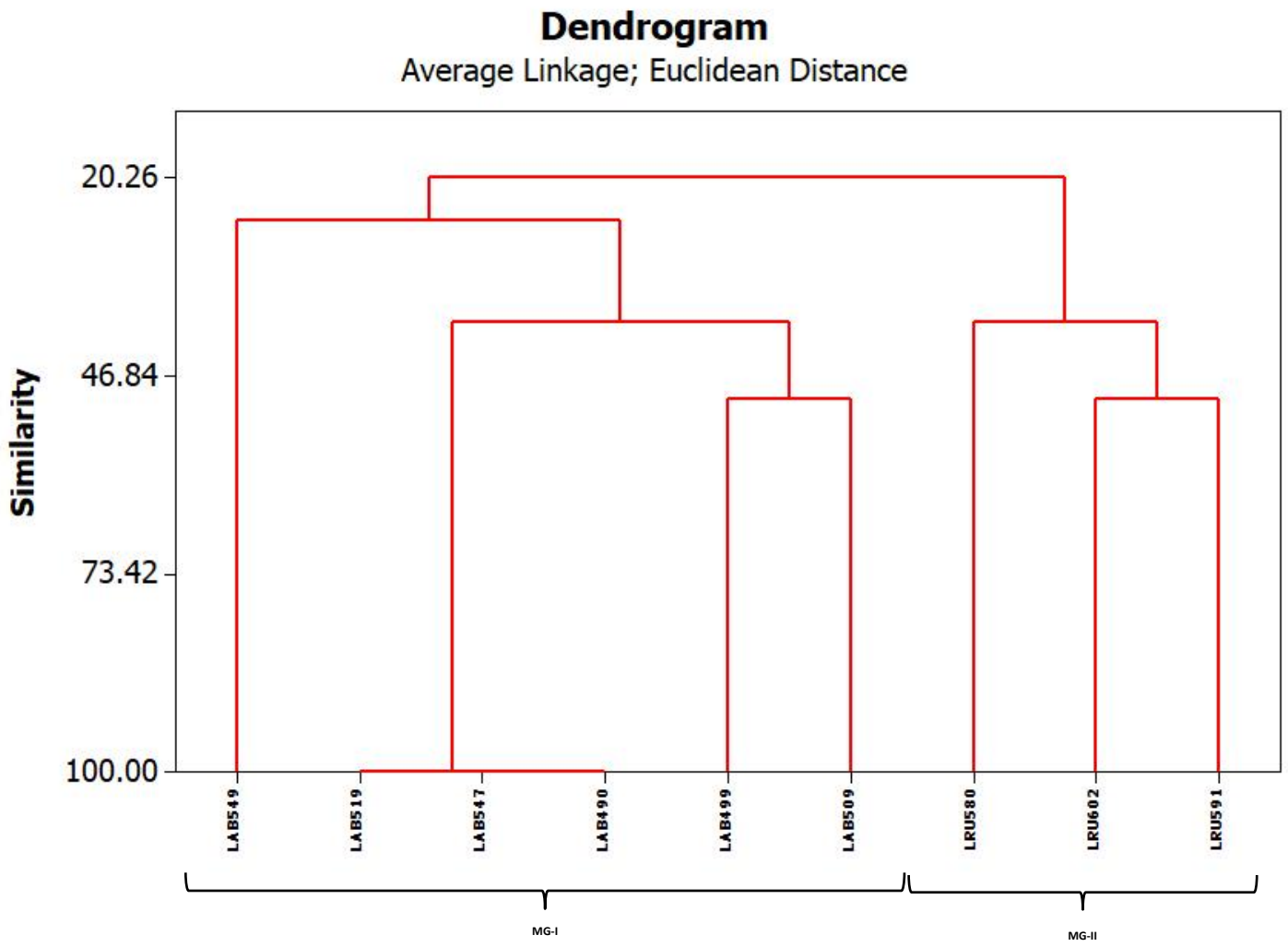


Figure 4.73. Cluster analysis of *Limodorum* populations.

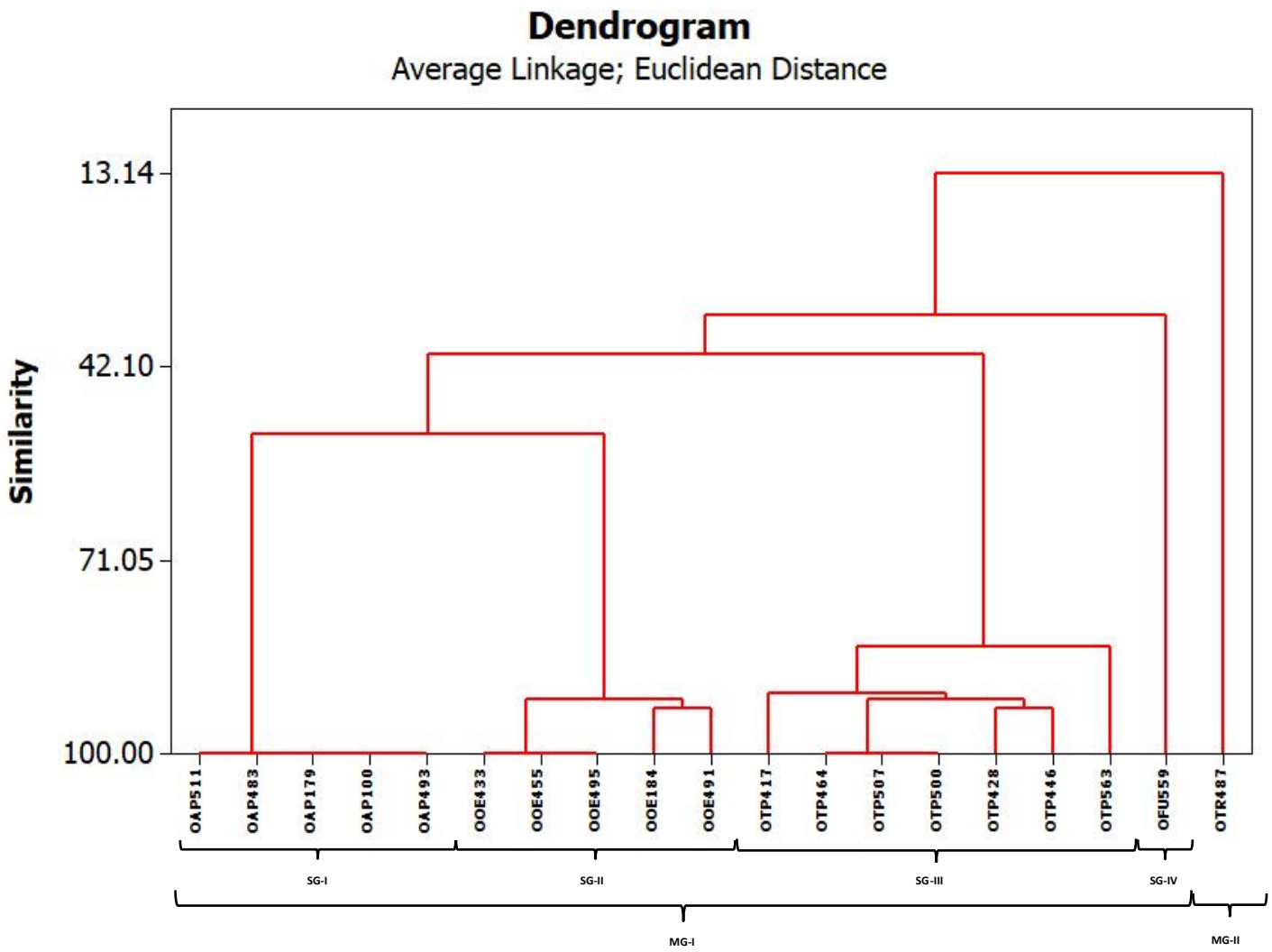


Figure 4.74. Cluster analysis of *Ophrys* populations.

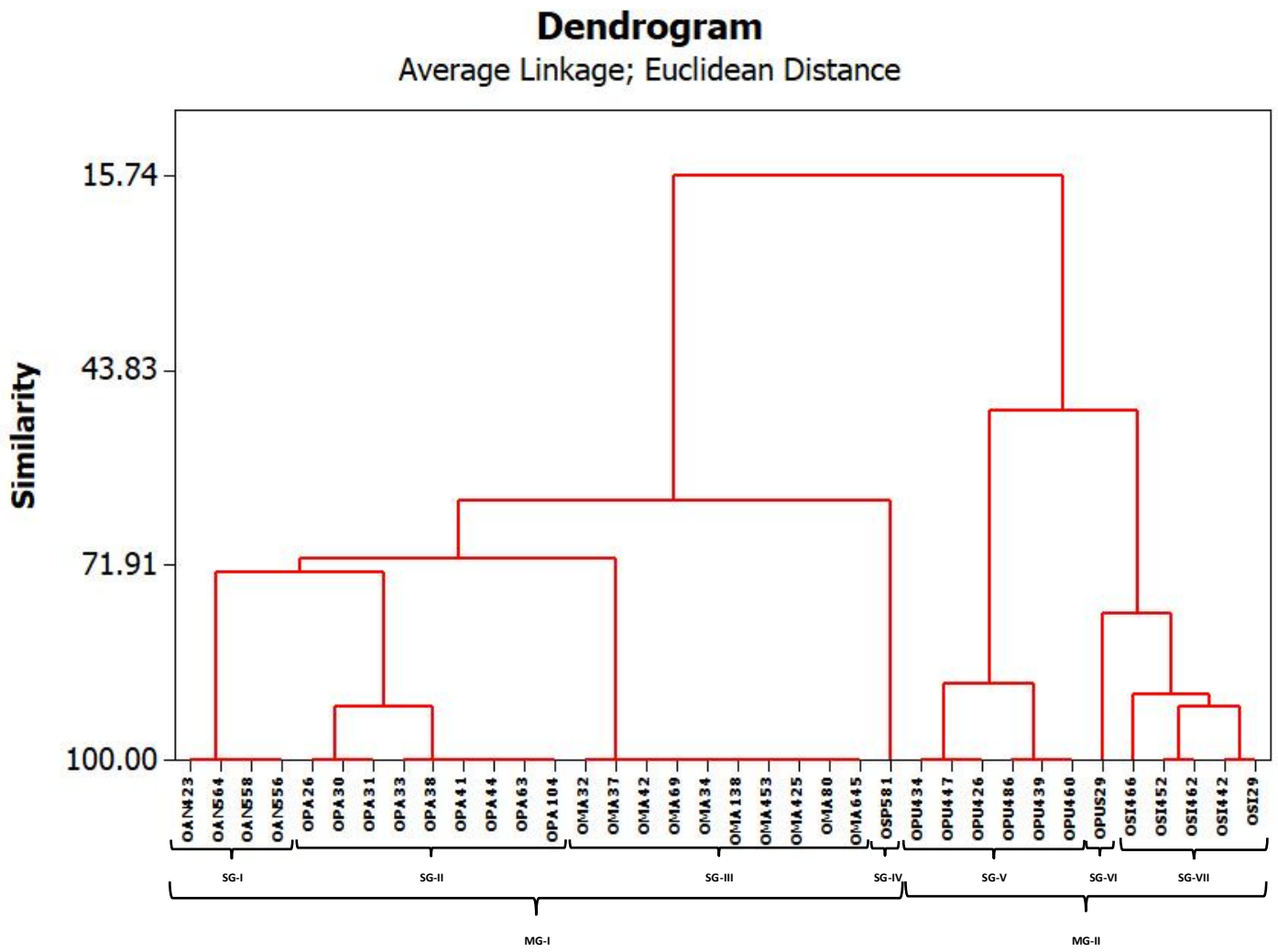


Figure 4.75. Cluster analysis of *Orchis* populations.

5. DISCUSSION

Orchids are taxonomically one of the most complex plant families in the world. Although some taxonomic studies carried out in Turkey, there is no a common consensus among researchers about nomenclature and systematic positions of taxa. Extensive studies at population level are needed to solve these taxonomic problems. Bolu province has a flora rich in orchids and however there is no direct study related with orchids before. In Demir and Eker's (2015) study, which has the most comprehensive inventory about orchids and geophytes, it was emphasized that the Orchidaceae should be studied in detail.

Compared to previous floristic studies in Bolu, both in previous studies and in this study, *Dactylorhiza* and *Epipactis* had the maximum number of taxa among the other genera. When the studies performed in previous years are examined, it is seen that the most common taxa belong to *Cephalanthera* and *Orchis*. These genera are followed by *Anacamptis* genus. In this study, more taxa have been reached than the number of taxa detected in all studies conducted previously in the region (Table 5.1).

In the previous studies, the number of taxa was low and ranged between 1 and 27, except in "*Flora of Turkey* (Davis 1984, 1988, Güner 2000)", Demir (2013), Eker et al. (2018)'s studies. The number of taxa identified in these three studies was 32, 36 and 38, respectively. Demir and Eker (2015)'s research was one of the most extensive regional studies related with geophytes, wherein the number of orchids was counted as 38. The reason for the low number in the other studies might probably be that these studies were either performed in narrow areas, or did not consist of the whole orchids within the city border. In the remaining studies, the number of taxa is lower than 27. Thus, with the present study, the highest number of orchids has been reached for a regional study by accounting for 53 taxa (Table 5.1).

Table 5.1. A comparison of genera in Bolu as reported by the present study and previous studies: 1) Akman & Ketenoğlu 1978; 2) Akman & Ketenoğlu 1979; 3) Akman & Ketenoğlu 1979; 4) Akman & Yurdakulol 1983; 5) Ekim & İlarslan 1982; 6) Davis 1984-1988, Güner et al., 2000; 7) Uçar 1996; 8) Turgut 1996; 9) Türker & Güner 2003; 10) İkinci & Güner 2007; 11) Aksoy 2009; 12) Kreutz & Çolak 2009; 13) İkinci 2011; 14) Sungurlu 2011; 15) Kanoğlu 2011; 16) Tunçkol 2012; 17) Arslan et al. 2013; 18) Demir 2013; 19) Çoban 2013; 20) Demir & Eker 2015; 21) Özkan et al. 2016; 22) Kanoğlu et al. 2016; 23) Eker et al. 2018; 24) İkinci & Bayındır 2019, 25) Eker et al. 2019

Previous studies / Genera	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Present Study
Anacamptis	–	–	–	–	1	2	2	2	2	1	–	3	–	–	2	2	–	5	–	5	1	2	3	–	–	**7**
Cephalanthera	1	2	1	1	1	3	2	3	2	3	1	3	2	–	3	1	–	4	2	4	1	3	4	–	–	**4**
Coeloglossum	–	–	–	–	–	1	1	–	1	–	–	1	–	–	–	–	–	1	–	1	–	–	–	–	1	**1**
Corollorhiza	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
Dactylorhiza	–	–	–	–	1	9	7	–	8	3	–	6	–	–	–	1	–	5	–	5	1	–	2	3	3	**10**
Epipactis	–	–	–	–	–	4	2	1	2	–	1	3	–	–	–	–	–	6	–	6	1	–	1	–	–	**6**
Epipogium	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–		–	1	**1**
Himantoglossum	–	–	–	–	–	2	–	1	–	1	–	2	1	–	1	1	–	2	–	2	1	1	1	–	–	**3**
Limodorum	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	1	1	1	1	–	1	–	–	**2**
Neotinea	–	–	–	–	–	–	1	–	1	–	–	1	–	–	–	1	–	1	–	1	–	–	1	–	–	**1**
Neottia	–	–	–	1	–	1	1	–	1	1	–	1	–	–	–	–	1	1	1	1	–	–	1	–	–	**1**
Ophrys	–	–	–	–	–	3	1	–	1	–	–	3	1	–	–	1	–	2	–	3	–	–	3	–	–	**5**
Orchis	1	1	1	–	1	4	2	1	2	3	1	3	2	1	–	2	1	4	1	4	4	–	3	–	–	**7**
Platanthera	–	–	–	–	–	1	–	1	–	1	–	–	–	–	1	–	1	1	–	1	–	1	1	–	–	**1**
Serapias	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	**1**
Spiranthes	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	1	–	–	**1**
Steveniella	–	–	–	–	–	1	1	–	1	–	–	1	–	–	–	–	–	1	–	1	–	–	1	–	–	**1**
Total	2	3	2	4	4	32	20	9	21	13	3	27	6	1	7	10	3	36	5	38	10	7	24	3	5	**53**

Which quantitative and qualitative characters are important for taxonomy of orchids are seen in cluster and PCA analyzes. In the classification analysis conducted on the basis of species, the species where the labellum are divided into two parts as "*epichile*" and "*hypochile*" (SG-X–SG-XI–SG-XII–SG-XIII) are previously separated from the other groups (Figure 4.67). This separation is also reflected in the PCA graph. It can be said that underground structures are also effective in separating these groups each other (Figure 4.57). The position of *Serapias bergonii* which emerged among the *Cephalanthera* taxa is remarkable. This is due to the fact that although it is tuberous, the labellum structure is two-parted. Furthermore, the fact that the plant length resembles *Cephalanthera* taxa is the other reason for this species to be included in SG-X (Figure 4.67).

The taxa belonging to *Anacamptis, Coeloglossum, Dactylorhiza, Neotinea, Orchis* and *Steveniella* genera which form the complex group mentioned in PCA, were intertwined also in the classification analysis. It can be seen in the PCA and cluster analysis results that the taxa which constitute the complex group are the taxa belonging to the genera changed from *Orchis* (sensu lato). The most important factor in this confusion is the fact that these taxa have tuber and three-parted labellum. On the other hand, *O. simia, O. purpurea* and their hybrid (*Orchis* × *angusticruris*) are separated from the complex group. The length and width of the lobules in the labellum structures, the length and width of the teeth, the length of the middle lobe and the length of the lateral lobe may be the reason of the separation from the complex group in cluster analysis and PCA (Figure 4.67). This result also supports the conclusion conducted by Tyteca et al. (2012) where *Orchis* species with anthropomorphic lip were found significantly differentiated from other *Orchis* and *Anacamptis* species.

When the complex group was further discussed in PCA (Figure 4.58), *Steveniella satyrioides, Ophrys fusca* subsp. *thracica* and *Anacamptis papilionacea* subsp. *papilionacea* were clearly separated from this complex. As a matter of fact, OFU was placed among *Ophrys* taxa in the cluster analysis and APP, STR and OFU were already separated from the complex group (Figure 4.58). While the *Dactylorhiza* taxa of the complex group coexist in PCA, the APA and ALA, which are very similar to *Dactylorhiza* in terms of the size of the labellum, interfere in them. *Orchis* taxa and *Coeloglossum viride* are also seen as the group that has the

closest characteristics to the *Dactylorhiza* taxa (Figure 4.58). Later, they were followed by *Anacamptis* taxa.

PCA and cluster analyzes were also performed for the genera with more than one taxon and taxonomically more complex at population level.

In the cluster analysis of *Anacamptis* genus, all taxa were placed in separate clusters. In PCA, all taxa were separated from each other except for *Anacamptis palustris* subsp. *palustris* and *A. laxiflora* subsp. *laxiflora* (Figure 4.59 and Figure 4.68). When PCA and cluster analysis results were examined, it was found that *A. papilionacea* subsp. *papilionacea* can be said to be rather different. While APA and ALA were interlinked in PCA, they were included in different clusters in cluster analysis. The main differences of these two taxa are given in Table 5.2.

