

## Chorological and Ecological Investigations on Cheilanthoid Ferns in Turkey

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### ABSTRACT

In this study, the determined localities of taxa belonging to the Cheilanthoid ferns in Turkey collected by us have been indicated on the map. In addition, ecological properties of these ferns have been established, based on rock and soil samples collected in the area, as well as investigation of the growth environment.

**Key Words:** Cheilanthoid ferns, Chorology, Ecology, Turkey.

### INTRODUCTION

The genus *Cheilanthes* Sw. (not including *Notholaena* R. Br. and *Cosentinia* Tod.) is represented in Macaronesia and in the Mediterranean area by seven species. Four of them are ancestral diploids and the remaining three species are allotetraploids, formed by chromosome doubling in the diploid hybrids of *C. maderensis* Lowe with the other three diploids (Rasbach and Reichstein 1982; Rasbach et al 1982; Rasbach et al 1983; Vida et al 1983). *Notholaena* and *Cosentinia* have often been placed in a separate genus and some experts still prefer to follow this procedure (Jermy and Paul 1993). The fact that their basic chromosome number is 29 while the others have 30 (Vida et al 1970; Nardi et al 1978), combined with small differences in morphology (Nardi et al 1979).

Although not a conspicuous element of the vegetation, colonies of ferns are a common phenomena of the somewhat mountainous terrain. These ferns, which are found more frequently on north or west-facing slopes, grow on rock ledges, cliffs, bluffs, canyon walls, tallus slopes, in cavities under overhanging rocks, in crevices of boulders. The rigor of these ecological niches would seem to be augmented by the variable edaphic and extreme climatic factors of the environment in which the Cheilanthoid ferns grow. Considerable variability of edaphic tolerances exist among the Cheilanthoid ferns. Some species are restricted to sedimentary rocks such as limestones or calcareous sandstones, while others occur more frequently on igneous rocks such as basalt or granite (Hevly 1969).

Although many studies related with the chorology of Turkish ferns have been reported in the literature (Demiriz et al 1969; Demiriz et al 1977; Demiriz and Kaynak 1977; Kaynak 1980; Paris and Fraser-Jenkins 1980; Kaynak and Tuyji 1991; Kaynak et al 1996 a; Kaynak et al 1996 b; Yıldırım 1996), a few ecological studies was found (Kaynak 1989; Benlioğlu et al 1997). However, the chorological and ecological studies about all of Cheilanthoid ferns in Turkey have not been carried out. The purpose of this investigation was to establish the ecological properties and distribution of Cheilanthoid ferns in Turkey on the basis of their growth environment.

### MATERIALS AND METHODS

This study included Cheilanthoid fern specimens, soil and rock samples were collected from different localities in Turkey between 1994 and 2008. Five taxa belonging to the Cheilanthoid ferns are distributed in Turkey. These taxa are *Cheilanthes acrostica* (Balb.) Tod., *C. tinaei* Tod., *C. persica* (Bory) Mett. ex Kuhn, *Notholaena marantae* (L.) Desv. subsp. *marantae* and *Cosentinia vellea* (Aiton) Tod. subsp. *vellea*. The distribution of Cheilanthoid ferns were determined and indicated on the map. When determination of chorology of these ferns, some previous collected specimens were used (Demiriz and Kaynak 1977; Kaynak 1980). The other fern specimens were collected by us during this study and all fern specimens were kept at the Herbarium of Uludağ University Department of Biology (BULU).

Ecological properties and growth environment of specimens collected from the area were determined on the basis of soil samples taken from the growth environment, along with rock samples. pH and CaCO<sub>3</sub> contents of soil samples were measured. Data on pH and CaCO<sub>3</sub> are summarized Table 1. Identification of rock samples was carried out by Dumlupınar University Geology Department. Data for the types of rocks are provided in Table 2.

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The localities of collected fern specimens, soil and rock samples are;

*Cheilanthes acrostica* (Syn: *C. pteridioides* (Reich.) C. Chr.; *C. fragrans* Sw.; *C. odora* Sw.)

