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Short note

CONTRIBUTION TO THE PHYTOSOCIOLOGY AND CONSERVATION OF TERTIARY RELICT SPECIES IN NORTHEASTERN ANATOLIA (TURKEY)

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ABSTRACT. — We investigated the phytosociological structure of the *Quercus pontica-Betula medwediewii* community in the Artvin province in northeastern Anatolia (Turkey). The *Querco ponticii-Betuletum medwediewii* association was scattered at an altitude of 1300-1700 m on south, west, southwest, southeast and northwest facing slopes. The *Geranio-Pinion* alliance was characterized by *Hypericum bithynicum.* The main components of the *Pino-Piceetalia orientalis* were *Picea orientalis* and *Abies nordmanniana* subsp. *nordmanniana.* The components of the *Geranio-Pinion* alliance and the *Pino-Piceetalia orientalis* order were well represented in this association and should be considered within those syntaxa units. Northeastern Anatolia has a unique flora and is a relictual refuge for many plant species that are remnants of the ancient Mediterranean flora. Ten endemic taxa were found in the study area. According to a CCA ordination, pH and clay content are the most significant soil parameters determining community composition.

KEY WORDS. — Artvin, Camili, Colhic, syntaxonomy, vegetation, western lesser Caucasus.

INTRODUCTION

Turkey is situated at the junction of three important phytogeographic regions: the Mediterranean, the Irano-Turanian, and the Euro-Siberian regions, each with its own endemic species and natural ecosystems. These include the Caucasian mountain mixed temperate rain forests and the alpine ecosystems of the northeastern Black Sea coast (DAVIS 1965, OLSON *et al.* 2000).

The combination of a temperate climate which is at the junction of sub-tropical and temperate zones, a rugged topography, varied geology, and geographic proximity with both Europe and the Near East contribute to the uniqueness and complexity of plant life in northeastern Anatolia (Turkey). Two parts of Turkey are included in Conservation International's 25 World "biodiversity hotspots": southern and a small part of northeastern Anatolia are included in the "Mediterranean Basin" and "Caucasus" hotspots, respectively. Turkey is also included in four of the Global 200 ecoregions, including the "Caucasus-Anatolian-Hyrcanian temperate forests". Our study area is the most significant refuge and relict area for Tertiary forests of western Eurasia. The occurrence of deciduous temperate forests has remained uninterrupted in this region since the Tertiary. Also the largest natural

forest ecosystems of Europe and Mid-Asia are found in this region (WWF & IUCN 1994).

Although the area belongs to one of the well-protected regions in Turkey, there has been no study of the vegetation of the area so far. Several floristic and vegetation studies, however, have been carried out in localities close to the research area (e.g. EMINAĞAOĞLU & ANŞIN 2004).

We studied the phytosociological aspects of the *Quercus pontica-Betula medwediewii* community in the Artvin province, located in western lesser Caucasus corridor. Moreover, we identified rare and endemic plant species and evaluated the significance of this area for nature conservation.

MATERIAL AND METHODS

The research area is located in the Colchic sector of the Euro-Siberian floristic area in the Holarctic region (DAVIS 1965). It is a transitional zone between the Euro-Siberian and Irano-Turanian phytogeographical regions and it is situated in the Artvin province in Turkey within the A9 square (Fig. 1), according to DAVIS's grid system (DAVIS 1965). The area (ca. 25274 ha) is located between 41°20'49" and 41°31'32"N, and between 41°49'36" and 42°05'27"E. It is situated between 450 and 3435 m a.s.l. It includes the Camili, Efeler, Maral, Uğur, Düzenli and Kayalar villages, Kışlas (low mountain pastures) and Yaylas (high mountain pastures) (Fig. 1).

Meteorological data are only available from one station in the area, and were obtained between 1971 and 1996 in Borçka. The mean annual temperature was 13.5 °C and the mean precipitation was 1010.2 mm. Maximum temperature of the hottest month and minimum temperature of the coldest month were 27.1 and 1°C, respectively. The coldest month was February with a minimum temperature of -9.8 °C and the hottest month was August with a maximum temperature of 42.4 °C. The rainfall regime of the study area is