Table 5.2. Basic morphological differences between *Anacamptis laxiflora* subsp. *laxiflora* and *A. palustris* subsp. *palustris.*

Character States	*A. laxiflora* subsp. *laxiflora*	*A. palustris* subsp. *palustris*
Bract length	(13−)17−25(−32) mm	(15−)21−41(−52) mm
Bract width	2−4.5 mm	2.5−4 mm
Inflorescence length	(3.5−)6−10(−25.5) cm	15−26(−34.5) cm
Labellum middle lobe width	(2−)2.5−4.5(−6) mm	3−7 mm
Labellum lateral lobe direction	strongly deflexed	directed forwards to deflexed
Spur direction	horizontal to directed upwards	horizontal to directed downwards

Anacamptis pyramidalis was separated from all other taxa in both analyzes. The main reason for the differences between the APY populations appearing in the cluster analysis may be the diversity of the quantitative character variation of the populations within this species. One population consists of robust individuals, while another population may consist of gracile individuals. *Anacamptis morio* subsp. *morio* was clearly separated from other taxa in both analyzes. In the cluster analysis, it can be said that AMO populations do not show a significant variation and are combined in the same cluster at 100% similarity level.

The hybrid (ALAC) of ALA and ACO taxa were found near the AMO in PCA and between ACO and AMO in cluster analysis. The hybrid taxon *Anacamptis* × *parvifolia* shares morphological properties between parental taxa *A. coriophora* subsp. *coriophora* and *A. laxiflora* subsp. *laxiflora* (Table 5.3). It is much more similar to *A. laxiflora* subsp. *laxiflora* in terms of the color of the sepals and petals,

length of the labellum lateral lobes, and spur length. The color and length of the bract, the labellum sizes, the surface ornamentation of the labellum side lobes and the edge properties, the surface ornamentation and width of the middle lobe of the labellum are similar to *A. coriophora* subsp. *coriophora*. The middle lobe length and column length of the hybrid taxon are at the upper limit size of one of the parents while the lower limit size of the other. The column width is at the lower boundary of both parents. The petal sizes are longer than the upper limit of one parent and less than the lower limit of the other. The number and shape of the leaves, the length of the inflorescence, the width of the bract, the shape of the petals, the shape and position of the labellum side lobes, the shape, the direction and the width of the spur are also within the character range of both parents.

The feature of lateral sepals to be upwards or backwards indicated by Chaubard (1821, 1851) for *Anacamptis* × *parvifolia* differs in the hybrid individuals we have detected. In our hybrid samples, the perianth segments were joined as a loose helmet. The reason for dissimilarity of this character can be considered as a reflection of more similarity to *Anacamptis coriophora* subsp. *coriophora* from the parents. This can be explained by the morphological variation of the hybrids that may occur as various combinations of the two parents.

Anacamptis morio subsp. *morio* is also located in the area of parental taxa. At the beginning, the possibility that one of the parents may be this taxon was taken into consideration. In our detailed morphological studies and observations, one of the parents was diagnosed with *A. laxiflora* subsp. *laxiflora*, while the other parent was either *A. coriophora* subsp. *coriophora* or *A. morio* subsp. *morio*. In the morphological measurements in all populations of other three taxa and the populations where found hybrid individuals in Bolu, the labellum sizes of *A. morio* subsp. *morio* [7.5−12 × (6.5−)7−10 mm] and *A. laxiflora* subsp. *laxiflora* [7−12(−14) × (8−)11−16(−20) mm] were found to be larger than *Anacamptis* × *parvifolia* (6 × 5−7.5 mm). That is, if hybridization is between these two taxa, labellum sizes of hybrid taxon are expected to be between the dimensions of both taxa. It is understood that one of the parents has smaller labellum sizes. The taxon in the field that corresponds to this definition is *A. coriophora* subsp. *coriophora* (labellum sizes 5.5−8 × 4−7 mm). When we only compare the labellum measurements of the

individuals mentioned above in the areas where the hybrid is located, it also showed consistency with the measurements we received from the populations across Bolu.

Other findings confirming that the parent is *A. coriophora* subsp. *coriophora* are as follows: The speckles that make up the labellum pattern are larger in *A. morio* subsp. *morio*, while in *A. coriophora* subsp. *coriophora* they are in the form of smaller speckles and this is also reflected in hybrid individuals. while the dorsal and lateral sepals of *A. coriophora* subsp. *coriophora* were completely tightly bonded, in *A. morio* subsp. *morio* they are loosely close to each other. The postures of sepals, and shrinkages at the ends of sepals in *A. coriophora* subsp. *coriophora* were observed in hybrid individuals. The expansion of the end of the spur and the feature of the lightly ulcerated structure of the labellum in the *A. morio* subsp. *morio* were not observed in hybrid individuals. As in the *A. coriophora* subsp. *coriophora*, only the papillose surface feature was seen and no spur expansion was recorded. Although it is possible for the hybrid individuals to take their characters from their other parent *A. laxiflora* subsp. *laxiflora*, all the morphological similarities mentioned above indicate *Anacamptis coriophora* subsp. *coriophora* as the other parent. The main differences of these three taxa are given in Table 5.3.

Table 5.3. Basic differences between *A. laxiflora* subsp. *laxiflora*, *A.* × *parvifolia* and *A. coriophora* subsp. *coriophora*.

Character States	*A. laxiflora* subsp. *laxiflora*	*A.* × *parvifolia*	A. *coriophora* subsp. *coriophora*
Leaf number	6−9	7−8	5−10(−11)
Leaf shape	linear to lanceolate	linear to linear-lanceolate	linear to lanceolate
Infloracence length	(3.5−)6−10(−25.5) cm	5.3−7 cm	(2.5−)3.5−10(−12) cm
Bract color	purple	green, more or less suffused with purple	green with more or less purple-tinged on the margin
Bract length	(13−)17−25(−32) mm	11.5−13 mm	9−17 mm
Bract width	2−4.5 mm	2−2.5 mm	(1−)1.5−3(−4) mm
Sepal and petal color	purple	purple	brownish-red
Petal shape	ovate to obliquely oblong	ovate-lanceolate	linear-lanceolate
Petal length	6.5−8.5(−10) mm	6 mm	3.5−5 mm
Petal width	(2−)2.5−3(−4) mm	2 mm	1(−1.5) mm
Labellum lobe number	indistinctly 3-lobed	3-lobed	3-loplu
Labellum length	7−12(−14) mm	6 mm	5.5−8 mm
Labellum width	(8−)11−16(−20) mm	5−7.5 mm	4−7 mm

Table 5.3. (cont'd)

Labellum lateral lobe length	1.5−3(−5) mm	2−2.5 mm	1−2 mm
Labellum lateral lobe width	3−6 mm	3.5 mm	1−2.5(−3.5) mm
Labellum lateral lobe shape	oblong to oblong-orbicular	rhombic to oblong-orbicular	rhombic to semi-ovate
Labellum lateral lobe direction	strongly deflexed	deflexed	straight to deflexed
Labellum lateral lobe surface ornamentation	glabrous	papillose	papillose
Labellum lateral lobe margin	with entire margin	dentate margin at apex	entire to dentate margin at apex
Labellum middle lobe length	1−2 mm	2 mm	2−3(−3.5) mm
Labellum middle lobe width	(2−)2.5−4.5(−6) mm	2 mm	1−2.5 mm
Labellum middle lobe surface ornamentation	glabrous	papillose	papillose
Column length	3.5−5 mm	3.5 mm	2.5−3.5 mm
Column width	0.5−1 mm	0.5 mm	0.5−1 mm
Spur shape	cylindrical	conical-cylindrical	conical
Spur direction	horizontal to directed upwards	directed downwards to upwards	directed downwards
Spur length	8−13(−14) mm	8,5−11 mm	(4−)4.5 mm−7.5 mm
Spur width	1−2 mm	2 mm	(1−)1.5−2.5(−3) mm

In PCA and cluster analysis of the genus *Orchis*, all taxa were included in separate clusters (Figure 4.66 and Figure 4.75). When we examine the results of PCA and cluster analysis, it is seen that the populations of taxa are divided into two groups as anthropomorphic and non-anthropomorphic. It can be said that *O. simia*, *O. purpurea* subsp *purpurea* and their hybrid (*Orchis* × *angusticruris*) are differentiated from other *Orchis* taxa by different lobules length and width, tooth length and width, middle lobe width and lateral lobe length in labellum structures. This result also supports the conclusion of Tyteca et al. (2012) in which *Orchis* species with anthropomorphic lip were significantly differentiated from other *Orchis* species. The populations belonging to the remaining taxa were also clearly seperated in both analyzes. OSP had the most important difference among taxa. It can be said that column length, spur width and shape characters are effective in separating of this population from other populations of remaining taxa. In the cluster analysis, it can be said that the OMA and OAN populations do not show a significant variation and that each is combined with 100% similarity in its own cluster. The main reason for the

differences between the populations of other taxa may be the diversity of the quantitative character variation of the populations within the species. The main differences between the hybrid taxon *Orchis* × *angusticruris* and its parents are given in Table5.4.

Table 5.4. Basic differences between *Orchis simia*, *Orchis* × *angusticruris* and *Orchis purpurea* subsp. *purpurea*.

Character States	*Orchis simia*	*Orchis* × *angusticruris*	*Orchis purpurea* subsp. *purpurea*
Labellum lateral lobe width	0.5−1 mm	1.5 mm	1.5−2.5 mm
Labellum lateral lobe direction	upcurved	upcurved	directed forwards
Labellum lateral lobe surface ornamentation	papillose	papillose	papillose and tuft of long papillae and/or hairs
Labellum middle lobe width	(3−)5−10(−11) mm	9 mm	7−14(−16) mm
Labellum tooth width	0.5−1 mm	1 mm	0.5 mm
Lobules width	0.5−1(−1.5) mm	2.5 mm	2.5−6 mm
Lobules shape	narrowly linear	oblong-linear	broadly oblong-rhombic
First blooming location	terminal flowers	bottom flowers	bottom flowers

In the analyzes of the species of *Dactylorhiza*, it is seen that the populations belonging to the taxa passed into each other in PCA are clearly grouped separately in the clustering analysis (Figure 4.61 and Figure 4.70). The reason for the location of DRO populations farther than other taxa in PCA may be due to the fact that the petal width has the highest values among *Dactylorhiza* taxa. In addition, *Dactylorhiza* × *vogtiana* (DIBI599) hybrid is observed that it is closer to *D. incarnata* subsp. *incarnata* populations in PCA and cluster analysis. The most important characters of this hybrid to be more closer to *D. incarnata* subsp. *incarnata* are ”spur length, spur width, labellum lateral lobe direction, petal margin property and spur shape". The main differences seen between *Dactylorhiza* × *vogtiana* and its parents are given in Table 5.5.

Table 5.5. Basic differences between *Dactylorhiza iberica*, *Dactylorhiza* × *vogtiana* and *Dactylorhiza incarnata* subsp. *incarnata*

Character States	*Dactylorhiza iberica*	*Dactylorhiza* × *vogtiana*	*Dactylorhiza incarnata* subsp. *incarnata*
Bract length	10−25 mm	30 mm	23−50 mm
Bract width	(1.5−)2−5.5 mm	4.5 mm	4−8(−12) mm
Column length	2.5−3.5 mm	5 mm	2.5−3 mm
Column width	0.5−1 mm	0.5 mm	0.5−1 mm
Spur length	(2.5−)3−6(−6.5) mm	9 mm	5.5−7.5(−8) mm
Spur width	1−1.5(−2) mm	3 mm	2−2.5(−3) mm
Labellum lateral lobe direction	directed forwards	deflexed	more or less deflexed
Petal margin property	entire	scarcely crenulate	scarcely crenulate
Spur direction	horizontal to directed downwards	directed downwards	horizontal to directed downwards
Spur shape	narrowly cylindrical	conical	conical to conical-cylindrical

Although *Dactylorhiza* × *renzii* (DINN595) hybrid taxon is located away from their parents in cluster analysis, it is separated from the complex group in PCA and is located closer to *D. incarnata* subsp. *incarnata* populations. It can be said that the most important character that makes this hybrid closer to *D. incarnata* subsp. *incarnata* is lebellum lobe number. The main differences between *Dactylorhiza* × *renzii* and its parents are given in Table 5.6.

Table 5.6. Basic differences between *Dactylorhiza incarnata* subsp. *incarnata*, *Dactylorhiza* × *renzii* and *Dactylorhiza nieschalkiorum*

Character States	*Dactylorhiza incarnata* subsp. *incarnata*	*Dactylorhiza* × *renzii*	*Dactylorhiza nieschalkiorum*
Bract width	4−8(−12) mm	4 mm	(2.5−)3.5−9 mm
Column length	2.5−3 mm	4 mm	4.5−5.5 mm
Lebellum lobe number	3-lobed	3-lobed	undivided or 3-lobed at apex
Labellum width	(5−)5.5−8 mm	9 mm	(9−)11−16 mm
Spur length	5.5−7.5(−8) mm	10.5 mm	8−14 mm
Spur width	2−2.5(−3) mm	3 mm	2−5 mm
Labellum lateral lobe direction	more or less deflexed	directed forwards to deflexed	directed forwards to upcurved
Leaf blotch presence	without blotch	with blotch	with or without blotch
Petal margin property	scarcely crenulate	entire	entire
Spur shape	conical to conical-cylindrical	conical to inflated cylindrical	inflated cylindrical

Although individuals belonging to *Dactylorhiza* × *abantiana* coexist in the cluster analysis, one of the hybrid individuals (DIBN595B) is separated from the complex group in PCA and is located closer to the *Dactylorhiza iberica* populations. This may be due to the fact that some character measurements (bract width, spur width, column length) of DIBN595B are closer to *Dactylorhiza iberica*. This can be explained by the morphological variation of the hybrids that may occur as various combinations of the two parents. The main differences between *Dactylorhiza* × *abantiana* and its parents are given in Table 5.7.

Table 5.7. Basic differences between *Dactylorhiza iberica*, *Dactylorhiza* × *abantiana* and *Dactylorhiza nieschalkiorum*

Character States	*Dactylorhiza iberica*	*Dactylorhiza* × *abantiana*	*Dactylorhiza nieschalkiorum*
Bract length	10−25 mm	18−50 mm	15−63(−78) mm
Column width	0.5−1 mm	1 mm	1 mm
Lebellum lobe number	shortly 3-lobed	3-lobed	undivided or 3-lobed at apex
Spur length	(2.5−)3−6(−6.5) mm	8−9.5 mm	8−14 mm
Labellum lateral lobe direction	directed forwards	directed forwards to slightly upcurved	directed forwards to upcurved
Leaf blotch presence	without blotch	without blotch	with or without blotch
Spur direction	horizontal to directed downwards	directed downwards	horizontal to directed downwards

Individuals belonging to the *Dactylorhiza* × *balabaniana* hybrid were located in the same cluster in the cluster analysis and were located between their parents in the PCA. In PCA and clustering analysis, *D. nieschalkiorum* and *D. urvilleana* subsp. *ilgazica* taxa are located very close to each other. In both analyzes, it was observed that individuals of *Dactylorhiza* × *balabaniana* were closer to these two taxa than its other parent *Dactylorhiza iberica*. Although hybrid taxon has similar characteristics to *D. iberica* in the comparison table (labellum lobe number, labellum middle lobe direction, leaf blotch presence), it can be said that other characters in these two analyzes of all *Dactylorhiza* populations may have influenced *Dactylorhiza* × *balabaniana* to be close to *D. urvilleana*. The main differences between *Dactylorhiza* × *balabaniana* and its parents are given in Table 5.8.

Table 5.8. Basic differences between *Dactylorhiza iberica*, *Dactylorhiza* × *balabaniana* and *Dactylorhiza urvilleana* subsp. *ilgazica*

Character States	*Dactylorhiza iberica*	*Dactylorhiza* × *balabaniana*	*Dactylorhiza urvilleana* subsp. *ilgazica*
Bract length	10−25 mm	19−20 mm	20−51(−57) mm
Bract width	(1.5−)2−5.5 mm	3−3.5 mm	(3−)3.5−8 mm
Column length	2.5−3.5 mm	4 mm	4−5 mm
Column width	0.5−1 mm	1 mm	1 mm
Labellum lobe number	shortly 3-lobed	3-lobed	undivided or 3-lobed at apex
Spur width	1−1.5(−2) mm	2−2.5 mm	2.5−4.5(−6) mm
Labellum lateral lobe direction	directed forwards	directed forwards to slightly upcurved	directed forwards to deflexed or slightly upcurved
Labellum middle lobe direction	directed forwards	directed forwards	directed forwards to deflexed
Leaf blotch presence	without blotch	without blotch	with irregularly distributed blotces
Spur direction	horizontal to directed downwards	directed downwards	horizontal to slightly directed downwards
Spur shape	narrowly cylindrical	cylindrical	conical

Dactylorhiza nieschalkiorum and *D. urvilleana* subsp. *ilgazica* are taxa that can be mixed in diagnostics. In the results of PCA and cluster analysis, both taxa were separated. The main differences between *Dactylorhiza nieschalkiorum* and *D. urvilleana* subsp. *ilgazica* are given in Table 5.9.

Table 5.9. Basic differences between *Dactylorhiza nieschalkiorum* and *Dactylorhiza urvilleana* subsp. *ilgazica*

Character States	*Dactylorhiza nieschalkiorum*	*Dactylorhiza urvilleana* subsp. *ilgazica*
Labellum lateral lobe direction	directed forwards to upcurved	directed forwards to deflexed or slightly upcurved
Labellum middle lobe direction	directed forwards to slightly upcurved	directed forwards to deflexed
Leaf blotch presence	with or without blotch	with irregularly distributed blotces
Spur shape	inflated cylindrical	conical

In the PCA and cluster analyzes of the genus *Ophrys*, all taxa were included in separate clusters (Figure 4.65 and Figure 4.74). However, as a result of both analyzes, one of the *O. transhyrcana* subsp. *paphlagonica* populations (OTP563) was found to be a bit away from the OTP group. When we examine the character status of all OTP populations, it is seen that this difference is caused by the "labellum lobe number" character. The labellum lobe of *O. transhyrcana* subsp.

paphlagonica may be undivided or triple-lobed. As a matter of fact, unlike other OTP populations, the labellums of individuals belonging to the OTP563 population are undivided.

When we compare the results of analysis, the most distinctive group in PCA was *Ophrys fusca* subsp. *thracica*, whereas in cluster analysis *O. tremoris*. The reason why *O. fusca* subsp. *thracica* is positioned quite differently from other populations in PCA may be the effect of not having the characters of beak, horn/hump, appendix structures found in other *Ophrys* taxa. In addition, the other *Ophrys* taxa show various pubescence characteristics for the petal surface ornamentation, while the *O. fusca* subsp. *thracica* petals are glabrous. Evaluation of different characters in the cluster analysis revealed that *O. tremoris* firstly formed a different cluster. When the data are examined, it was seen that these characters were labellum lobe number, labellum width, labellum horn/hump length, speculum pattern and appendix direction. The *O. tremoris* population with unlobed labellum is different from all populations except the OTP563 population when compared to other *Ophyrs* populations according to the labellum division. In addition, the *O. tremoris* population has the widest labellum and the shortest hump among the *Ophyrs* populations detected in Bolu. It is also different from other *Ophrys* taxa with its H-shaped speculum pattern adorned with lateral points and the forward stance of the appendix structure.

In PCA and cluster analysis, *Ophrys apifera* populations did not show a significant variation and were included in the same cluster with 100% similarity in cluster analysis. On the other hand, *O. transhyrcana* subsp. *paphlagonica* and *O. tremoris* are the two closest taxa to each other in appearance and analysis results. The main differences between *O. transhyrcana* subsp. *paphlagonica* and *O. tremoris* are given in Table 5.10.