B3: ISPARTA; Uluborlu, Taşköprü, around Güllük location, *Pinus-Quercus-Juniperus* forest, rocky slopes, 1100 m, 20. 04. 1996, *G. Kaynak*, BULU 11882 A - Karacaören, around II Baraj, macchie, damp rocks, 235 m, 22. 05. 1997, *G. Kaynak*, BULU 26671.

B8: SİİRT; Kozluk, Malabadi to Sason, 22 km, around Çevrecik, on rocks, 870 m, 30. 04. 1978, *G. Kaynak*, DUF 3969 - DİYARBAKIR; Lice to Diyarbakır, 31 km, rocks, 15. 03. 1977, *G. Kaynak*, BULU 3973.

C1: AYDIN; Çine to Yatağan, İncekemer, 21. 02. 1996, *G. Kaynak*, BULU 26481 – Söke, on Pirene ruins walls, 100 m, 24. 05. 1996, *G. Kaynak*, BULU 26487 - Kuşadası, rock crevices, 10. 01. 2006, *G. Kaynak*, BULU 26519 - İZMİR; Selçuk, Efes ruins, on walls, 23. 05. 1996, *G. Kaynak*, BULU 26483 - MUĞLA; Milas to Yatağan, 15 km, sparse *Pinus brutia* forest, macchie, rocks, 700 m, 24. 05. 1996, *G. Kaynak*, BULU 26492 - Milas to Yatağan, 15 km, 700 m, 24. 05. 1996, *G. Kaynak*, BULU 26497 - Muğla to Marmaris, Sakar pass, *P. brutia* forest, damp rocks, 250-300 m, 06. 05. 2001, *G. Kaynak*, BULU 26772 – around Marmaris, macchie, on serpentine rocks, 0-50 m, 06. 05. 2001, *G. Kaynak*, BULU 26826.

C2: AYDIN; Çine, Eski Çine to Kuruköy, macchie, on stream banks, 150 m, 18. 05. 1996, *G. Kaynak*, BULU 26539 - MUĞLA: Köyceğiz to Fethiye, 190 m, 24. 05. 1996, *G. Kaynak*, BULU 26498 - Fethiye; Kayaköyü, on ruin walls, 180 m, 25. 05. 1996, *G. Kaynak*, BULU 26501 – Fethiye; Ölüdeniz to Faralya, macchie, on serpentine rocks, 50 m, 07. 05. 2001, *G. Kaynak*, BULU 26833 - Fethiye; Ölüdeniz to Faralya, *P. brutia* forest, macchie, on rocks, 100 m, 07. 05. 2001, *G. Kaynak*, BULU 26835 - ANTALYA; Kalkan to Kaş, Kapıtaş, 70 m, cliffs, 25. 05. 1996, *G. Kaynak*, BULU 26504 - Kaş, Patara, macchie, on rocks, 20 m, 25. 05. 1996, *G. Kaynak*, BULU 26509 - Kaş; Letoon antique theatre walls, calcerous theatre stone crevices, 150 m, 07. 05. 2001, *G. Kaynak*, BULU 26837.

C3: ANTALYA; Düden waterfall, 18. 05. 1996, *G. Kaynak*, BULU 26600 - Perge ruins, on ruin walls, 45 m, 25. 05. 1996, *G. Kaynak*, BULU 26516 - Alanya, on castle walls, 250 m, 25. 05. 1996, *G. Kaynak*, BULU 26518 - Side ruins, on the Amphitheater walls, 65 m, 25. 05. 1996, *G. Kaynak*, BULU 26525 - Antalya, Isparta to Antalya, 90 km, macchie, on calcerous rock crevices, 510 m, 22. 05. 1997, *G. Kaynak*, BULU 26670 - Köprülü canyon national park, on rocks, 260 m, 14. 05. 2008, *G. Kaynak*, BULU 29975.

C4: ANTALYA; Alanya to Gazipaşa, on ruin walls, 20-30 m, 23. 05. 1997, *G. Kaynak*, BULU 26678 - Anamur to Aydıncık, on rocks, 23. 05. 1997, *G. Kaynak*, BULU 26680.

C4: İÇEL; Silifke to Mut, Göksu valley, 9-12 km, on rocks, under forest screes, 130 m, 30. 03. 1996, *G. Kaynak*, BULU 26477 - Ermenek to Mut, 27 km, on rocks, 1100-1200 m, 02. 06. 1996, *G. Kaynak*, BULU 26607.