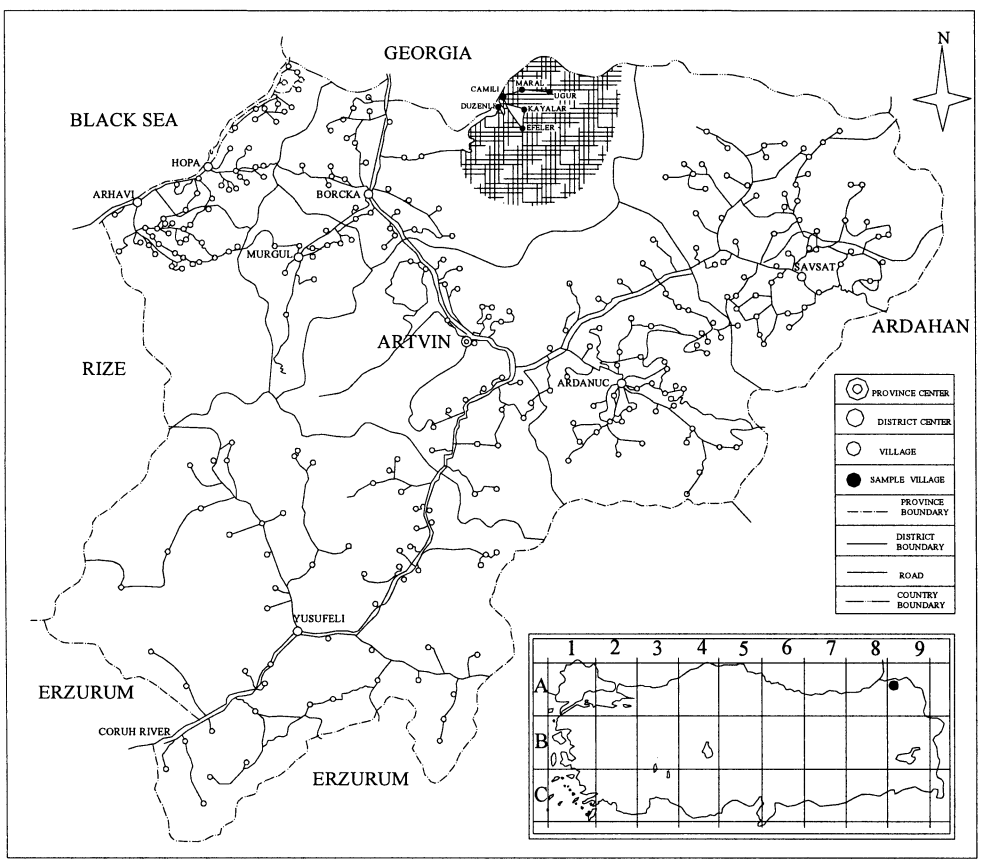

Fig. 1. Location of the study area.

"autumn-winter-summer-spring" of semi-terrestrial origin (AKMAN 1999).

The geological structure of the research area mostly contains rocks belonging to the Upper Cretaceous period. There are four large soil groups in the study area: eutric cambisols, humic acrisols, eutric podzoluvisol, and haplic castanozem. The most widespread are eutric cambisols (AYDINALP & FITZPATRICK 2004).

Plants were identified using the Flora of Turkey (DAVIS 1965), and other floras (KETZKHOVELI & GAGNIDZE 2001). The vegetation study was carried out according to Braun-Blanquet's method (BRAUN-BLANQUET 1932). The plant association was named and classified according to International Code of Phytosociological Nomenclature (WEBER *et al.* 2000). The cover values of all vascular species were estimated in each vegetation layer (tree, shrub and herb layers) according to the Braun-Blanquet cover-abundance scale. Ten soil samples were taken from each plot. These samples were taken at a depth between 0 and 30 cm during mid-growing season (August 2004). Soil texture and pH, electrical conductivity, organic matter content, nitrogen and $CaCO_3$ content were determined using standard methods (BAYRAKLI 1987). To identify the interactions between soil factors and species composition, a canonical correspondence analysis (CCA) was performed using CAP version 1.5 (HENDERSON & SEABY 1999) and ECOM version 1.33 (HENDERSON & SEABY 2001).

RESULTS AND DISCUSSION

The syntaxonomical interpretation of the studied association is as follows:

Querco-Fagea FUKAREK -FABIJANIK 1968
Querco-Fagetea (BRAUN - BLANQUET ET VLIEGLER, 1937) FUKAREK -FABIJANIK 1968
Pino-Piceetalia orientalis QUEZEL *et al.* 1980
Geranio-Pinion QUEZEL *et al.* 1980
Querco ponticii-Betuletum medwediewii ass. nov.

The typus of the *Querco ponticii-Betuletum medwediewii* ass. nov. is Rel. no. 2, Table 2. This association is scattered at an altitude of 1300-1700 m on south, west, southwest, southeast and northwest facing slopes. The *Geranio-Pinion* alliance is characterised by *Hypericum bithynicum.* The main components of the *Pino-Piceetalia orientalis* are *Picea orientalis* and *Abies nordmanniana* subsp. *nordmanniana.* The characteristic species of the *Querco-Fagetea* are *Carex sylvatica, Athyrium filix-femina, Mycelis muralis*, and *Blechnum spicant.* The *Querco-Fagea* is characterised by *Corylus avellana* var. *avellana, Fragaria vesca*, *Lapsana communis* subsp. *intermedia*, *Clinopodium vulgare* subsp. *vulgare, Teucrium chamaedrys* subsp. *trapenzuntinus*, *Cerasus avium*, *Brachypodium sylvaticum, Geranium robertianum*, *Poa nemoralis*, *Salvia glutinosa*, and *Epilobium montanum.* The characteristic species of the *Vaccinio myrtilli-Rhododendrion caucasici* alliance, *Fagetalia sylvatica, Rhododendro-Fagetalia orientalis* order and *Daphno-Festucetea* and *Salicetea herbaceae* classes are shown in Table 1. Components of the *Geranio-Pinion* alliance and the *Pino-Piceetalia orientalis* order are represented in this association. Hence, this association must be considered in those syntaxonomical units (Table 1).