Table 5.10. Basic differences between *Ophrys transhyrcana* subsp. *paphlagonica* and *Ophrys tremoris*

Character States	*Ophrys transhyrcana subsp. paphlagonica*	*Ophrys tremoris*
Labellum horn/hump length	hump 1−2 mm	hump 0.5−1
Labellum width	(−7)8−11(−13) mm	10−15.5 mm
Dorsal sepal length	(9.5−)10−13 mm	13−14 mm
Lateral sepal length	10−14 mm	13.5−17 mm
Speculum pattern	H-shaped	H-shaped, mostly with lateral blotches
Appendix direction	slightly upcurved	directed forwards
Labellum lobe number	undivided or 3-lobed	undivided
General surface ornamentation of labellum	papillose, minutely velutinous and pilose	minutely velutinous and pilose
Petal margin property	slightly undulate to somewhat revolute margin	slightly undulate to revolute margin

In the results of clustering analysis of the genus *Epipactis*, all taxa are clearly separated (Figure 4.62 and Figure 4.71). In both analyzes, the distance between taxa is the same. However, in PCA, *Epipactis helleborine* subsp. *helleborine* and *E. turcica* were intertwined. The main morphological differences between these two taxa which are very close to each other are given in Table 5.11.

Table 5.11. Basic differences between *Epipactis helleborine* subsp. *helleborine* and *Epipactis turcica*

Character States	*Epipactis helleborine* subsp. *helleborine*	*Epipactis turcica*
Bract width	(4.5−)5−24 mm	3.5−16(−23) mm
Inflorescence length	(3−)8.2−33(−37.9) cm	10.6−28.6(−31.2) cm
Ovary surface ornamentation	glabrous or sparsely pubescent	sparsely pubescent
Leaf arrangement	distributed along the stem	densely distributed especially bottom of the stem, clasping stem at base
Flower arrangement	all-sided	almost one-sided

The EPE332 population approached the *E. helleborine* subsp. *helleborine* and *E. turcica* groups in both analyses. The characters separating the EPE332 population from other *E. persica* populations were hypochile width and petal width. The population of EPE332 was approximated to these taxa by entering the character range of *E. helleborine* subsp. *helleborine* and *E. turcica* in terms of hypochile width and petal width measurements.

In the cluster analysis of the genus *Cephalanthera*, all taxa were included in separate clusters. Although the results similar with PCA, the distinction between *C.*

longifolia and *C. damasonium* populations is not as clear as in cluster analysis (Figure 4.60 and Figure 4.69). However, *C. longifolia* and *C. damasonium* taxa are morphologically clearly separated by different leaf shapes (Table 5.12).

Table 5.12. Basic differences between *Cephalanthera longifolia* and *Cephalanthera damasonium*

Character States	*Cephalanthera longifolia*	*Cephalanthera damasonium*
Bract width	2.5−9.5 mm	(1.5−)6−20(−28) mm
Column width	1−1.5(−2) mm	1−3 mm
Epichile length	4−6 mm	4−7.5 mm
Hypochile length	4−5.5 mm	4−8.5 mm
Hypochile width	6−11 mm	7.5−14 mm
Leaf shape	linear-lanceolate to lanceolate	oblong-ovate to ovate-lanceolate

In cluster analysis, it can be said that the variations in other *Cephalanthera* taxa are not seen to a large extent among CRU populations. The main reason for the separation of CRU250 and CRU513 populations from other CRU populations is that the brach length is different.

In the cluster analysis of the genus *Himantoglossum*, all taxa are included in separate clusters and this result is similar in PCA (Figure 4.63 and Figure 4.72). There was no problem in the discrimination of the *Himantoglossum* taxa. The main differences of these three taxa are as follows (Table 5.13).

Table 5.13. Basic differences between *Himantoglossum caprinum*, *Himantoglossum affine* and *Himantoglossum comperianum*

Character States	*Himantoglossum caprinum*	*Himantoglossum affine*	*Himantoglossum comperianum*
Labellum lateral lobe length	(4−)5−22(−31) mm	3−6 mm	13−41(−53)
Lobules width	0.5−1 mm	1 mm	1 mm
Petal length	7−11(−11.5) mm	10−11 mm	10−11 mm
Dorsal sepal length	(8.5−)9−12(−15) mm	12−14 mm	12−14 mm
Lateral sepal length	10−15 mm	12−14 mmm	12−14 mm
Spur length	(2−)2.5−5 mm	Spur 3−4.5 mm	3−4.5 mm
Labellum lateral lobe direction	mostly deflexed	mostly deflexed	directed forwards to deflexed or slightly upcurved
Labellum middle lobe direction	directed forwards	directed forwards	mostly deflexed
Spur direction	horizontal to directed downwards	horizontal to directed downwards	horizontal to directed downwards
Spur shape	conical	pyramidal-conical	pyramidal-conical

In the cluster analysis of *Limodorum* taxa, *Limodorum abortivum* var. *abortivum* and *L. abortivum* var. *rubrum* were included in separate clusters (Figure 4.64 and Figure 4.73). Due to the existence of many color variations and combinations of the species, the characters related to the plant colors were not used in the analyzes. However, the most important discriminative character known between *L. abortivum* var. *abortivum* and *L. abortivum* var. *rubrum* is the color of the flower. Therefore, there is no clear distinction in PCA, although taxa has been separated in cluster analysis. There are two prominent characters in the morphological comparison of these two varieties. The color of the flower in *L. abortivum* var. *abortivum* is purple and its shades, while in *L. abortivum* var. *rubrum* is reddish pink and its shades. According to our measurements, quantitative characters were insufficient to separate two varieties. The other character that gives partially difference is dorsal sepal width. The dorsal sepal width of *L. abortivum* var. *abortivum* was 8-12 mm while it was measured as 10.5-13 mm in *L. abortivum* var. *rubrum*.

The regions with the highest diversity of orchids in the province of Bolu are Abant, BAİBÜ central campus, north of Merkeşler Village, around Şirinyazı pond and northern slopes of Taşkesti (Figure 4.?5). The regional conservation assessment was evaluated for all populations in Bolu province in the part of "*Morphological Features of Taxa*" in the thesis. The five regions shown on the map are under pressure due to especially urbanization and tourism activities, and these regions should be urgently *in-situ* protected.

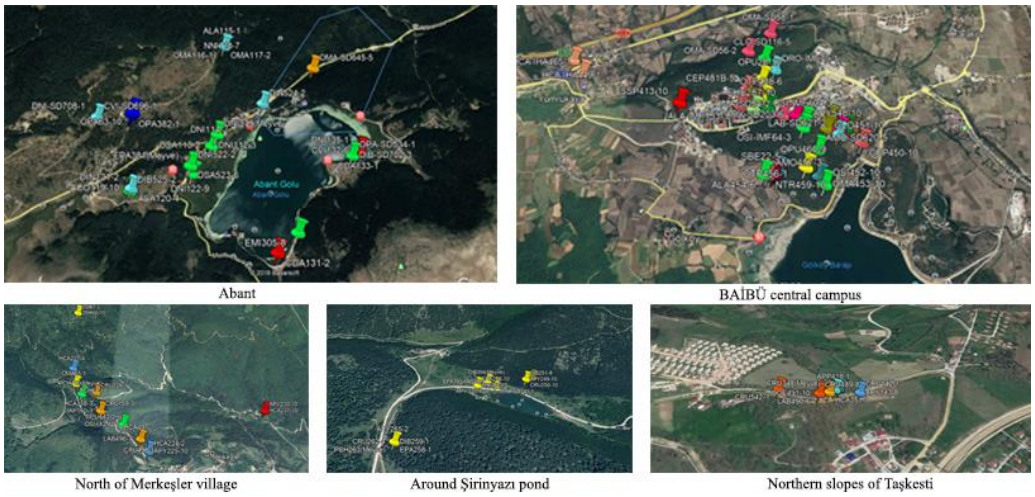


Figure 5.1. Regional hotspots for Bolu province in terms of terrestrial orchids.

6. CONCLUSION

This study is not only a floristic study but also a regional revision work on orchids. Both the methods used in morphometric analyzes and the samples and characters will be an important source for further research. Within this frame, preparation of inventory of orchids and determination of habitat features and intensity of populations will contribute to both Bolu and Turkish Floras. In addition, it will also contribute to the solutions of some taxonomic problems. At the point of solving taxonomic problems of orchids, there is a need for much more regional revision studies at population level. Moreover, it is of great importance to conduct regional conservation assessments of orchids during these studies.

The orchids, considered as world's most valuable ornamental plants, are mainly used in the floriculture, food and pharmaceutical industries. Our country is one of the important centers of biodiversity in the world in terms of terrestrial orchids, especially the Aegean coast and the Mediterranean region. This rich diversity has attracted the attention of local people, especially foreign plant traders and researchers since the 1930s, and the orchids were collected as ornamental, food or medicinal plants for many years. However, as a result of excessive and unconscious collections, the generations of orchid species have been threatened. In 1974, although attempts were made to prevent the collection of plant with the prohibition of exportation of orchids used in salep production, illegal harvests still continue. It would be a better way to focus on the income to be achieved through the improvement of ecotourism, as seen in developed countries rather than the income derived from salep sales. As in this study, in addition to the emergence of scientific findings, it is of great importance to establish basic data for the development of strategies for the *in-situ* conservation of orchids. On the other hand, in the production methods, when a tuber is used instead of seed, it is necessary to determine very well the taxa to be extracted from the nature for production. Salep content of the orchids to be produced and the quality of production of tuber should be based. The exclusion of rare, endemic or narrowly distributed orchid taxa and their habitats from this planning is important for the future of species.

7. REFERENCES

Abbott LA, Bisby FA and Rogers DJ (1985) Taxonomic Analyses in Biology. Columbia University Press, New York.

Akman Y and İlarslan R (1983) "The Phytosociological Investigation in the District of Uluhan-Mudurnu", Communications Faculty Sciences University Ankara, C1(5), 55-70.

Akman Y and Ketenoğlu O (1978) "The Phytosociological Investigation of Köroğlu Mountain", Communications Faculty Sciences University Ankara, C2(22), 1-24.

Akman Y and Ketenoğlu O (1979a) "Contribution a l'etude de la Flore du Mont de Köroğlu", Communications Faculty Sciences Univiversity Ankara, C22(23), 1-20.

Akman Y and Ketenoğlu O (1979b) "Flora of the Gerede-Aktaş Forest (Bolu) ", Communications Faculty Sciences University Ankara, C2(23), 21-57.

Akman Y and Yurdakulol E (1981a) "Contributions to the Flora of Bolu Mountains", Communications Faculty Sciences University Ankara, C2(24), 1-42.

Akman Y and Yurdakulol E (1981b) "Contributions to the Flora of Semen Mountains", Communications Faculty Sciences University Ankara, C2(24), 1-43.

Akman Y, Yurdakulol E and Aydoğdu E (1983a). A phytosociological research on the Vegetation of Bolu Mountains. Communications Faculty Sciences University Ankara, C1, 87-107.

Akman Y, Yurdakulol E and Demirörs M (1983b). The phytosociological research on the Vegetation of the Semen Mountains (Bolu). Communications Faculty Sciences University Ankara, C1, 6, 71-86.

Aksoy N (2009) "Karakiriş Dağı (Seben-Nallıhan) Florası", Ormancılık Dergisi, 2(5), 104-125.

Allaby M (2001) Plants and Plant Life, (9). Flowering Plants the Monocotyledons, Danbury, Connecticut Grolier.

Almeida MT and Bisby FA (1984) A Simple Method for Establishing Taxonomic Characters from Measurement Data. Taxon 33(3): 405-409.

Altundag E, Sevgi E, Kara O, Sevgi O, Tecimen HB and Bolat I (2012) "Studies on the Chorology, Ecology, Morphology and Conservation Strategies of *Orchis anatolica* Boiss (Orchidaceae)", Journal of Environmental Biology, 33: 325-333.

Anonymous (2014) Salep Eylem Planı 2014-2018. T.C. Orman ve Su İşleri Bakanlığı Orman Genel Müdürlüğü.

Arslan M, Kılınç İ and Vural M (2013) "Flora of Kale-Bolu Fındığı (Turkey) Nature Protection Area", Biological Diversity and Conservation, 6/3: 107-119.

Arslan N (2010) Ankara ve Civarı Orkidelerinin Sistematik ve Korolojik Yönden İncelenmesi, Yüksek Lisans Tezi, Eskişehir Osmangazi Üniversitesi, Fen Bilimleri Enstitüsü, Eskişehir.

Aybeke M (1997) Edirne Çevresindeki *Ophrys* L. (Orchidaceae) Türleri Üzerinde Morfolojik, Karyolojik ve Palinolojik Araştırmalar, Yüksek Lisans Tezi, Trakya Üniversitesi, Fen Bilimleri Enstitüsü, Edirne.

Aybeke M (2004) Trakya Bölgesinde Bazı Orkide Türleri Üzerinde Anatomik Araştırmalar, Doktora Tezi, Trakya Üniversitesi, Fen Bilimleri Enstitüsü, Edirne.

Aybeke M (2007) "Pollen and Seed Morphology of Some *Ophrys* L. (Orchidaceae) Taxa", Journal of Plant Biology, 50(4): 387-395

Aybeke M (2017) "Vessel anatomy studies in orchids (Orchidaceae)", Acta Biologica Turcica, 30(4): 89-93.

Aybeke M, Sezik E and Olgun G (2010) "Vegetative Anatomy of Some *Ophrys*, *Orchis* and *Dactylorhiza* (Orchidaceae) Taxa inTrakya Region of Turkey", Flora, 205: 73–89

Bayındır N (2013) Aquatic plant diversity of Gölköy and Yumrukaya (Bolu,Turkey), Master Thesis, Abant İzzet Baysal University, Graduate School of Natural Science, Bolu.

Baytop T and Sezik E (1968) "Türk Salep Çeşitleri Üzerinde Araştırmalar", İstanbul Üniversitesi Eczacılık Fakültesi Mec., 4 (61): 61-68.

Bektaş E, Cüce M and Sökmen A (2013) "In Vitro Germination, Protocorm Formation, and Plantlet Development of *Orchis coriophora* (Orchidaceae), a Naturally Growing Orchid Species in Turkey", Turkish Journal of Botany, 37: 336-342.

Boissier E (1884) Flora Orientalis 5 (Orchidaceae), Genevae.

Bozkurt N and Yıldırım H (2015) "Türkiye İçin Yeni Bir Tür Kaydı: Ophrysa pollonae Paulus & M. Hirth (Orchidaceae)", Bağbahçe Bilim Dergisi, 2(2): 20-26.

Cullen J (1992) The Orchid Book, Cambridge Universty Press, England.

Çoban S (2013) Bolu-Ayıkaya Bölgesi Bitki Toplumları ve Meşcere Kuruluş Özellikleri, Doktora Tezi, İstanbul Üniversitesi, Fen Bilimleri Enstitüsü, İstanbul.

Daşkın R, Yılmaz Ö and Kaynak G (2007) "A new record for the flora of Turkey: *Dactylorhiza maculata* (L.) Soó (Orchidaceae)", J. Biol. Environ. Sci. 1(1), 11-14

Davis PH (edit.) (1965-1988) Flora of Turkey and the East Aegean Islands 1-10. Edinburgh University Press.

Delforge P (1995) Orchids of Britain and Europe.Harper Collins Publisher, London.

Demir S (2013) Monocotyledonous Geophytic Flora of Bolu Province, Master Thesis, Abant İzzet Baysal University, Graduate School of Natural Science, Bolu.

Demir S and Eker İ (2015) Petaloid Monocotyledonous Flora of Bolu Province, Including Annotations on Critical Petaloid Geophytes of Turkey, 1. edition, Pagem Akademi, Ankara

Doğan S (2014) In Situ Conservation Possibilities of Some Endemic Species in Gölköy Campus, Bolu, Master Thesis, Abant İzzet Baysal University, Graduate School of Natural Science, Bolu.

Düşünen K, Çıngay B, Can L and Cabi E (2013) "Tekirdağ İlimizin Salep Çeşitliliği", Ekoloji 2013 Conference, Tekirdağ.

Eker İ, Kaya A, Çelik A, Eker N (2018) Bolu Abant İzzet Baysal Üniversitesi Kampüs Florası, 1. baskı, Kemal Matbaacılık, Bolu.

Eker İ, Çelik A, Kaya A and Aydın A (2019) Bolu'nun Endemik ve Nadir Bitkileri, 1. baskı, Dumat Ofset Matbaacılık, Ankara

Ekim T and İlarslan R (1982) "Yedigöller Milli Parkı'nın (Bolu) Florası", Orman Araştırma Enstitüsü Dergisi, 28(56), 53-67.

Ekim T, Koyuncu M, Vural M, Duman H, Aytaç Z and Adıgüzel N (2000) Türkiye Bitkileri Kırmızı Kitabı. Ankara:Türkiye Tabiatını Koruma Derneği ve Yüzüncü Yıl Üniversitesi Yayınları, Barışcan Ofset.

Ertem G (1977) "Trakya Florası İçin Yeni Olan *Ophrys bombyliflora* Link. Üzerinde Çalışmalar", Biyoloji Dergisi, 27(1): 39-44.

Govaerts R (2014) World Checklist of Selected Plant Families. http://apps.kew.org/wcsp/home.do, 5 November 2014

Gönülşen N, Önal K, Ercan N, Yıldızgördü K, Sekercioğlu E, Biçici M and Eskalen, A, (1996) Ege ve Doğu Akdeniz Bölgelerinde Doğal Yayılış Gösteren Orchidaceae Familyasına Ait Bazı Türlerin In Vitro ve In Vivo Koşullarda Üretilmeleri Üzerine Araştırmalar, TÜBİTAK Proje No: TBGAG-52, Ankara, 92 s.

Güler N (1997) Edirne Çevresindeki *Orchis* L. (Orchidaceae) Türleri üzerinde Morfolojik, Sistematik, Korolojik, Karyolojik ve Palinolojik Araştırmalar, Yüksek Lisans Tezi, Fen Bilimleri Enstitüsü, Edirne.

Güler N (2005) Kazdağları'nda Yetişen Orchıdaceae Familyası Bitkileri Üzerinde Morfolojik ve Korolojik Araştırmalar, Doktora Tezi, Trakya Üniversitesi, Fen Bilimleri Enstitüsü, Edirne.

Güler N (2016) "Seed Micromorphology of *Orchis* Tourn. ex L. (Orchidaceae) and Allied Genera Growing in Edirne Province, Turkey", PhytoKeys, 68: 9-25

Güler N and Deniz İG (2012) Orchidaceae. Şu eserde: Güner A., Aslan, S., Ekim, T., Vural, M & Babaç, M. T. (edlr.). Türkiye Bitkileri Listesi (Damarlı Bitkiler). Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını. İstanbul.

Güler N, Göynüz A, Hürkan K and Döver E (2008) Çan Değerleri Sempozyumu. Çanakkale: Çanakkale Onsekiz Mart Üniversitesi Yayınları.

Güner A, Özhatay N, Ekim T and Başer KHC (edits.) (2000) Flora of Turkey and the East Aegean Islands 11. Edinburgh Univ. Press, Edinburgh.

Hágsater E and Dumont V (1996) Orchids. - Status Survey and Conservation Action Plan. - IUCN/SSC Orchid Specialist Group. Gland. Switzerland & Cambrige. UK.

Hahn W and Passin J (1997) "Orchideenfunde in Karien (Südwesttürkei)", Ber. Arbeitskrs. Heim. Orchid., 14 (1): 41-61.

İkinci N (2011) “Gamma-diversity of vascular plant taxa of the surrounding of Lake Sünnet (Bolu, NW Turkey) compared with other regions in Bolu”, Biological Diversity and Conservation, 4/1: 107-121.