C5: İÇEL; Erdemli to Silifke, 12 km, macchie, on rocks, 20-50 m, 30. 03. 1996, *G. Kaynak*, BULU 26470 - Silifke to Erdemli, Cennet and Cehennem caves, the mouth of cave, rocks, 170 m, 30. 03. 1996, *G. Kaynak*, BULU 26472.

C6: HATAY; İskenderun, Belen, macchie, rocky places, 900-950 m, 29. 03. 1996, *G. Kaynak*, BULU 26461 - ADANA; Toprakkale, Toprakkale ruins, on ruin walls, 29. 03. 1996, *G. Kaynak*, BULU 26463 - KAHRAMANMARAŞ; Yukarı Ceyhan valley, around Küçükşır village, macchie, on rocks, 520 m, 26. 06. 1996, *G. Kaynak*, BULU 26561.

C7: ADIYAMAN; Kahta, Kahta to Damlacık, 1.5 km, around Cendere bridge, rocks crevices, 10. 06. 1978, *G. Kaynak*, BULU 3972.

*Cheilanthes tinaei* (Syn. *C. corsica* Reichst.; *C. duriensis* Mendonca et Vasc.)

C3: ANTALYA; Beyşehir to Akseki, 15 km, on naked rocks, 1250 m, 03. 06. 1996, *G. Kaynak*, BULU 26610.

*Cheilanthes persica* (Syn. *C. szovitsii* Fischer et C. A. Mey.; *Notholaena persica* Bory)

A3: BİLECİK; Boğaz to Demirköy, 5 km, on rocks, 500 m, 21. 05. 1987, *G. Kaynak*, BULU 2002.

B2 BURSA; Orhaneli to Keles, around Göynükbelen, on rocks, 500 m, *G. Kaynak*, 01. 07. 1987, BULU 2465.

B3: ISPARTA; Uluborlu, İnesera, rocky slopes, 1200-1350 m, 31. 07. 1998, *G. Kaynak*, BULU 8897 - Uluborlu, above Senirkent, stony slopes, 1200 - 1300 m, 12. 08. 1997, *G. Kaynak*, BULU 10159 - Uluborlu, around İleydağ, on naked rocks, 1000-1100 m, 21. 08. 1996, *G. Kaynak*, BULU 26619 - Uluborlu, Eskidereköy, on naked calcerous rocks, 1130 m, 20. 08. 1998, *G. Kaynak*, BULU 26701 - ISPARTA; Eğirdir, around Yazılıkaya, on rocks, 02. 08. 1994, *G. Kaynak*, BULU 8914.

B7: TUNCELİ; Tunceli to Ovacık, 16 km, Munzur valley, on rocks, 970 m, 20. 06. 1981, *G. Kaynak*, BULU 3802 - ELAZIĞ; Keban to Poyraz, 3 km, on rocks, 880 m, 18. 06. 1977, *G. Kaynak*, BULU 3776 -

DİYARBAKIR; Çermik to Çüngüş, 8 km, rocky slopes, 21. 06. 1977, *G. Kaynak*, BULU 3799 - DİYARBAKIR; Dicle to Ergani, 16 km, around Bademli village, on rocks, 900 m, 18. 04. 1979, *G. Kaynak*, BULU 3800.

B8: SİİRT; Baykan to Bitlis, 5 km, valley, on rocks, 820 m, 19. 06. 1976, *H. Demiriz, Ö. Saya, G. Kaynak*, BULU 3961 - BİTLİS; Baykan to Bitlis, 18 km, on rocks, 870 m, 24. 04. 1979, *G. Kaynak*, BULU 3796 A - DİYARBAKIR; Dicle to Hani, 3 km, on damp rocks, 750 m, 18. 04. 1979, *G. Kaynak*, BULU 3804.

B9: BİTLİS; Bitlis to Baykan, 30 km, on rocks, 1040 m, 19. 06. 1976, *H. Demiriz, Ö. Saya, G. Kaynak*, BULU 3962.