İkinci N and Bayındır N (2019) "Distribution and Richness of Aquatic Plants of Bolu Provi", Fresenius Environmental Bulletin, Vol. 28, No. 1/2019, 244-256.

İkinci N and Güner A (2007) "Flora of the Gölcük Area (Bolu, Turkey)", Turkish Journal of Botany, 31, 87-107.

İşler S (2005) Van Salebinin Menşei ve Van Civarının Orkideleri, Yüzüncü Yıl Üniversitesi, Fen Bilimleri Enstitüsü, Doktora Tezi, Van.

Kanoğlu SS (2011) Sülüklügöl (Bolu - Mudurnu, Göynük / Adapazarı - Akyazı) Çevresinin Florası, Yüksek Lisans Tezi, Düzce Üniversitesi, Fen Bilimleri Enstitüsü, Düzce.

Kanoğlu SS, Aksoy N and Kaya A (2016) “Sülüklü Göl (Bolu-Adapazarı / Türkiye) çevresinin florası”, Bağbahçe Bilim Dergisi, 3(2): 20-42.

Ketenoğlu O (1983) The Phytosociological and phytoecological investigation of the Gerede-Aktaş forest. Comm. Fac. Of Sci. UA. C1: 21-38.

Koyuncu O, Yaylacı ÖK, Öztürk D, Erkaka İP, Savaroğlu F, Osoydan K and Ardıç M (2011) “Distribution, Elements of Destruction and Evaluation of Risk Categories of Orchids in Osmaneli (Bilecik/Turkey) and Its Environs”, Biological Diversity and Conservation, 4/1: 122-133

Kreutz CAJ (1998) Die Orchideen der Turkei: Beschreibung, Okologie, Verbreitung, Gefahrdung, Schutz. Landgraaf, Netherlands.

Kreutz CAJ (2000) "Orchidaceae. In: Flora of Turkey and The East Aegean Islands (Edit. Güner et al.)", University Pres, 11,275-305, Edinburgh.

Kreutz CAJ and Çolak AH (2009) Türkiye Orkideleri (1. Baskı), Rota Yayınları, İstanbul.

Levesque R (2007) SPSS Programming and Data Management: A Guide for SPSS and SAS Users, Fourth Edition, SPSS Inc., Chicago Ill.

Massart DL, Smeyers-Verbeke J, Capron X and Schlesrer K (2005) Visual presentation of data by means of box plots. LC-GC Europe 18: 215-218.

Meyer RK and Krueger DD (2004) A Minitab Guide to Statistics (3rd ed.). Upper Saddle River, NJ: Prentice-Hall Publishing.

Orhan Ç (2006) Akdağmadeni (Yozgat) Salebi Üzerine Araştırmalar, Yüksek Lisan Tezi, Gazi Üniversitesi, Sağlık Bilimleri Enstitüsü, Ankara.

Özkan NG, Aksoy N, Aslan S, Tunçkol B and Koçer N (2016) “Flora of Argözü Valley (Kıbrıscık-Bolu)”, International Forestry Symposium, December 2016, Kastamonu

Petrou N, Petrou M, Deniz İG, Sezik E, Georgiadis C, Gletsos M (2016) “Greek-Turkish White Paper Current Status and Best Practice Analysis for Greek and Turkish native orchid flora conservation”, Interactive Conservation Platform for Orchids Native to Greece -Turkey ICON.

Renz R and Taubenheim G (1984) “*Dactylorhiza* Necker ex Nevski“, In: Flora of Turkey and the East Aegean Islands (ed: P.H. Davis) (8), 535-551.

Roe D (2008) Trading Nature. A Report, with Case Sudies, on the Contribution of Wild Life Trade Management to Sustainable Livelihoods and the Millennium Development Goals. TRAFFIC International and WWF International.

Rückbrodt U, Rückbrodt D, Hansen K and Hansen RB (1992) “Bemerkungen zu den in der Turkei Vorkommenden Orchideenarten und ihrer Verbrei-tung. - Ber. Arbeitskrs. Heim. Orchid. 9 (1): 4-113, 161, 161-176 (66 Abb.).

Sandal Erzurumlu G, Sultana N, Vural M and Serçe S (2018) “Genetic and phenotypic variation among Turkish terrestrial orchid species as revealed by RAPD and morphological characteristics”, Turkish Journal of Agriculture and Forestry, 42: 227-236.

Sandal Erzurumlu G and Doran İ (2011) “Türkiye'de Salep Orkideleri ve Salep Kültürü”, HR.Ü.Z.F. Dergisi, 15(1): 29-34

Schönfelder M and Schönfelder H (1998) "Turkische Schwarzmeerkuste: eine neue Ophrys Art sowie interessante Funde aus der Provinz Ordu, Ber. Arbeitskrs", Heim. Orchid., 14(2): 16-25. Schultes, R.E. & Pease, A.S.

Sezik E (1967a) Researches on the Orchids of Turkey and Turkish Saleps, Ph. D. Thesis, İstanbul University, İstanbul University Graduate School of Pharmacy, İstanbul.

Sezik E (1967b) “Türkiye'nin salepgilleri Ticari Salep Çeşitleri ve Özellikle Muğla Salebi Üzerinde Araştırmalar“, Doktora Tezi, İstanbul Üniversitesi Eczacılık Fakültesi, İstanbul.

Sezik E (1969) “Muğla Civarında Salep Elde Edilen Bitkilerin Mahalli İsimleri (The Native Names of Salep Producing Plants Around Muğla) “, J. Fac. Pharm. İstanbul 5 (77): 77-79.

Sezik E (1982) “Türkiye'de Orchidaceae Familyası“, IV Bitkisel İlaç Hammaddeleri Toplantısı - Eskişehir, 27-29: 77-83

Sezik E (1984) Orkidelerimiz, Türkiye'nin Orkideleri (6. Baskı). Ali Rıza BASKAN - Güzel Sanatlar Matbaası A.Ş. / İstanbul: Sandoz Kültür Yayınları.

Sezik E (1988) “An Unknown Side of Turkey: An Orchid Paradise“, Image12: 11-15

Sezik E (1989) “Turkish Orchids and Salep“, Orchidées Botaniques du Monde entier, Société Française d'Orchidophile, Colloque 11,181-189. Paris

Sezik E (1990) “Türkiye'nin Orkideleri“, Bilim ve Teknik Aylık Popüler Dergi, 23,5-8.

Sezik E (2002a) "Türkiye'nin Orkideleri ve Salep", Acta Pharmaceutica Turcica, 44, 151-157.

Sezik E (2002b) "Destruction and Conservation of Turkish Orchids", Biomolecular Aspects of Biodiversity and Utilization, 391.

Sezik E and Baykal T (1991) “Maraş Salebi'nin Menşei (The origin of Maraş Salep) “, Doğa - Tr. J. of Pharmacy 1, 10-16.

Sezik E and Özer YB (1983) Kastamonu Salebi’nin Menşei ve Kastamonu Civarının Orkideleri, TÜBİTAK projesi, TBAG-424, Ankara.

Sümer N (2002) “Flora of Lake Yeniçağa“, Master Thesis, Abant Izzet Baysal University Graduate School of Natural Science, Bolu.

Şenel G, Akbulut MK and Şeker ŞS (2018) “Comparative anatomical properties of some Epidendroideae and Orchidoideae species distributed in NE Turkey”

Sezik E, İsler S, Güler N, Orhan Ç, Aybeke M, Deniz İG and Üstün O (2007) Selep ve Orkidelerin Tahribi, Tübitak araştırma projesi raporu, No:TBAG-Ç- SEK/23 (103T008), Ankara, 107 s.

Sneath PAH and Sokal RR (1973) Numerical Taxonomy. Freeman Press. San Francisco.

Sungurlu A (2011) “Kartalkaya Subalpin Çayırlarının Florası“, Yüksek Lisans Tezi, Ankara Üniversitesi, Fen Bilimleri Enstitüsü, Ankara.

Tamer CE, Karaman B and Copur U (2006) “A Traditional Turkish Beverage: Salep”, Food Reviews International, 22:1, 43-50.

Tekinşen KK and Güner A (2010) “Chemical Composition and Physicochemical Properties of Tubera Salep Produced From Some Orchidaceae Species”, Food Chemistry, Vol: 121, Issue: 2, 468-471.

Tunçkol B (2012) Taşlıyayla ve Kızık (Bolu-Seben) çevresinin florası, Yüksek Lisans Tezi, İstanbul Üniversitesi, Fen Bilimleri Enstitüsü, İstanbul.

Turgut T (1996) “Flora of Abant İzzet Baysal University“, Master Thesis, Abant Izzet Baysal University Graduate School of Natural Science.

Türker A and Güner A (2003) “Plant Diversity in Abant Nature Park (Bolu) “, Turkish Journal of Botany, 27, 185-221.

Tyteca D, Ceinos M, Gathoye JL, Brys R and Jackumyn H (2012) “On the morphological, biological and genetic heterogeneity of the genus Orchis (Orchidaceae, Orchidinae)”, Phytotaxa, 75: 19–32

Uçar A (1996), Flora of Abant, Master Thesis, Abant İzzet Baysal University, Graduate School of Natural Science, Bolu.

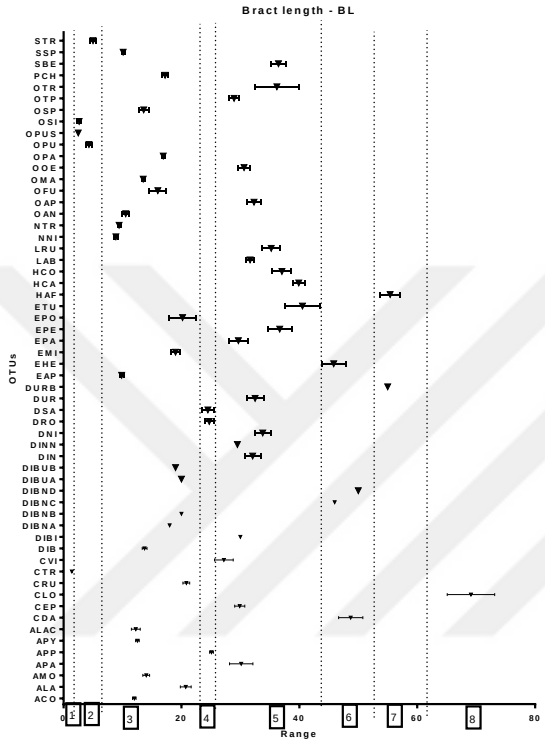
Uluğ M (1999) Gökçeler Dağı’nın (Gerede-Eskipazar) Florası. Yüksek lisans tezi. A. Ü., Fen Bil. Ens. (Gökçeler Mountain (Gerede-Eskipazar) Flora. MSc. Grad. School, AU.

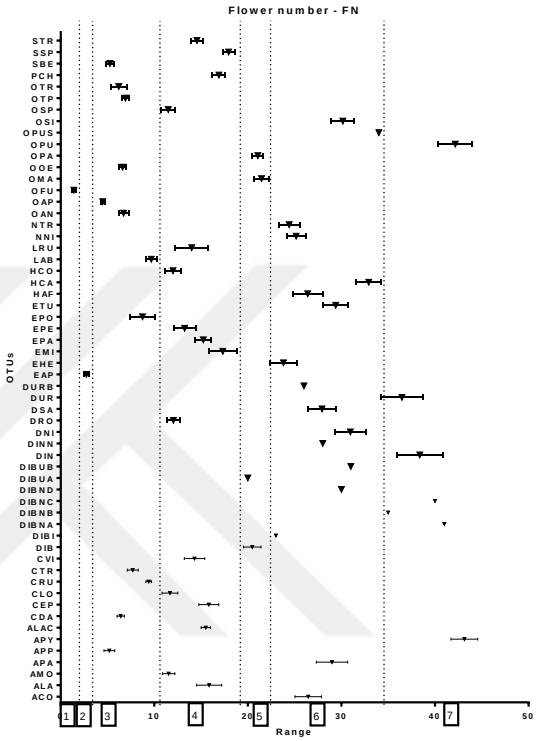
Yaman K (2013) "1920’den Günümüze T.C. Resmi Gazete Arşivinde Salep ve Ticareti İle İlgili Yasal Düzenlemeler", Tarih Kültür ve Sanat Araştırmaları Dergisi, 2(1), 172-180.

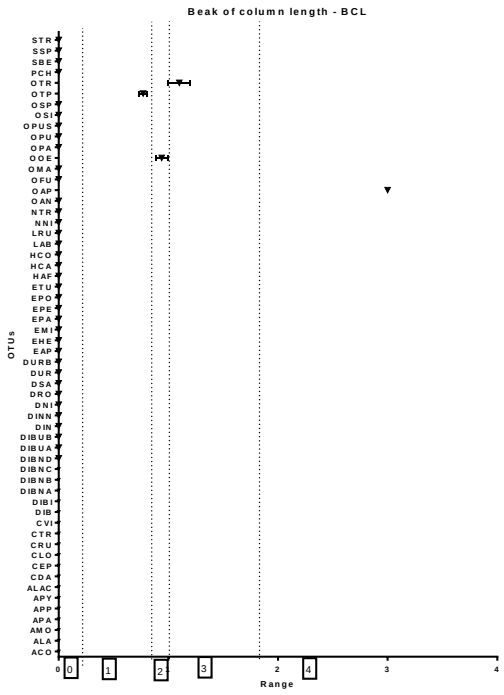
APPENDICES

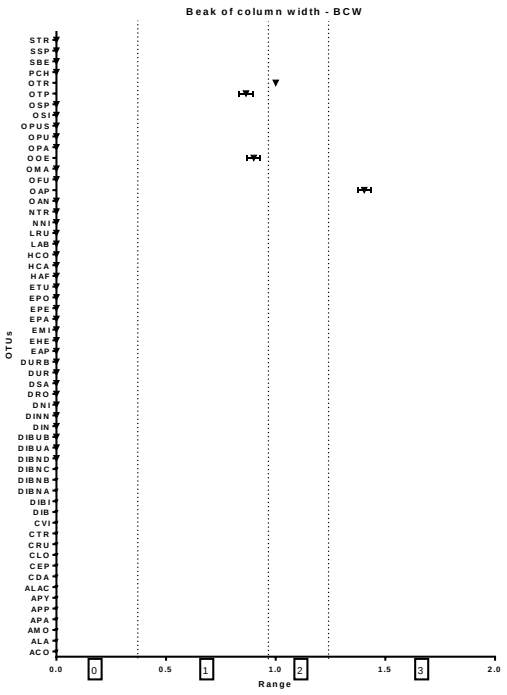
8. APPENDICES

Appendix A Codified Quantitative Characters in Graphpad Program (Means with Standart Error Plots).