C1: MUĞLA; Muğla to 30 km, around Tokuşbeli mountain pass, *P. nigra* forest, on stream banks, rocks, 900 m, 05. 05. 2001, *G. Kaynak*, BULU 26812 - Muğla to İzmir exit, 5 km, *P. brutia* forest, macchie, 500-600 m, 05. 05. 2001, *G. Kaynak*, BULU 26813 - around Göcek, *P. brutia* forest, on calcerous rocks, 100-150 m, 06. 05. 2001, *G. Kaynak*, BULU 26828.

C2: DENİZLİ; Kale to Muğla, Muğla to 35 km, Boynuzcuk pass, *P. brutia* forest, calcerous rocky crevices, 1060-1100 m, 05. 05. 2001, *G. Kaynak*, BULU 26806 - Kale, Kale to Beyağaç, under calcerous rocks covered with *Quercus coccifera* scrub, 900-1000 m, 17. 08. 2002, *G. Kaynak*, BULU 26997 - ANTALYA; Kalkan to Kaş, around Kapıtaş, cliffs, 70 m, 25. 05. 1996, *G. Kaynak*, BULU 26503 - east of Kalkan, macchie, calcerous rocky crevices, 50-80 m, 07. 05. 2001, *G. Kaynak*, BULU 26842 - Kaş, around Kaleköy, calcerous rocky crevices, 5-30 m, 14. 05. 2007, *G. Kaynak*, BULU 29577.

C3: ANTALYA; Akseki to Seydişehir, Toros mountains, *Abies cilicica* forest, on rocks, 1300 m, 26. 05. 1996, *G. Kaynak*, BULU 26531 - Beyşehir to Akseki, 20 km, on naked rocks, 1250 m, 03. 06. 1996, *G. Kaynak*, BULU 26612 - Isparta to Antalya, around Kazak II tunnel, macchie, on calcerous rocks, 670 m, 22. 05. 1997, *G. Kaynak*, BULU 26619.

C4: KONYA; Seydişehir, calcerous rocky crevices, 1300 m, 05. 07. 2000, *G. Kaynak*, BULU 26763.

C5: NİĞDE; Ulukışla to Pozantı, around Çakıt 2 stream, cliffs, 900 m, 02. 07. 1996, *G. Kaynak*, BULU 26566 - ADANA; around Tekirbeli pass, *P. nigra* forest, on stream banks, on damp rocks, 1300 m, 02. 07. 1996, *G. Kaynak*, BULU 26568 - KARAMAN; Kızılkaya, Ağaçcıbaşı hill, on rocks, 1500-1600 m, 02. 06. 1996, *G. Kaynak*, BULU 26608 - KARAMAN; Karaman to Mut, 27 km, around Alahan, *P. nigra* forest, on rocks, 1400 m, 19. 05. 2002, *G. Kaynak*, BULU 26892 - İÇEL; Tarsus, Çamlıyayla, below Fakılı village, calcerous rocky crevices, 700-850 m, 18. 07. 2002, *G. Kaynak*, BULU 26965.

C6: KAHRAMANMARAŞ; Göksun to Kahramanmaraş, 20 km, naked rocky crevices, macchie, 400 m, 02. 07. 1996, *G. Kaynak*, BULU 26579 - OSMANİYE; Düziçi, around Haruniye thermal spring, calcerous rocky crevices covered with macchie, 250-300 m, 17. 07. 2002, *G. Kaynak*, BULU 26934.

C7: ADIYAMAN; Kahta, Damlacık to Old castle, on castle walls, 10. 06. 1978, *G. Kaynak*, BULU 3949.

C8: DİYARBAKIR; Çınar to Mardin, 14 km, 1.5 km from Aşağıkonak, rocky slopes, 06. 04. 1975, *H. Demiriz, Ö. Saya, İ. Emre*, BULU 3934 - MARDİN; Savur, edge of brigade, on rocks, 800 m, 10. 04. 1979, *G. Kaynak*, BULU 3801.

*Notholaena marantae* subsp. *marantae* (Syn. *C. marantae* (L.) Domin; *Acrostichum marantae* L.)

A2 (A): YALOVA; Termal, around Gökçedere dam, macchie, *G. Kaynak*, 18. 05. 1985, BULU 411 - BURSA; Uludağ, Keles road, Soğukpınar Karaislah fork to Soğukpınar, 1.5 km, stony slopes, 890 m, 27. 05. 2003, *G. Kaynak, R. Daşkın, Ö. Yılmaz*, BULU 15390.

A5: KASTAMONU; Tosya, between Tosya and Çiftlik, rocky places, 1120 m, 21. 08. 1994, *G. Kaynak, N. Şimşek*, BULU 8941 B.

A8: RİZE; İspir, around Gültepe village, on rocks, 1200 m, 15. 07. 1995, *G. Kaynak, N. Şimşek*, BULU 9524 B.

B2: BALIKESİR; Dursunbey, Alaçam mountains, northern slopes of Asar tepe, on rocks, 100 m, 06. 06. 1987, *G. Kaynak*, BULU 600 - BURSA; Orhaneli, on rocks, 700-800 m, 17. 07. 2005, *G. Kaynak*, BULU 30391.

B3: ISPARTA; Uluborlu, slopes of Gültepe village, rock crevices, 19. 05. 1995, *G. Kaynak*, BULU 9510.

C1: MUĞLA; around Marmaris, *P. brutia* forest, macchie, on serpentine rocks, 0-50 m, 06. 05. 2001, *G. Kaynak*, BULU 26825.

C2: DENİZLİ; Kale to Muğla, 40 km, sparse *P. nigra* forest, on serpentine rocks, 1350-1400 m, 05. 05. 2001, *G. Kaynak*, BULU 26804 - Kale to Muğla, 30 km, Beyağaç crossroads, on naked serpentine rocks, 1000 m, 05. 05. 2001, *G. Kaynak*, BULU 26809.

C6: KAHRAMANMARAŞ; Yukarı Ceyhan valley, Çimen stream, entrance of Çokran village, on stream banks, on rocks, 100 m, 25. 06. 1996, *G. Kaynak*, BULU 26548 - OSMANİYE; Düziçi, Berke dam, Ilıca, 350-450 m, on serpentine rocks covered with macchie, 350-450 m, 17. 07. 2002, *G. Kaynak*, BULU 26937 - OSMANİYE; Düziçi, Yukarı Hacılar, Kızılca localition, *P. brutia* forest, macchie, 800-1000 m, 17. 07. 2002, *G. Kaynak*, BULU 26948.

*Cosentinia vellea* subsp. *vellea* (Syn. *C. cataenensis* (Cosent.) H. P. Fusch; *Notholaena vellea* (Aiton) R. Br.; *Acrostichum velleum* Aiton)

C1: AYDIN; Söke, on Pirene ruin walls, 100 m, 24. 05. 1996, *G. Kaynak*, BULU 26486 - MUĞLA; around Göcek, *P. brutia* forest, on calcerous rocks, 100-150 m, 06. 05. 2001, *G. Kaynak*, BULU 26827.

C2: ANTALYA; Kalkan to Kaş, Kapıtaş, cliffs, 70 m, 25. 05. 1996, *G. Kaynak*, BULU 26505 - MUĞLA; Fethiye, Ölüdeniz to Faralya, macchie, on rocks, 100 m, 07. 05. 2001, *G. Kaynak*, BULU 26834.

C3: ANTALYA; Konyaaltı, above Hurma village, sparse macchie, calcerous rocky crevices, 20-50 m, 08. 05. 2001, *G. Kaynak*, BULU 26845 - Köprülü canyon national park, on rocks, 260 m, 14. 05. 2008, *G. Kaynak*, BULU 29942.

C5: MERSİN; Erdemli to Silifke, 12 km, macchie, on rocks, 20-50 m, 30. 03. 1996, *G. Kaynak*, BULU 26469.

C6: ADANA; Toprakkale, on Toprakkale ruins walls, 29. 03. 1996, *G. Kaynak*, BULU 26464.