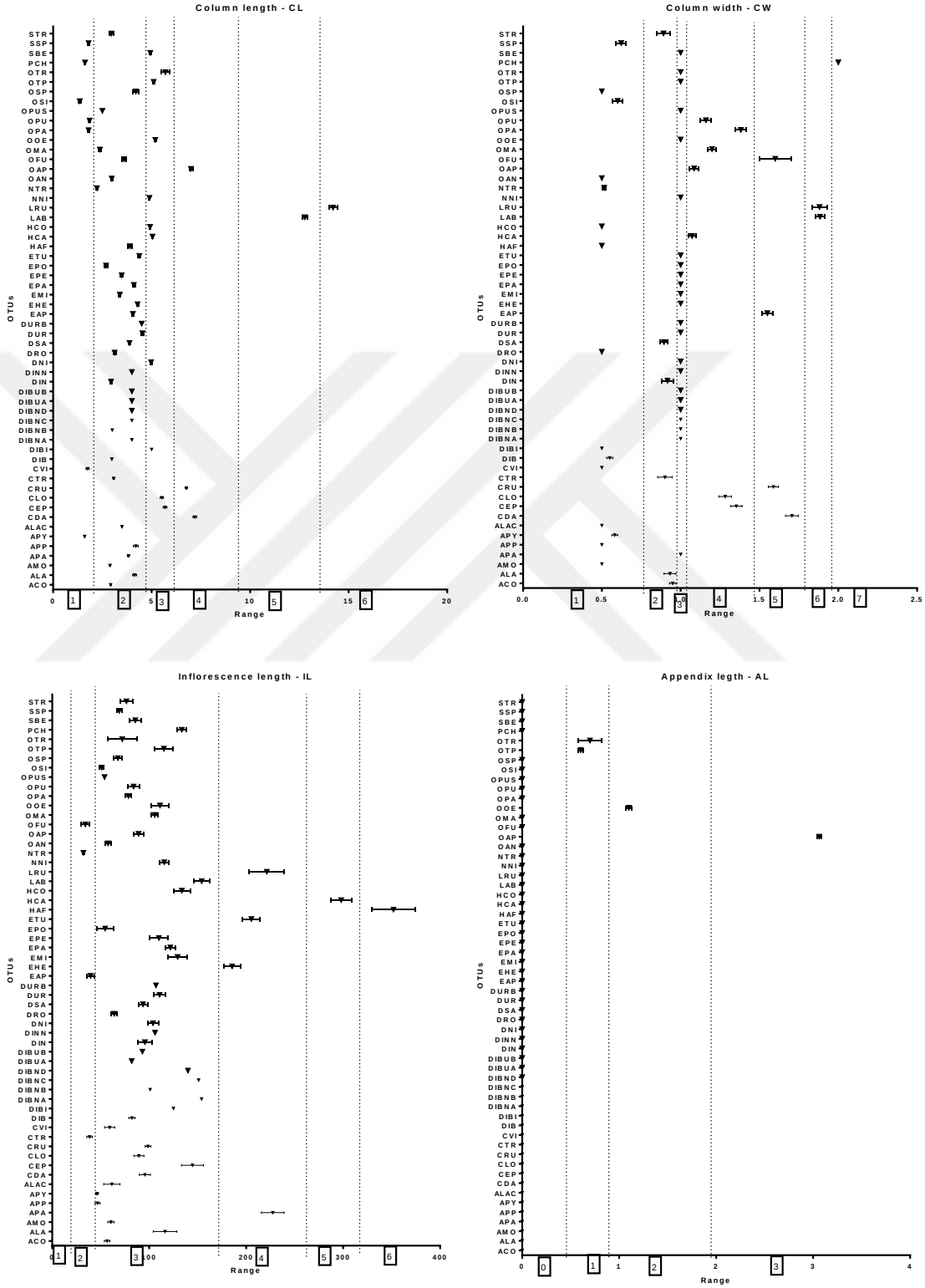




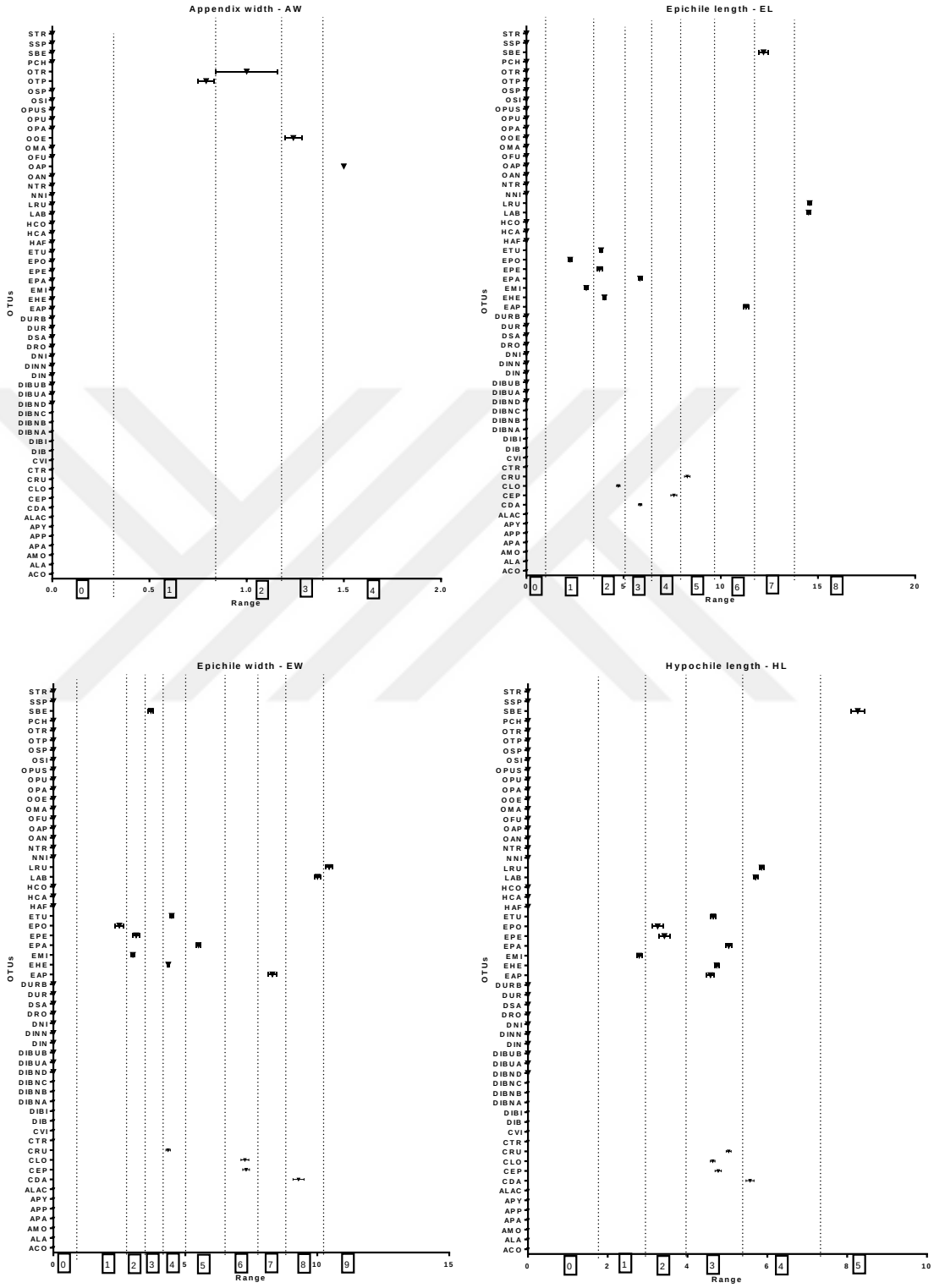




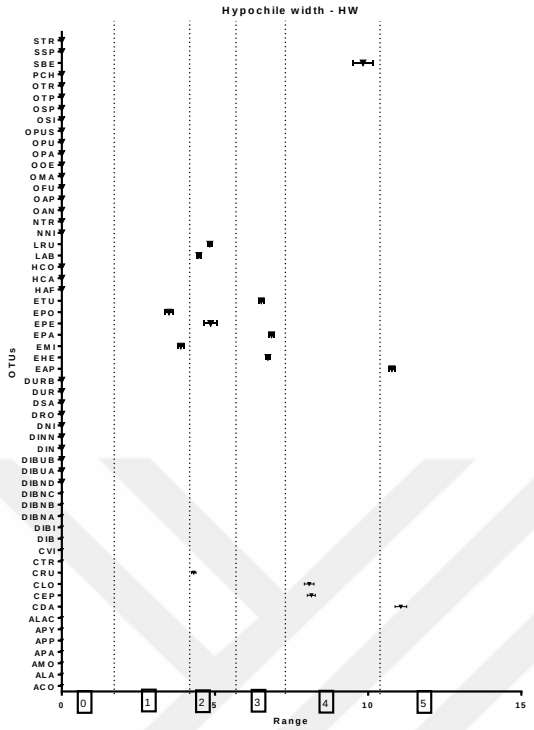
Appendix A (continued)

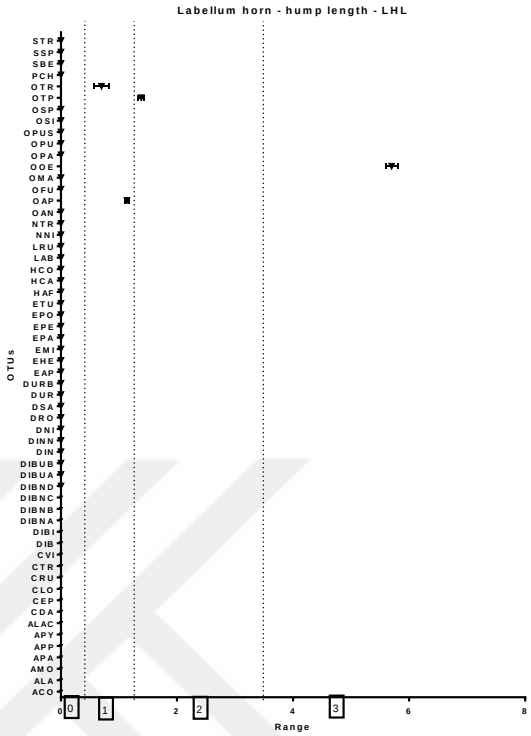


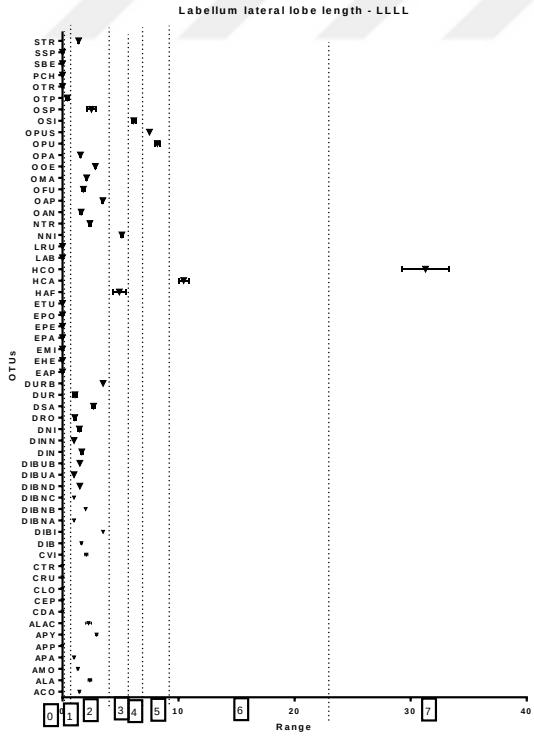
Appendix A (continued)

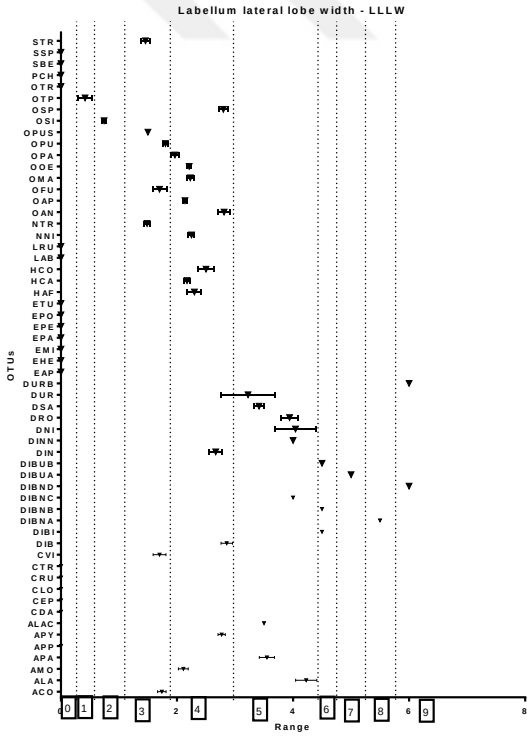


Appendix A (continued)

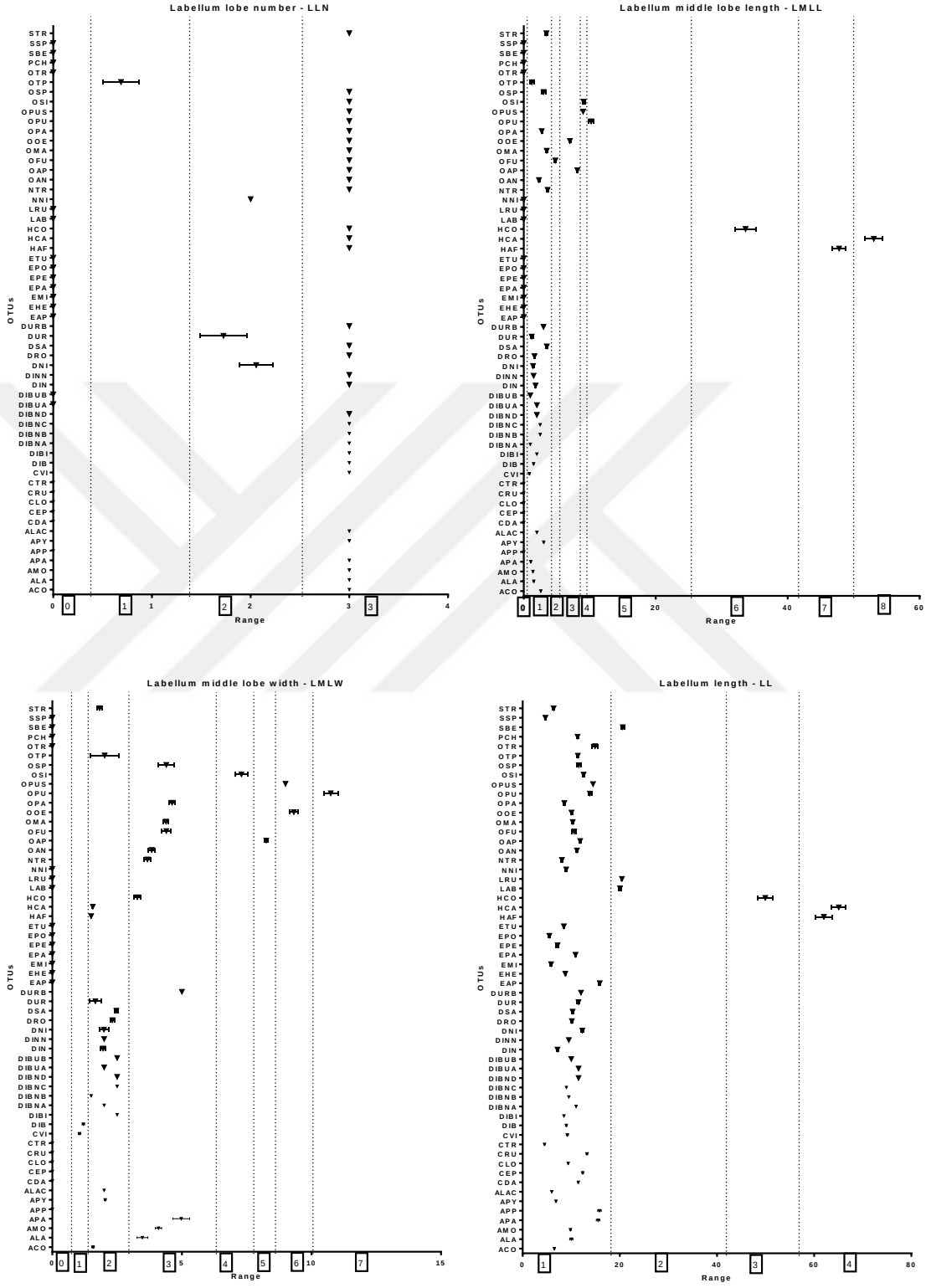




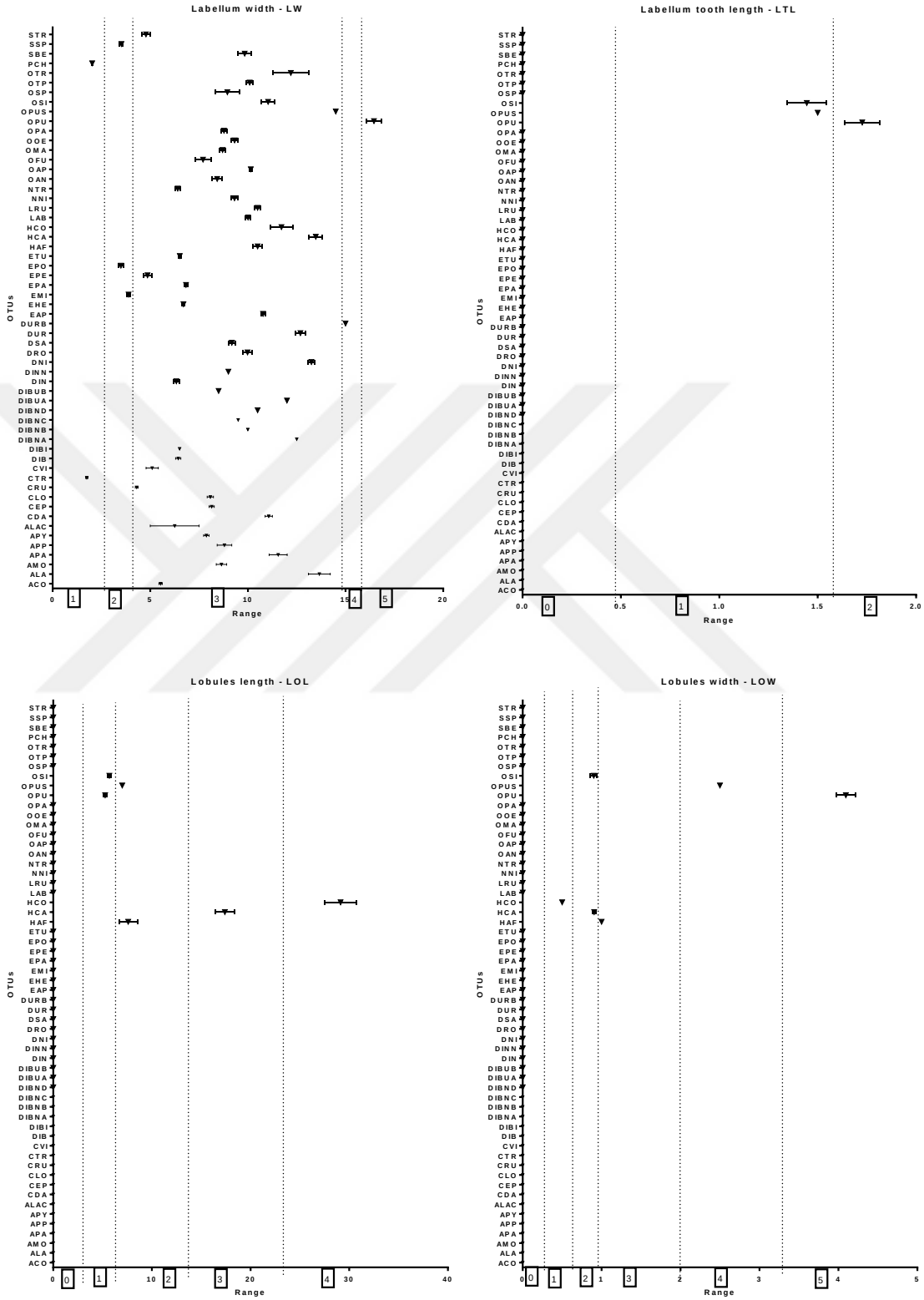




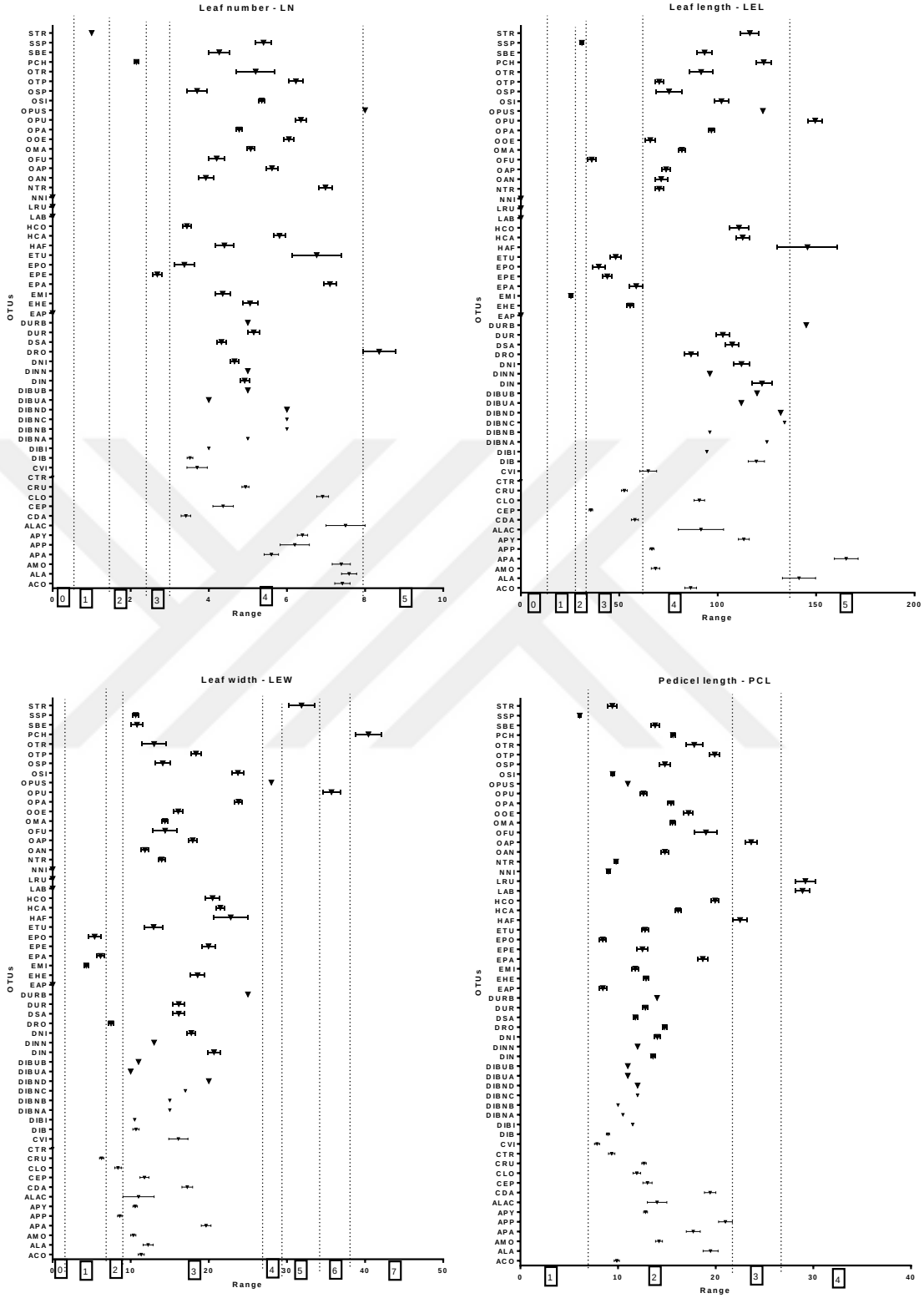
Appendix A (continued)