## RESULTS AND DISCUSSION

At the end of the studies, the distribution of five taxa belonging to the Cheilanthoid ferns in Turkey have been established. *Cheilanthes persica* and *C. acrostica* were found to be the most widespread species whereas, *C. tinaei* is very rare species in Turkey (Figure 1). *Notholaena marantae* subsp. *marantae* and *Cosentinia vellea* subsp. *vellea* are less widespread species (Figure 2). When distribution of Cheilanthoid ferns was examined it was found these ferns are generally distributed in south of Turkey. Especially, *Cosentinia vellea* subsp. *vellea* are distributed in Mediterranean region of Turkey. *Cheilanthes acrostica* and *C. persica* are distributed in Turkey entirely.

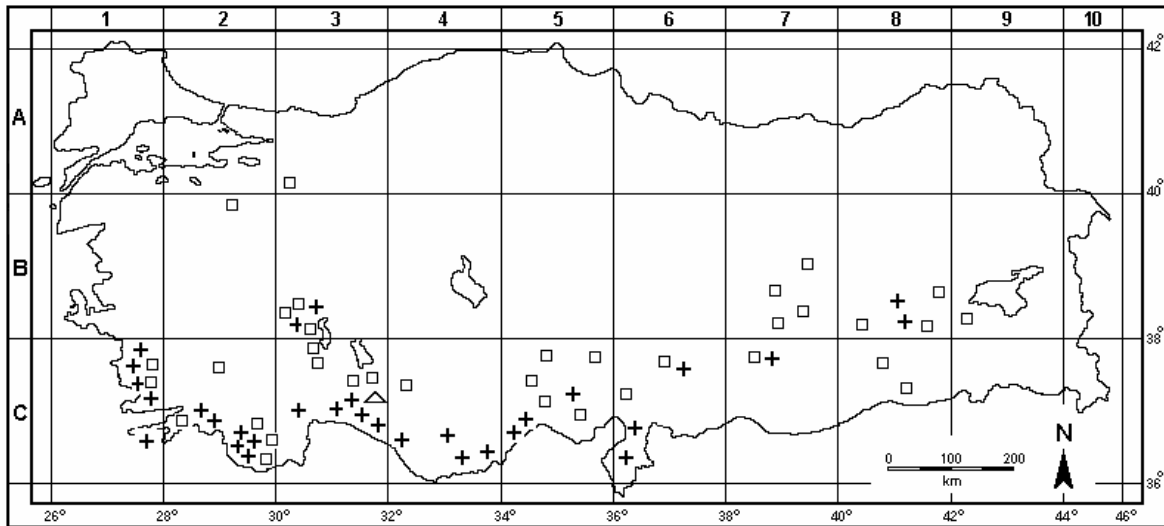
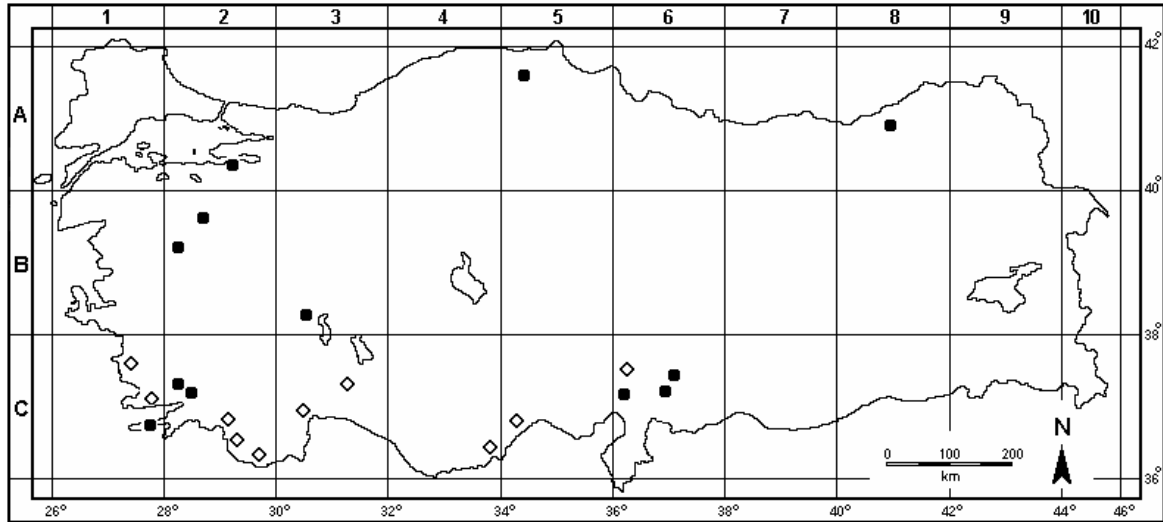


Figure 1. Distribution of *Cheilanthes acrostica* (+), *C. persica* (□) and *C. tinaei* (△) in Turkey.

Observations from the ecological results based on soil and rock samples from the growth environment are in general agreement with the findings reported in literature (Viane et al. 1996). These results indicate certain preference as by the ferns to one or more of soil pH types, acidic, neutral or alkaline, as shown in Table 1.

Furthermore, fern samples were classified according to the rock outcrops type they were attached, as calcicole or silicicole and in some cases as highly tolerant types which grow on both rock types (Table 2). Accordingly, *Cheilanthes tinaei* growing on acidic soil types is classified as acidophil. On the other hand, *C. acrostica*, *C. persica* and *Cosentinia vellea* subsp. *vellea* are calcicole Cheilanthoid ferns which prefer grow

on alkaline soil types. These results were agree with those of Kaynak (1989) who studied chorology and ecology of ferns of Diyarbakır and its surroundings (Elazığ, Bingöl, Bitlis, Siirt, Mardin, Urfa and Adıyaman provinces). *Notholaena marantae* subsp. *marantae* exhibit growth on alkaline and pH-neutral soil environment. In addition, this fern were found to be neutrophil-basiphil fern types.



**Figure 2.** Distribution of *Notholaena marantae* subsp. *marantae* (■) and *Cosentinia vellea* subsp. *vellea* (◇) in Turkey.

**Table 1.** Classification of Turkish Cheilanthoid ferns according to soil reaction

Species	Total Specimen Number	% CaCO <sub>3</sub>				pH	
		0-2	2-10	10-20	20 <		
<i>Cheilanthes acrostica</i>	33	7	14	4	8	7.1-8.2	Basiphil
<i>C. tinaei</i>	1	1				4.2	Acidophile
<i>C. persica</i>	46	1	13	19	13	7.0-8.3	Basiphil
<i>Notholaena marantae</i> subsp. <i>marantae</i>	14	13	1			6.6-7.7	Neutrophil-Basiphil
<i>Cosentinia vellea</i> subsp. <i>vellea</i>	7			3	4	7.4-8.2	Basiphil

**Table 2.** Substrata of taxa belonging to the Cheilanthoid ferns in Turkey.

Species	Total Specimen Number	Calcareous Rocks *								Silica Rocks **					
		1	2	3	4	5	6	7	8	9	10	11	12	13	
<i>Cheilanthes acrostica</i>	33	21		3	2	3					1	3			Calcicole
<i>C. tinaei</i>	1										1				Silicicole
<i>C. persica</i>	46	24	2	2	2	8	5	2		1					Calcicole
<i>Notholaena marantae</i> subsp. <i>marantae</i>	14								1	8	2	2	1		Silicicole
<i>Cosentinia vellea</i> subsp. <i>vellea</i>	7	6			1										Calcicole

\* 1. Limestone 2. Crystalline limestone 3. Dolomite 4. Travertine 5. Calc-shist 6. Calc-tufa 7. Calc-sandstone

\*\* 8. Quartz 9. Quartzite 10. Serpentine 11. Magnesite 12. Diorite 13. Aplite

*Chelanthus acrostica*, *C. persica* and *Cosentinia vellea* subsp. *vellea* are both calcicole and casmophyte ferns growing only in fissures on limestone. In contrast, *C. tinaei* and *Notholaena marantae* subsp. *marantae* are silicicole casmophyte ferns, and grow only in the fissures of rocks rich in silica like quartz, quartzite, serpentine, magnesite, diorite and aplite.

## ACKNOWLEDGEMENT

Some specimens of Cheilanthoid ferns which were examined in this study, were collected during the field trips for “Chorological, Morphological, Ecological and Cytological Investigations on Ferns of Western, Southern and Central Anatolian Project”. The authors thank Research Found of Uludağ University for financial support (Project no: 2000/15).

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