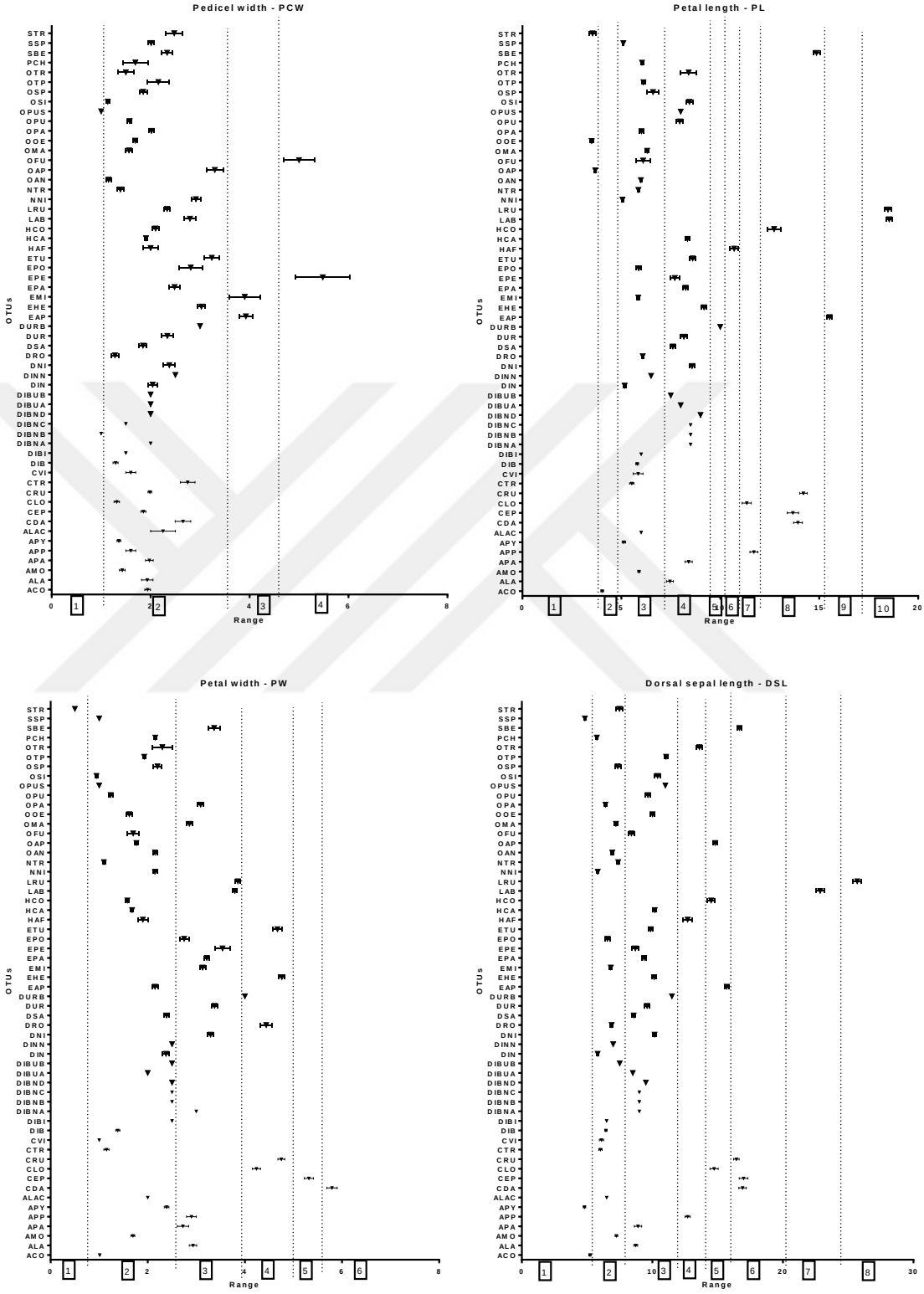
Appendix A (continued)



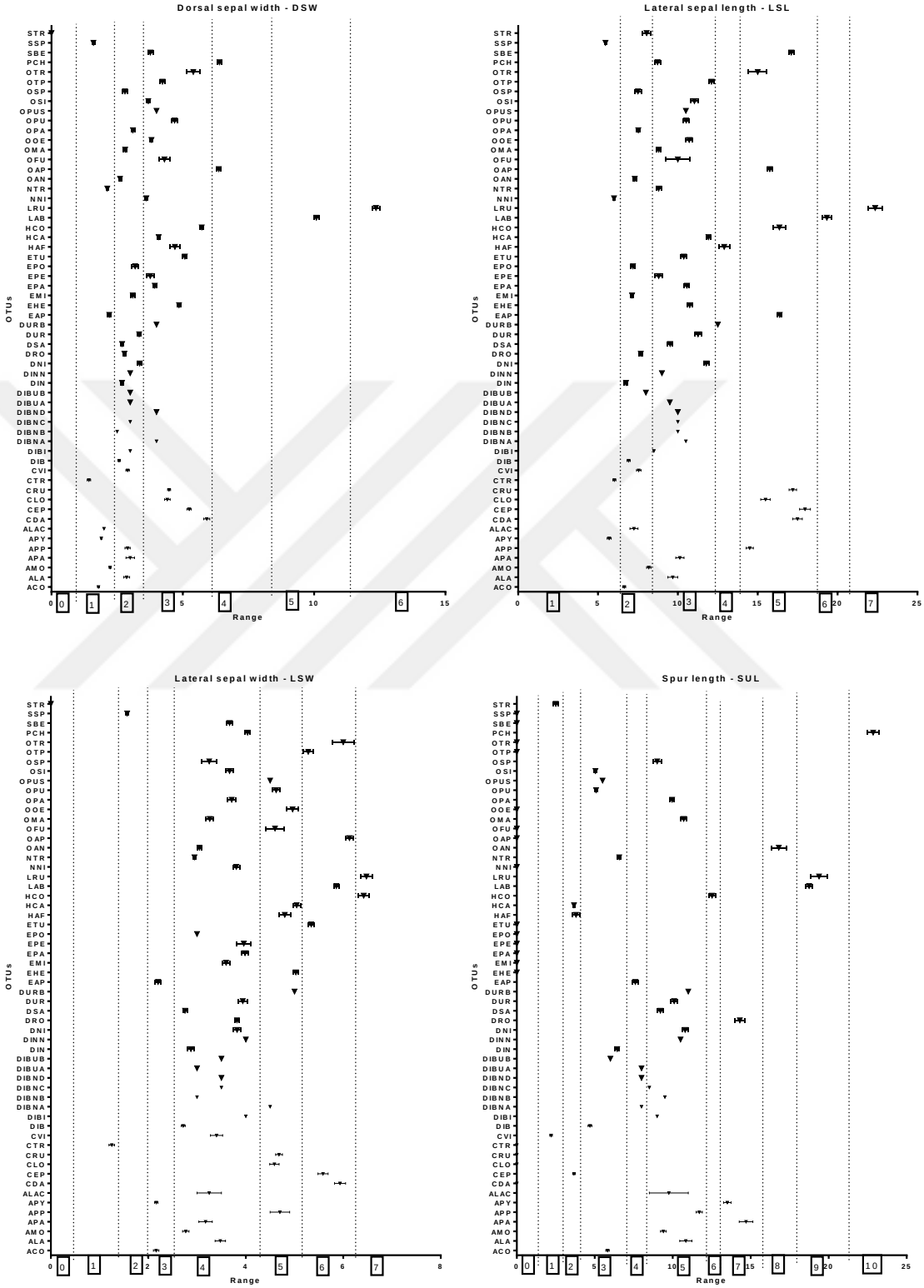
Appendix A (continued)



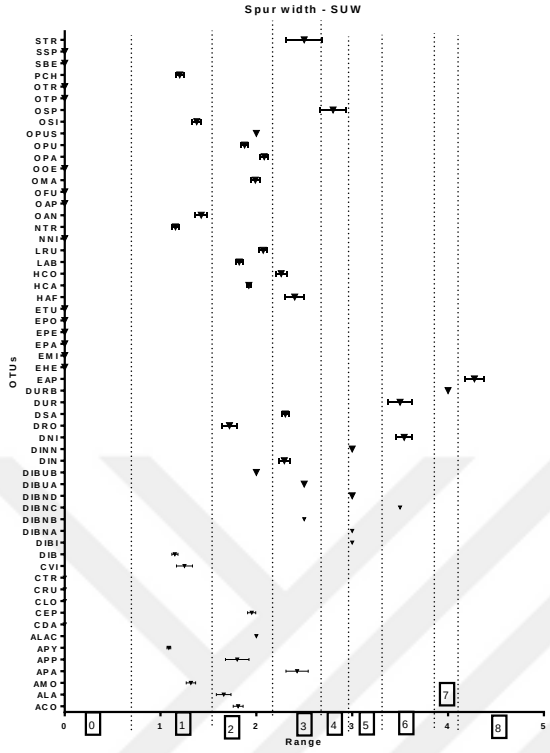
Appendix A (continued)

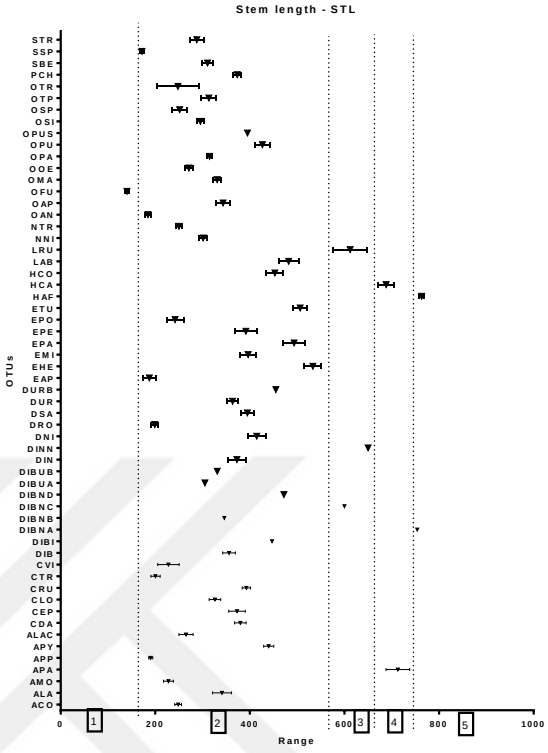


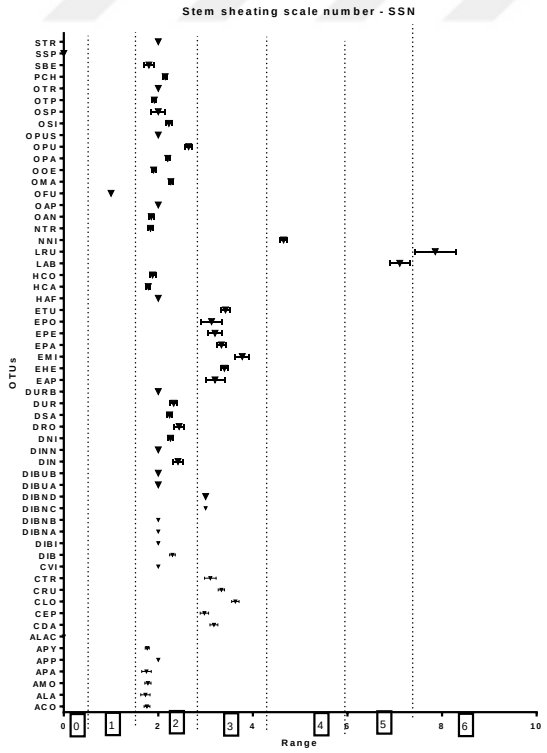
Appendix A (continued)



Appendix A (continued)







Appendix B Selected characters and character states used in principal component and cluster analysis

Appendix B.1 Selected characters and character states used in principal component and cluster analysis for all taxa.

		CHARACTERS AND CHARACTER STATES FOR ALL TAXA																																										
	Ch	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
	OTUs	BL	FN	BCL	BCW	CL	CW	IL	AL	AW	EL	EW	HL	HW	LHL	LLLL	LLLW	LLN	LMLL	LMLW	LL	LW	LTL	LTW	LOL	LOW	LN	LEL	LEW	PCL	PCW	PL	PW	DSL	DSW	LSL	LSW	SUL	SUW	STL	SSN	FBL	USS	LF
1	ACO	3	6	0	0	2	2	3	0	0	0	0	0	0	0	2	3	3	1	2	1	3	0	0	0	0	4	4	3	2	2	2	2	1	1	2	3	3	2	2	2	1	2	1
2	ALA	3	4	0	0	2	2	3	0	0	0	0	0	0	0	2	5	3	1	3	1	3	0	0	0	0	4	5	3	2	2	4	3	3	2	3	4	5	2	2	2	1	2	1
3	AMO	3	4	0	0	2	1	3	0	0	0	0	0	0	0	2	4	3	1	3	1	3	0	0	0	0	4	4	3	2	2	3	2	2	1	2	4	5	1	2	2	1	2	1
4	APA	5	6	0	0	2	3	4	0	0	0	0	0	0	0	2	5	3	1	3	1	3	0	0	0	0	4	5	3	2	2	4	3	3	2	3	4	7	3	4	2	1	2	1
5	APP	4	3	0	0	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	4	4	2	2	2	7	3	4	2	5	5	5	2	2	2	1	2	1
6	APY	3	7	0	0	1	1	3	0	0	0	0	0	0	0	2	4	3	1	2	1	3	0	0	0	0	4	4	3	2	2	3	2	1	1	1	3	7	1	2	2	1	2	1
7	ALAC	3	4	0	0	2	1	3	0	0	0	0	0	0	0	2	5	3	1	2	1	3	0	0	0	0	4	4	3	2	2	3	2	2	1	2	4	5	2	2	0	1	2	1
8	CDA	6	3	0	0	4	5	3	0	0	3	8	4	5	0	0	0	0	0	0	1	3	0	0	0	0	4	3	3	2	2	8	6	6	3	5	6	0	0	2	3	1	1	1
9	CEP	5	4	0	0	3	4	3	0	0	4	6	3	4	0	0	0	0	0	0	1	3	0	0	0	0	4	3	3	2	2	8	5	6	3	5	6	2	2	2	3	1	1	1
10	CLO	8	4	0	0	3	4	3	0	0	2	6	3	4	0	0	0	0	0	0	1	3	0	0	0	0	4	4	2	2	2	7	4	5	3	5	5	0	0	2	3	1	1	1
11	CRU	3	3	0	0	4	5	3	0	0	5	4	3	2	0	0	0	0	0	0	1	3	0	0	0	0	4	3	1	2	2	8	4	6	3	5	5	0	0	2	3	1	1	1
12	CTR	1	3	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2	2	3	2	2	1	1	1	0	0	2	3	1	1	2
13	CVI	5	4	0	0	1	1	3	0	0	0	0	0	0	0	2	3	3	1	1	1	3	0	0	0	0	4	4	3	2	2	3	2	2	2	2	4	1	1	2	2	1	3	1
14	DIB	3	5	0	0	2	1	3	0	0	0	0	0	0	0	2	4	3	1	1	1	3	0	0	0	0	4	4	3	2	2	3	2	2	2	2	4	3	1	2	2	1	3	1
15	DIBI	5	6	0	0	3	1	3	0	0	0	0	0	0	0	2	6	3	1	2	1	3	0	0	0	0	4	4	3	2	2	3	2	2	2	3	4	5	5	2	2	1	3	1
16	DIBNA	3	7	0	0	2	3	3	0	0	0	0	0	0	0	2	8	3	1	2	1	3	0	0	0	0	4	4	3	2	2	4	3	3	3	3	5	4	5	5	2	1	3	1
17	DIBNB	3	7	0	0	2	3	3	0	0	0	0	0	0	0	2	6	3	1	2	1	3	0	0	0	0	4	4	3	2	1	4	2	3	2	3	4	5	3	2	2	1	3	1
18	DIBNC	6	7	0	0	2	3	3	0	0	0	0	0	0	0	2	5	3	1	2	1	3	0	0	0	0	4	4	3	2	2	4	2	3	2	3	4	5	6	3	3	1	3	1
19	DIBND	6	6	0	0	2	3	3	0	0	0	0	0	0	0	2	9	3	1	2	1	3	0	0	0	0	4	4	3	2	2	4	2	3	3	3	4	4	5	2	3	1	3	1
20	DIBUA	3	5	0	0	2	3	3	0	0	0	0	0	0	0	2	7	0	1	2	1	3	0	0	0	0	4	4	3	2	2	4	2	3	2	3	4	4	3	2	2	1	3	1
21	DIBUB	3	6	0	0	2	3	3	0	0	0	0	0	0	0	2	6	0	1	2	1	3	0	0	0	0	4	4	3	2	2	4	2	2	2	2	4	3	2	2	2	1	3	1
22	DIN	5	7	0	0	2	2	3	0	0	0	0	0	0	0	2	4	3	1	2	1	3	0	0	0	0	4	4	3	2	2	3	2	2	2	2	4	3	3	2	2	1	3	1
23	DINN	5	6	0	0	2	3	3	0	0	0	0	0	0	0	2	5	3	1	2	1	3	0	0	0	0	4	4	3	2	2	3	2	2	2	3	4	5	5	3	2	1	3	1
24	DNI	5	6	0	0	3	3	3	0	0	0	0	0	0	0	2	5	2	1	2	1	3	0	0	0	0	4	4	3	2	2	3	3	3	2	3	4	5	6	2	2	1	3	1
25	DRO	4	4	0	0	2	1	3	0	0	0	0	0	0	0	2	5	3	1	2	1	3	0	0	0	0	5	4	2	2	2	3	4	2	2	2	4	7	2	2	2	1	3	1
26	DSA	4	6	0	0	2	2	3	0	0	0	0	0	0	0	2	5	3	1	2	1	3	0	0	0	0	4	4	3	2	2	4	2	3	2	3	4	5	3	2	2	1	3	1
27	DUR	5	7	0	0	2	3	3	0	0	0	0	0	0	0	2	5	2	1	2	1	3	0	0	0	0	4	4	3	2	2	4	3	3	2	3	4	5	6	2	2	1	3	1
28	EAP	3	2	0	0	2	5	2	0	0	6	7	3	5	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	2	3	9	2	5	1	5	3	4	0	2	3	1	1	2
29	EHE	6	6	0	0	2	3	4	0	0	2	4	3	3	0	0	0	0	0	0	1	3	0	0	0	0	4	3	3	2	2	4	4	3	3	3	5	0	0	2	3	1	1	1
30	EMI	3	4	0	0	2	3	3	0	0	1	2	1	1	0	0	0	0	0	0	1	2	0	0	0	0	4	1	1	2	3	3	3	2	2	2	4	0	0	2	3	1	1	1
31	EPA	5	4	0	0	2	3	3	0	0	3	5	3	3	0	0	0	0	0	0	1	3	0	0	0	0	4	3	1	2	2	4	3	3	3	3	4	0	0	2	3	1	1	1
32	EPE	5	4	0	0	2	3	3	0	0	2	2	2	2	0	0	0	0	0	0	1	3	0	0	0	0	3	3	3	2	4	4	3	3	3	3	4	0	0	2	3	1	1	1
33	EPO	3	3	0	0	2	3	3	0	0	1	1	2	1	0	0	0	0	0	0	1	2	0	0	0	0	4	3	1	2	2	3	3	2	2	2	4	0	0	2	3	1	1	1
34	ETU	5	6	0	0	2	3	4	0	0	2	4	3	3	0	0	0	0	0	0	1	3	0	0	0	0	4	3	3	2	2	4	4	3	3	3	6	0	0	2	3	1	1	1
35	HAF	7	6	0	0	2	1	6	0	0	0	0	0	0	0	3	4	3	7	2	4	3	0	0	2	3	4	5	3	3	2	6	2	4	3	4	5	2	3	5	2	1	2	1
36	HCA	5	6	0	0	3	4	5	0	0	0	0	0	0	0	6	4	3	8	2	4	3	0	0	3	2	4	4	3	2	2	4	2	3	3	3	5	2	2	4	2	1	2	1
37	HCO	5	4	0	0	3	1	3	0	0	0	0	0	0	0	7	4	3	6	3	3	3	0	0	4	1	4	4	3	2	2	8	2	5	3	5	7	6	3	2	2	1	2	1

Appendix B.1 (continued)

38	LAB	5	3	0	0	5	6	3	0	0	8	8	4	2	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	4	2	10	3	7	5	6	6	9	2	2	5	1	1	2
39	LRU	5	4	0	0	6	6	4	0	0	8	9	4	2	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	4	2	10	3	8	6	7	7	9	2	3	6	1	1	2
40	NNI	3	6	0	0	3	3	3	0	0	0	0	0	0	0	3	4	2	0	0	1	3	0	0	0	0	0	0	0	2	2	3	2	2	3	1	4	0	0	2	4	1	1	2
41	NTR	3	6	0	0	2	1	2	0	0	0	0	0	0	0	2	3	3	1	3	1	3	0	0	0	0	4	4	3	2	2	3	2	2	1	3	4	3	1	2	2	1	2	1
42	OAN	3	3	0	0	2	1	3	0	0	0	0	0	0	0	2	4	3	1	3	1	3	0	0	0	0	4	4	3	2	2	3	2	2	2	2	4	8	1	2	2	1	2	1
43	OAP	5	3	4	3	4	4	3	3	4	0	0	0	0	1	2	4	3	3	5	1	3	0	0	0	0	4	4	3	3	2	1	2	5	4	5	6	0	0	2	2	1	2	1
44	OFU	3	1	0	0	2	5	2	0	0	0	0	0	0	0	2	3	3	2	3	1	3	0	0	0	0	4	3	3	2	4	3	2	3	3	3	5	0	0	1	1	1	2	1
45	OMA	3	5	0	0	2	4	3	0	0	0	0	0	0	0	2	4	3	1	3	1	3	0	0	0	0	4	4	3	2	2	3	3	2	2	3	4	5	2	2	2	1	2	1
46	OOE	5	3	2	1	3	3	3	2	3	0	0	0	0	3	2	4	3	3	6	1	3	0	0	0	0	4	4	3	2	2	1	2	3	3	3	5	0	0	2	2	1	2	1
47	OPA	3	5	0	0	1	4	3	0	0	0	0	0	0	0	2	4	3	1	3	1	3	0	0	0	0	4	4	3	2	2	3	3	2	2	2	4	5	2	2	2	1	2	1
48	OPU	2	7	0	0	1	4	3	0	0	0	0	0	0	0	5	3	3	5	7	1	5	2	1	1	5	4	5	6	2	2	4	2	3	3	3	5	3	2	2	2	1	2	1
49	OPUS	2	6	0	0	2	3	3	0	0	0	0	0	0	0	5	3	3	4	6	1	3	1	2	2	4	5	4	4	2	1	4	2	3	3	3	5	3	2	2	2	1	2	1
50	OSI	2	6	0	0	1	1	3	0	0	0	0	0	0	0	4	2	3	4	4	1	3	1	1	1	2	4	4	3	2	2	4	2	3	3	3	4	3	1	2	2	2	2	1
51	OSP	3	4	0	0	2	1	3	0	0	0	0	0	0	0	2	4	3	1	3	1	3	0	0	1	0	4	4	3	2	2	3	2	2	2	2	4	5	4	2	2	1	2	1
52	OTP	5	3	1	1	3	3	3	1	1	0	0	0	0	2	1	1	1	1	2	1	3	0	0	1	0	4	4	3	2	2	3	2	3	3	3	6	0	0	2	2	1	2	1
53	OTR	5	3	3	2	3	3	3	1	2	0	0	0	0	1	0	0	0	0	0	1	3	0	0	1	0	4	4	3	2	2	4	2	4	3	5	6	0	0	2	2	1	2	1
54	PCH	3	4	0	0	1	7	3	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	2	4	7	2	2	3	2	2	4	3	4	10	1	2	2	1	2	1
55	SBE	5	3	0	0	3	3	3	0	0	7	3	5	4	0	0	0	0	0	0	2	3	0	0	1	0	4	4	3	2	2	8	3	6	3	5	4	0	0	2	2	1	2	1
56	SSP	3	4	0	0	1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	1	0	4	2	3	1	2	3	2	1	1	1	2	0	0	2	0	1	2	1
57	STR	2	4	0	0	2	2	3	0	0	0	0	0	0	0	2	3	3	1	2	1	3	0	0	1	0	1	4	5	2	2	1	1	2	0	2	0	1	3	2	2	1	2	1

Appendix B.2 Selected characters and character states used in principal component and cluster analysis for populations of *Anacamptis* taxa

CHARACTERS AND CHARACTER STATES FOR POPULATIONS OF *ANACAMPTIS* TAXA																									
Ch / OTUs		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
		BL	BW	FN	CL	CW	IL	LLLL	LLLW	LLN	LMLL	LMLW	LW	PCL	PL	LSL	LSW	SUL	SSN	LLD	LLSO	MLD	MLSO	SD	SS
1	ACO77	1	1	2	1	2	1	1	2	2	1	1	2	2	1	1	3	1	1	3	4	3	4	1	3
2	ACO83	1	1	2	1	2	1	1	2	2	1	1	2	2	1	2	3	1	1	3	4	3	4	1	3
3	ACO130	1	1	2	1	2	1	1	2	2	1	1	2	2	1	2	3	1	1	3	4	3	4	1	3
4	ACO506	1	1	2	1	2	1	1	2	2	1	1	2	2	1	2	3	1	1	3	4	3	4	1	3
5	ACO505	1	1	2	1	2	1	1	2	2	1	1	2	2	1	2	3	1	1	3	4	3	4	1	3
6	ACO167	1	1	2	1	2	1	1	2	2	1	1	2	2	1	1	3	1	1	3	4	3	4	1	3
7	ALA80	1	1	2	2	2	1	1	2	2	1	1	3	3	2	2	3	2	1	1	1	2	1	4	2
8	ALA120	1	1	1	2	2	1	1	2	2	1	1	3	2	2	2	3	2	1	1	1	2	1	4	2
9	ALA454	1	1	2	2	2	1	1	2	2	1	2	3	2	2	2	3	2	1	1	1	2	1	4	2
10	AMO75	1	1	1	1	1	1	1	2	2	1	2	2	2	2	2	3	2	1	3	5	2	5	4	2
11	AMO166	1	1	1	1	1	1	1	2	2	1	2	2	2	2	2	3	2	1	3	5	2	5	4	2
12	AMO449	1	1	1	1	1	1	1	2	2	1	2	2	2	2	2	3	2	1	3	5	2	5	4	2
13	AMO430	1	1	1	1	1	1	1	2	2	1	2	2	2	2	2	3	2	1	3	5	2	5	4	2
14	AMO427	1	1	1	1	1	1	1	2	2	1	2	2	2	2	2	3	2	1	3	5	2	5	4	2
15	APA70	2	1	2	2	2	2	1	2	2	1	3	3	2	2	2	3	3	1	3	1	2	1	3	2
16	APA73	2	1	2	2	2	2	1	2	2	1	2	2	2	2	2	3	2	1	3	1	2	1	3	2
17	APP418	2	2	1	2	1	1	0	0	0	0	0	2	2	3	3	3	2	1	0	0	0	0	1	2
18	APY97	1	1	3	1	1	1	1	2	2	1	1	2	2	2	2	3	3	1	2	2	2	2	3	1
19	APY143	1	1	3	1	1	1	1	2	2	1	1	2	2	2	1	2	2	1	2	2	2	2	3	1
20	APY147	1	1	3	1	1	1	1	2	2	1	1	2	2	2	1	3	2	1	2	2	2	2	3	1
21	APY182	1	1	3	1	1	1	1	2	2	1	1	2	2	2	1	3	2	1	2	2	2	2	3	1
22	APY191	1	1	3	1	1	1	1	2	2	1	1	2	2	2	1	3	2	1	2	2	2	2	3	1
23	APY225	1	1	3	1	1	1	1	2	2	1	1	2	2	2	1	3	2	1	2	2	2	2	3	1
24	APY249	1	1	2	1	1	1	1	2	2	1	1	2	2	2	1	3	2	1	2	2	2	2	3	1
25	APY221	1	1	3	1	1	1	1	2	2	1	1	2	2	2	1	3	2	1	2	2	2	2	3	1
26	APY237	1	1	2	1	1	1	1	2	2	1	1	2	2	1	1	3	2	1	2	2	2	2	3	1
27	APY548	1	1	2	1	1	1	1	2	2	1	1	2	2	1	1	3	2	1	2	2	2	2	3	1
28	ALAC87	1	1	2	1	1	1	1	2	2	1	1	2	2	2	2	3	2	0	1	4	2	4	2	2

Appendix B.3 Selected characters and character states used in principal component and cluster analysis for populations of *Cephalanthera* taxa

CHARACTERS AND CHARACTER STATES FOR POPULATIONS OF *CEPHALANTHERA* TAXA																									
Ch / OTUs		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
		BL	BW	FN	CW	IL	EL	EW	HL	HW	LW	PCL	PW	DSL	SUL	SUW	BD	BSO	ESO	HSO	OSO	DSSO	LSSO	SD	SS
1	CDA170	2	3	1	3	1	2	3	3	3	2	2	3	2	0	0	1	0	2	1	0	0	0	0	0
2	CDA501	2	3	1	3	1	3	3	2	2	2	2	3	2	0	0	1	0	2	1	0	0	0	0	0
3	CDA502	2	3	1	3	1	3	4	3	3	2	2	3	2	0	0	1	0	2	1	0	0	0	0	0
4	CDA164	2	3	1	3	1	3	4	3	3	3	3	3	2	0	0	1	0	2	1	0	0	0	0	0
5	CDA528	3	3	1	3	1	3	4	3	3	3	2	3	3	0	0	1	0	2	1	0	0	0	0	0
6	CDA45	2	3	1	3	1	3	4	3	3	2	2	3	2	0	0	1	0	2	1	0	0	0	0	0
7	CDA207	2	3	1	3	1	3	4	3	3	3	2	3	2	0	0	1	0	2	1	0	0	0	0	0
8	CDA468	2	3	1	3	1	3	4	3	3	2	2	3	2	0	0	1	0	2	1	0	0	0	0	0
9	CEP85	2	3	2	2	2	4	3	2	2	2	2	3	2	1	1	0	0	2	1	0	0	0	1	3
10	CEP444	2	2	1	2	1	4	3	2	2	2	2	3	2	1	1	0	0	2	1	0	0	0	1	3
11	CEP450	2	2	2	3	1	4	3	2	2	2	2	3	2	1	1	0	0	2	1	0	0	0	1	3
12	CEP432	2	3	2	3	1	4	3	2	2	2	2	3	2	1	1	0	0	2	1	0	0	0	1	3
13	CEP49	2	2	1	2	1	4	3	2	2	2	2	3	2	1	1	0	0	2	1	0	0	0	1	3
14	CLO46	3	2	2	2	1	2	3	2	2	2	2	3	2	0	0	1	0	3	1	0	0	0	0	0
15	CLO451	3	2	1	2	1	2	3	2	2	2	2	2	2	0	0	1	0	3	1	0	0	0	0	0
16	CLO431	3	2	1	2	1	2	3	2	2	2	2	2	2	0	0	1	0	3	1	0	0	0	0	0
17	CLO440	2	2	1	2	1	2	3	2	2	2	2	3	2	0	0	1	0	3	1	0	0	0	0	0
18	CLO36	3	2	1	2	1	2	3	2	2	2	2	3	2	0	0	1	0	3	1	0	0	0	0	0
19	CRU180	1	1	1	3	1	4	1	2	1	2	2	3	2	0	0	0	3	2	2	3	2	2	0	0
20	CRU250	2	1	1	3	1	4	1	2	1	2	2	3	2	0	0	0	3	2	2	3	2	2	0	0
21	CRU319	1	1	1	3	1	4	1	2	1	2	2	3	2	0	0	0	3	2	2	3	2	2	0	0
22	CRU190	1	1	1	3	1	4	1	2	1	2	2	3	2	0	0	0	3	2	2	3	2	2	0	0
23	CRU146	1	1	1	3	1	4	1	2	1	2	2	3	2	0	0	0	3	2	2	3	2	2	0	0
24	CRU200	1	1	1	3	1	4	1	2	1	2	2	3	2	0	0	0	3	2	2	3	2	2	0	0
25	CRU489	1	1	1	3	1	4	1	2	1	2	2	3	2	0	0	0	3	2	2	3	2	2	0	0
26	CRU94	1	1	1	3	1	4	1	2	1	2	2	3	2	0	0	0	3	2	2	3	2	2	0	0
27	CRU220	1	1	1	3	1	4	1	2	1	2	2	3	2	0	0	0	3	2	2	3	2	2	0	0
28	CRU513	2	1	1	3	1	4	1	2	1	2	2	3	3	0	0	0	3	2	2	3	2	2	0	0

Appendix B.4 Selected characters and character states used in principal component and cluster analysis for populations of *Dactylorhiza* taxa.

CHARACTERS AND CHARACTER STATES FOR POPULATIONS OF *DACTYLORHIZA* TAXA																				
Ch / OTUs		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
		BL	BW	FN	CL	CW	LLLW	LLN	LW	PW	SUL	SUW	BD	LLD	LLSO	MLD	LBP	PMP	SD	SS
1	DIB597	1	1	2	1	1	2	2	2	2	1	1	0	2	3	2	3	0	3	2
2	DIB612	1	1	2	1	1	2	2	2	2	1	1	0	2	3	2	3	0	3	2
3	DIB592	1	1	2	1	1	2	2	2	2	1	1	0	2	3	2	3	0	3	2
4	DIB146	1	1	2	1	1	2	2	2	2	1	1	0	2	3	2	3	0	3	2
5	DIB206	1	1	2	1	1	2	2	2	2	1	1	0	2	3	2	3	0	3	2
6	DIB210	1	1	1	1	1	2	2	2	2	1	1	0	2	3	2	3	0	3	2
7	DIB252	1	1	2	1	1	2	2	2	2	1	1	0	2	3	2	3	0	3	2
8	DIBI599	2	2	2	2	1	2	2	2	2	2	2	0	1	3	2	3	4	1	3
9	DIBN594A	1	2	3	2	2	3	2	3	2	2	2	0	5	3	2	3	0	1	2
10	DIBN596B	1	1	2	1	2	2	2	2	2	2	1	0	5	3	2	3	0	1	2
11	DIBN623C	2	2	3	2	2	2	2	2	2	2	2	0	5	3	2	3	0	1	2
12	DIBN623D	2	2	2	2	2	3	2	2	2	2	2	0	5	3	2	3	0	1	2
13	DIBU618A	1	1	2	2	2	2	0	3	2	2	1	0	5	3	2	3	0	1	1
14	DIBU619B	1	1	2	2	2	2	0	2	2	1	1	0	5	3	2	3	0	1	1
15	DIN111	2	2	3	1	2	2	2	2	2	1	1	0	1	3	2	3	4	3	3
16	DIN71	2	2	3	1	2	2	2	2	2	1	1	0	1	3	2	3	4	3	3
17	DIN625	2	2	2	1	2	2	2	2	2	1	1	0	1	3	2	3	4	3	3
18	DINN595	2	1	2	2	2	2	2	2	2	2	2	0	1	3	2	1	0	3	3
19	DNI598	2	2	2	2	2	2	1	3	2	2	2	0	4	3	2	2	0	3	2
20	DNI628	2	2	2	2	2	2	1	3	2	2	2	0	4	3	2	2	0	3	2
21	DNI155	1	2	2	2	2	2	1	3	2	2	2	0	4	3	2	2	0	3	2
22	DNI622	2	2	3	2	2	2	1	3	2	2	2	0	4	3	2	2	0	3	2
23	DNI627	2	2	3	2	2	2	1	3	2	2	2	0	4	3	2	2	0	3	2
24	DNI213	2	2	2	2	2	2	1	3	2	2	2	0	4	3	2	2	0	3	2
25	DNI187	2	2	2	2	2	2	1	3	2	2	2	0	4	3	2	2	0	3	2
26	DNI157	2	2	2	2	2	2	1	3	2	2	2	0	4	3	2	2	0	3	2
27	DRO424	2	2	1	1	1	2	2	2	3	2	1	0	3	1	2	3	0	5	2
28	DRO567	2	2	1	1	1	2	2	2	3	2	1	0	3	1	2	3	0	5	2
29	DRO484	2	1	1	1	1	2	2	2	3	3	1	0	3	1	2	3	0	5	2
30	DSA255	1	1	2	2	2	2	2	2	2	2	1	1	2	3	2	2	0	3	5
31	DSA176	2	2	2	1	2	2	2	2	2	2	1	1	2	3	2	2	0	3	5
32	DSA601	2	1	2	2	2	2	2	2	2	2	1	1	2	3	2	2	0	3	5
33	DSA590	2	1	2	2	2	2	2	2	2	2	1	1	2	3	2	2	0	3	5
34	DSA324	2	1	3	2	2	2	2	2	2	2	1	1	2	3	2	2	0	3	5
35	DSA326	2	1	2	2	2	2	2	2	2	2	1	1	2	3	2	2	0	3	5
36	DSA273	2	1	2	2	2	2	2	2	2	2	1	1	2	3	2	2	0	3	5
37	DSA123	1	1	2	2	2	2	2	2	2	2	1	1	2	3	2	2	0	3	5
38	DUR608	2	2	3	2	2	2	1	3	2	2	2	0	3	3	3	1	0	3	3
39	DUR621	2	2	3	2	2	2	1	3	2	2	2	0	3	3	3	1	0	3	3
40	DUR624	2	2	3	2	2	2	1	3	2	2	2	0	3	3	3	1	0	3	3
41	DUR626	2	2	2	2	2	2	1	3	2	2	2	0	3	3	3	1	0	3	3

Appendix B.5 Selected characters and character states used in principal component and cluster analysis for populations of *Epipactis* taxa.

CHARACTERS AND CHARACTER STATES FOR POPULATIONS OF *EPIPACTIS* TAXA																				
Ch / OTUs		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
		BL	BW	FN	CL	IL	EL	EW	HL	HW	PL	PW	BD	BSO	HSO	LSO	OSO	PSO	DSSO	LSSO
1	EHE281	2	3	2	2	2	2	1	2	2	2	3	1	0	1	1	1	0	0	0
2	EHE285	2	3	2	2	2	2	1	2	2	2	3	1	0	1	1	1	0	0	0
3	EHE610	2	3	2	2	1	2	1	2	2	3	3	1	0	1	1	1	0	0	0
4	EHE330	2	3	2	2	2	2	1	2	2	2	3	1	0	1	1	1	0	0	0
5	EHE204	2	3	2	2	2	2	1	2	2	2	3	1	0	1	1	1	0	0	0
6	EHE236	2	3	3	2	2	2	1	2	2	2	3	1	0	1	1	1	0	0	0
7	EHE287	2	2	2	2	1	2	1	2	2	2	3	1	0	1	1	1	0	0	0
8	EHE311	2	2	1	2	1	2	1	2	2	2	3	1	0	1	1	1	0	0	0
9	EMI194	1	2	2	1	1	2	1	1	1	2	2	0	1	1	2	4	1	2	2
10	EMI305	1	1	1	1	1	2	1	1	1	2	2	0	1	1	2	4	1	2	2
11	EMI278	1	1	2	1	1	2	1	1	1	2	2	0	1	1	2	4	1	2	2
12	EMI588	1	1	2	1	1	2	1	1	1	2	2	0	1	1	2	4	1	2	2
13	EPA253	2	1	2	2	1	3	2	2	2	2	2	1	0	0	1	3	0	1	1
14	EPA245	2	1	2	2	1	3	2	2	2	2	2	1	0	0	1	3	0	1	1
15	EPA304	2	2	1	2	1	3	2	2	2	2	2	1	0	0	1	3	0	1	1
16	EPE346	2	3	1	1	1	2	1	1	1	2	2	2	0	1	1	1	0	0	0
17	EPE366	2	3	2	1	1	2	1	1	1	2	2	2	0	1	1	1	0	0	0
18	EPE332	2	3	1	1	1	2	1	1	2	2	3	2	0	1	1	1	0	0	0
19	EPO340	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	2	0	0	0
20	ETU535	2	2	2	2	1	2	1	2	2	2	3	1	0	1	1	3	0	0	0
21	ETU195	2	3	2	2	2	2	1	2	2	2	3	1	0	1	1	3	0	0	0
22	ETU268	2	3	2	2	2	2	1	2	2	2	3	1	0	1	1	3	0	0	0
23	ETU331	2	3	2	2	2	2	1	2	2	2	3	1	0	1	1	3	0	0	0

Appendix B.6 Selected characters and character states used in principal component and cluster analysis for populations of *Himantoglossum* taxa.

CHARACTERS AND CHARACTER STATES FOR POPULATIONS OF *HIMANTOGLOSSUM* TAXA																				
Ch / OTUs		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
		BW	FN	CW	IL	LLLL	LMLW	LW	LOW	PCL	PL	DSL	LSL	SUL	LLD	MLD	LS	LC	SD	SS
1	HAF551	1	2	1	2	2	1	2	2	3	3	1	2	1	1	2	2	1	3	3
2	HCA141	1	2	2	2	2	1	2	2	2	2	1	2	1	1	2	2	1	3	3
3	HCA185	1	2	2	2	2	1	3	2	2	2	1	2	1	1	2	2	1	3	3
4	HCA298	1	2	2	2	2	1	3	2	2	2	1	2	1	1	2	2	1	3	3
5	HCA231	1	3	2	2	2	1	3	2	2	2	1	2	1	1	2	2	1	3	3
6	HCA223	1	2	2	2	2	1	3	2	2	2	1	2	1	1	2	2	1	3	3
7	HCA227	1	2	2	2	2	1	3	2	2	2	1	2	1	1	2	2	1	3	3
8	HCA531	1	3	2	2	2	1	3	2	2	2	1	2	1	1	2	2	1	3	3
9	HCA232	1	3	2	2	2	1	3	2	2	2	1	2	1	1	2	2	1	3	3
10	HCA240	1	3	2	2	2	1	3	2	2	2	1	2	1	1	2	2	1	3	3
11	HCA514	1	2	2	2	2	1	2	2	2	2	1	2	1	1	2	2	1	3	3
12	HCO575	2	1	1	1	3	2	2	1	2	3	2	3	2	3	3	1	5	1	2
13	HCO543	1	1	1	2	3	2	2	1	2	3	2	3	2	3	3	1	5	1	2
14	HCO203	1	1	1	1	3	1	3	1	2	3	2	3	2	3	3	1	5	1	2

Appendix B.7 Selected characters and character states used in principal component and cluster analysis for populations of *Limodorum* taxa

CHARACTERS AND CHARACTER STATES FOR POPULATIONS OF *LIMODORUM* TAXA					
Ch / OTUs		1	2	3	4
		BW	FN	IL	DSW
1	LAB549	2	2	2	2
2	LAB519	2	1	1	2
3	LAB547	2	1	1	2
4	LAB490	2	1	1	2
5	LAB499	3	1	2	2
6	LAB509	3	1	1	2
7	LRU580	3	2	2	3
8	LRU602	3	1	2	3
9	LRU591	2	1	2	3

Appendix B.8 Selected characters and character states used in principal component and cluster analysis for populations of *Ophrys* taxa

.

CHARACTERS AND CHARACTER STATES FOR POPULATIONS OF *OPHRYS* TAXA																															
Ch / OTUs		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
		BL	BW	BCL	BCW	CL	CW	AL	AW	LHL	LLLL	LLLW	LLN	LMLL	LMLW	LW	PCL	PL	DSL	LSL	SC	SL	SML	SP	SSO	AD	LLD	LLSO	MLD	MLSO	PMP	PSO
1	OAP511	2	2	2	2	2	2	3	3	2	1	2	2	2	3	2	3	1	2	3	4	4	3	5	1	1	1	7	1	7	1	3
2	OAP483	2	2	2	2	2	2	3	3	2	1	2	2	2	3	2	3	1	2	3	4	4	3	5	1	1	1	7	1	7	1	3
3	OAP179	2	2	2	2	2	2	3	3	2	1	2	2	2	3	2	3	1	2	3	4	4	3	5	1	1	1	7	1	7	1	3
4	OAP100	2	2	2	2	2	2	3	3	2	1	2	2	2	3	2	3	1	2	3	4	4	3	5	1	1	1	7	1	7	1	3
5	OAP493	2	2	2	2	2	2	3	3	2	1	2	2	2	3	2	3	1	2	3	4	4	3	5	1	1	1	7	1	7	1	3
6	OFU559	1	2	0	0	1	3	0	0	0	1	2	2	1	2	2	2	2	1	2	1	1	2	1	2	0	2	9	2	9	3	0
7	OOE433	2	2	1	1	2	2	2	2	3	1	2	2	2	4	2	2	1	1	2	3	2	4	4	1	4	1	7	5	7	0	3
8	OOE184	2	1	1	1	2	2	2	2	3	1	2	2	2	3	2	2	1	1	2	3	2	4	4	1	4	1	7	5	7	0	3
9	OOE455	2	2	1	1	2	2	2	2	3	1	2	2	2	4	2	2	1	1	2	3	2	4	4	1	4	1	7	5	7	0	3
10	OOE495	2	2	1	1	2	2	2	2	3	1	2	2	2	4	2	2	1	1	2	3	2	4	4	1	4	1	7	5	7	0	3
11	OOE491	2	2	1	1	2	2	2	2	3	1	2	2	2	3	2	2	1	1	2	3	2	4	4	1	4	1	7	5	7	0	3
12	OTP417	2	2	1	1	2	2	1	1	2	0	1	1	1	2	2	3	2	1	2	2	3	1	2	1	3	6	6	5	6	2	2
13	OTP464	2	2	1	1	2	2	1	1	2	0	1	1	1	1	2	2	2	1	2	2	3	1	2	1	3	6	6	5	6	2	2
14	OTP507	2	2	1	1	2	2	1	1	2	0	1	1	1	1	2	2	2	1	2	2	3	1	2	1	3	6	6	5	6	2	2
15	OTP428	2	2	1	1	2	2	1	1	2	0	1	1	1	2	2	2	2	1	2	2	3	1	2	1	3	6	6	5	6	2	2
16	OTP500	2	2	1	1	2	2	1	1	2	0	1	1	1	1	2	2	2	1	2	2	3	1	2	1	3	6	6	5	6	2	2
17	OTP446	2	2	1	1	2	2	1	2	2	0	1	1	1	2	2	2	2	1	2	2	3	1	2	1	3	6	6	5	6	2	2
18	OTP563	2	2	1	1	2	2	1	1	2	0	0	0	0	0	2	2	2	1	2	2	3	1	2	1	3	6	6	5	6	2	2
19	OTR487	2	2	1	1	2	2	1	1	1	0	0	0	0	0	3	2	2	2	3	2	3	1	3	1	2	0	0	0	0	0	2

Appendix B.9 Selected characters and character states used in principal component and cluster analysis for populations of *Orchis* taxa.

CHARACTERS AND CHARACTER STATES FOR POPULATIONS OF *ORCHIS* TAXA																									
Ch / OTUs		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
		FN	CL	CW	LLLW	LMLL	LMLW	LW	LTL	LTW	LOL	LOW	LEW	SUL	SUW	FBL	LLD	LLSO	MLD	MLSO	LS	LC	LBP	SD	SS
1	OAN423	1	1	1	2	1	2	2	0	0	0	0	1	3	1	0	1	1	3	3	0	1	2	4	2
2	OAN564	1	1	1	2	1	2	2	0	0	0	0	1	3	1	0	1	1	3	3	0	1	2	4	2
3	OAN558	1	1	1	2	1	2	2	0	0	0	0	1	3	1	0	1	1	3	3	0	1	2	4	2
4	OAN556	1	1	1	2	1	2	2	0	0	0	0	1	3	1	0	1	1	3	3	0	1	2	4	2
5	OMA32	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	1	1	2	1	0	3	3	4	2
6	OMA37	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	1	1	2	1	0	3	3	4	2
7	OMA42	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	1	1	2	1	0	3	3	4	2
8	OMA69	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	1	1	2	1	0	3	3	4	2
9	OMA34	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	1	1	2	1	0	3	3	4	2
10	OMA138	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	1	1	2	1	0	3	3	4	2
11	OMA453	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	1	1	2	1	0	3	3	4	2
12	OMA425	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	1	1	2	1	0	3	3	4	2
13	OMA80	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	1	1	2	1	0	3	3	4	2
14	OMA645	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	1	1	2	1	0	3	3	4	2
15	OPA26	2	1	3	2	1	2	2	0	0	0	0	1	2	1	0	2	3	2	3	0	1	3	5	2
16	OPA30	2	1	3	2	1	2	2	0	0	0	0	1	2	1	0	2	3	2	3	0	1	3	5	2
17	OPA31	2	1	3	2	1	2	2	0	0	0	0	1	2	1	0	2	3	2	3	0	1	3	5	2
18	OPA33	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	2	3	2	3	0	1	3	5	2
19	OPA38	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	2	3	2	3	0	1	3	5	2
20	OPA41	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	2	3	2	3	0	1	3	5	2
21	OPA44	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	2	3	2	3	0	1	3	5	2
22	OPA63	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	2	3	2	3	0	1	3	5	2
23	OPA104	2	1	2	2	1	2	2	0	0	0	0	1	2	1	0	2	3	2	3	0	1	3	5	2
24	OPU434	2	1	2	2	2	4	3	1	1	1	4	1	1	1	0	2	8	2	8	5	1	3	1	2
25	OPU486	3	1	2	2	2	4	3	1	1	1	4	2	1	1	0	2	8	2	8	5	1	3	1	2
26	OPU439	3	1	2	2	2	4	3	1	1	1	4	2	1	1	0	2	8	2	8	5	1	3	1	2
27	OPU460	3	1	2	2	2	4	3	1	1	1	4	2	1	1	0	2	8	2	8	5	1	3	1	2
28	OPU447	2	1	2	2	2	4	3	1	1	1	4	1	1	1	0	2	8	2	8	5	1	3	1	2
29	OPU426	2	1	2	2	2	4	3	1	1	1	4	1	1	1	0	2	8	2	8	5	1	3	1	2
30	OPUS29	2	1	2	2	2	3	3	1	2	1	3	1	1	1	0	5	4	4	8	4	1	3	1	2
31	OSI466	2	1	2	1	2	3	2	1	1	1	2	1	1	1	1	5	4	4	8	3	2	3	1	2
32	OSI452	2	1	1	1	2	3	2	1	1	1	2	1	1	1	1	5	4	4	8	3	2	3	1	2
33	OSI442	2	1	1	1	2	3	3	1	1	1	2	1	1	1	1	5	4	4	8	3	2	3	1	2
34	OSI29	2	1	1	1	2	3	3	1	1	1	2	1	1	1	1	5	4	4	8	3	2	3	1	2
35	OSI462	2	1	1	1	2	3	2	1	1	1	2	1	1	1	1	5	4	4	8	3	2	3	1	2
36	OSP581	1	2	1	2	1	2	2	0	0	0	0	1	2	2	0	1	1	3	3	0	1	3	1	3

Appendix C Principal Component Analyses

Appendix C.1 PCA for all OTUs

Component	Total	% of Variance	Cumulative %
1	12.133	28.2	28.2
2	6.302	14.7	42.9
3	5.369	12.5	55.4
4	3.380	7.9	63.2
5	3.046	7.1	70.3
6	2.392	5.6	75.9
7	1.362	3.2	79.0
8	1.217	2.8	81.9
9	1.061	2.5	84.3
10	0.941	2.2	86.5

Appendix C.2 PCA for the complex group.

Component	Total	% of Variance	Cumulative %
1	6.4047	24.6	24.6
2	4.1136	15.8	40.5
3	3.5893	13.8	54.3
4	2.8234	10.9	65.1
5	1.8726	7.2	72.3
6	1.1961	4.6	76.9
7	1.0118	3.9	80.8
8	0.8355	3.2	84.0
9	0.7349	2.8	86.9
10	0.6804	2.6	89.5

.

Appendix C.3 PCA for populations of *Anacamptis* taxa.

Component	Total	% of Variance	Cumulative %
1	8.0937	33.7	33.7
2	4.2993	17.9	51.6
3	3.6656	15.3	66.9
4	2.6498	11.0	78.0
5	1.8343	7.6	85.6
6	1.1445	4.8	90.4
7	0.9016	3.8	94.1
8	0.5863	2.4	96.6
9	0.3191	1.3	97.9
10	0.2253	0.9	98.8

Appendix C.4 PCA for populations of *Cephalanthera* taxa.

Component	Total	% of Variance	Cumulative %
1	10.267	42.8	42.8
2	5.676	23.6	66.4
3	3.187	13.3	79.7
4	1.186	4.9	84.6
5	1.041	4.3	89.0
6	0.900	3.7	92.7
7	0.635	2.6	95.4
8	0.503	2.1	97.5
9	0.281	1.2	98.6
10	0.141	0.6	99.2

Appendix C.5 PCA for populations of *Dactylorhiza* taxa.

Component	Total	% of Variance	Cumulative %
1	5.6870	29.9	29.9
2	3.3234	17.5	47.4
3	3.0793	16.2	63.6
4	2.0222	10.6	74.3
5	1.6337	8.6	82.9
6	0.9090	4.8	87.7
7	0.5685	3.0	90.6
8	0.4672	2.5	93.1
9	0.3716	2.0	95.1
10	0.2898	1.5	96.6

Appendix C.6 PCA for populations of *Epipactis* taxa.

Component	Total	% of Variance	Cumulative %
1	9.4326	49.6	49.6
2	3.9734	20.9	70.6
3	2.3941	12.6	83.2
4	1.1124	5.9	89.0
5	0.7740	4.1	93.1
6	0.5338	2.8	95.9
7	0.3482	1.8	97.7
8	0.2573	1.4	99.1
9	0.1322	0.7	99.8
10	0.0421	0.2	100.0

Appendix C.7 PCA for populations of *Himantoglossum* taxa.

Component	Total	% of Variance	Cumulative %
1	14.825	78.0	78.0
2	1.853	9.8	87.8
3	0.986	5.2	93.0
4	0.745	3.9	96.9
5	0.397	2.1	99.0
6	0.193	1.0	100.0
7	0.000	0.0	100.0
8	0.000	0.0	100.0
9	0.000	0.0	100.0
10	0.000	0.0	100.0

Appendix C.8 PCA for populations of *Limodorum* taxa.

Component	Total	% of Variance	Cumulative %
1	2.0763	51.9	51.9
2	0.9694	24.2	76.1
3	0.6700	16.7	92.9
4	0.2842	7.1	100.0

Appendix C.9 PCA for populations of *Ophrys* taxa.

Component	Total	% of Variance	Cumulative %
1	13.978	45.1	45.1
2	7.005	22.6	67.7
3	5.769	18.6	86.3
4	2.872	9.3	95.6
5	0.841	2.7	98.3
6	0.266	0.9	99.1
7	0.171	0.6	99.7
8	0.073	0.2	99.9
9	0.025	0.1	100.0
10	0.000	0.0	100.0

Appendix C.10 PCA for populations of *Orchis* taxa.

Component	Total	% of Variance	Cumulative %
1	12.542	52.3	52.3
2	4.078	17.0	69.3
3	3.111	13.0	82.2
4	2.046	8.5	90.7
5	0.965	4.0	94.8
6	0.648	2.7	97.5
7	0.296	1.2	98.7
8	0.196	0.8	99.5
9	0.117	0.5	100.0
10	0.000	0.0	100.0

9. CURRICULUM VITAE

Name SURNAME **:** Mustafa BAŞARAN

Place and Date of Birth **:** Yalova / 07.10.1989

Universities

Bachelor's Degree **:** Bolu Abant İzzet Baysal University

e-mail **:** fotografsevdam@gmail.com

Address **:** Gaziosmanpaşa Mahallesi Kemerköprü Caddesi Balkan Sokak No:24/3

List of Publications **:**

1. Eker İ and Başaran M (2019) "Türkiye Florası için yeni bir hibrit orkide kaydı: *Anacamptis x parvifolia* (Orchidaceae)", Bağbahçe Bilim Dergisi, 6(1) 2019: 33-39.

2. Başaran M and Eker İ (2017) "Orchids of Bolu (Turkey)", Conference: Interactive Conservation Platform for Orchids Native to Greece-Turkey (ICON), April 2017.

3. Eker İ, Başaran M, Çelik A, DİNÇER N, KAYA A and EKER N (2016) "Orkide Cenneti: Bolu", 4007 TÜBİTAK Bilim Şenliği "Bolu Bilimle Buluşuyor", poster, Mayıs 2016.

4. Eker İ, Başaran M, Çelik A, DİNÇER N, KAYA A and EKER N (2016) "Doğanın Mücevherleri: Orkideler", 4007 TÜBİTAK Bilim Şenliği "Bolu Bilimle Buluşuyor", poster, Mayıs 2016.

5. Eker İ, Başaran M, Çelik A, DİNÇER N, KAYA A and EKER N (2016) "Doğanın Mücevherleri: Orkideler", 4007 TÜBİTAK Bilim Şenliği "Bolu Bilimle Buluşuyor", prochure, Mayıs 2016.

6. Eker İ, DİNÇER N, Çelik A, Başaran M, EKER N and KAYA A (2016) "Biyolojik Miras", 4007 TÜBİTAK Bilim Şenliği "Bolu Bilimle Buluşuyor", Poster, Mayıs 2016.

7. Eker İ, DİNÇER N, Çelik A, Başaran M, EKER N and KAYA A (2016) "Bir Varmış Bir Yokmuş...", 4007 TÜBİTAK Bilim Şenliği "Bolu Bilimle Buluşuyor", poster, Mayıs 2016.

8. Eker İ, DİNÇER N, Çelik A, Başaran M, EKER N and KAYA A (2016) "Türkiye'deki Sıcak Noktalar", 4007 TÜBİTAK Bilim Şenliği "Bolu Bilimle Buluşuyor", poster, Mayıs 2016.

9. Eker İ, DİNÇER N, Çelik A, Başaran M, EKER N and KAYA A (2016) "Biyolojik Çeşitliliği Etkileyen Faktörler", 4007 TÜBİTAK Bilim Şenliği "Bolu Bilimle Buluşuyor", poster, Mayıs 2016.

10. Eker İ, DİNÇER N, Çelik A, Başaran M, EKER N and KAYA A (2016) "Biyolojik Miras", 4007 TÜBİTAK Bilim Şenliği "Bolu Bilimle Buluşuyor", broşür, Mayıs 2016.

Awards **:**

Hobbies (Optional) **:** Photography, Fishing, Football