High pH values were associated with the occurrence of the endemic species *Doronicum balansae* and *Papaver lateritium*, whereas a high clay content was associated with the endemic *Inula helenium* subsp. *orygalis*. pH and clay content were also related with the occurrence of *Myosotis lithospermifolia*, *Gentiana septenfida*, *Galium odoratum* and *Vaccinium arctostaphylos* and *Polygala alpestris*, *Carex sylvatica*, *Trifolium ambiguum* and *Quercus pontica*, respectively. High EC values were associated with *Epilobium montanum* and *Picea orientalis* (Fig. 2). Species diversity (H') and evenness (J) were 1.08 ± 0.21 and 0.83 ± 0.14, respectively in the *Querco ponticii-Betuletum medwediewii* association.

ØKLAND & EILERSTEN (1993) found that pH may be the single environmental parameter explaining the variation in species distribution. In the present study, both pH and clay content were identified as the most significant soil parameters.

In the study area, 10 endemic taxa were identified: *Acer cappadocicum* Gled. var. *stenocarpum* Yalt. (Aceraceae), *Centaurea appendicigera* C.Koch, *C. hedgei* Wagenitz, *C. pecho* Albov, *Doronicum balansae* Cavill., *Helichrysum artvinense* P.H. Davis and Kupicha, *Inula helenium* L.

Table 1. Phytosociological table of the *Querco ponticii-Betuletum medwediewii* Eminağaoğlu and Kutbay ass. nov.

No of relevé in table	1	2	3	4	5	6	7	8	9	10	
Field no of relevé	1	2*	3	7	9	11	12	17	18	20	
Year	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	
Day & Month	20.07	20.07	25.07	10.07	10.07	20.07	20.07	10.07	30.07	30.07	
Size of Quadrat (m2)	100	100	100	100	100	100	100	100	100	100	
Altitude (m)	1300	1350	1400	1400	1550	1550	1650	1650	1700	1700	
Exposure	SW	SW	W	SE	S	NW	W	W	W	NW	
Inclination (%)	80	80	90	90	70	80	80	90	90	90	
Height of tree layer (m)	.	.	25	30	25	25	.	.	.	.	
Coverage of the tree layer (%)	.	.	1	1	1	1	.	.	.	.	
Height of the shrub layer (m)	4	5	4	4	4	4	5	5	4	5	
Coverage of the shrub layer (%)	90	90	100	90	90	80	95	90	90	100	
Height of the herb layer (cm)	40	50	20	30	30	20	30	20	40	20	
Cover of the herb layer (%)	50	30	30	30	30	30	40	30	50	50	Constancy
Characteristic and differential species of the association											
Quercus pontica	12	12	11	+2	11	+2	12	11	+2	+1	V
Betula medwediewii	44	44	33	44	53	44	54	33	44	53	V
Rhododendron smirnowii	22	.	+2	+2	.	.	+2	.	12	12	III
Epigaea gaultherioides	12	.	.	22	.	22	12	.	.	12	III
Ruscus colchicus	12	22	.	.	22	12	.	22	.	.	III
Veronica peduncularis	+1	.	+1	+1	.	.	.	+2	+1	.	III
Doronicum balansae	.	.	+2	.	.	+2	.	.	.	.	I
Inula helenium subsp. orgyalis	.	.	.	.	+2	.	.	.	.	.	I
Papaver lateritium	.	.	.	.	.	.	.	+2	.	.	I
Helichrysum artvinense	.	12	.	.	.	.	.	.	.	.	I
Characteristic species of *Geranio-Pinion*											
Hypericum bithynicum	+1	.	.	.	+1	+1	.	+1	.	.	II
Characteristic species of *Pino-Piceetalia orientalis*											
Picea orientalis	.	.	+1	.	+1	+1	.	.	.	.	II
Abies nordmanniana subsp. nordmanniana	.	.	.	+1	.	.	.	.	.	.	I
Characteristic species of Rhododendro-Fagetalia orientalis											
Rhododendron ponticum		+1	+1	.	.	.	+1	.	.	+1	III
Rhododendron luteum	.	.	+1	.	.	+1	.	.	.	.	I
Vaccinium arctostaphyllos	.	.	.	+2	.	.	.	+1	.	.	I
Characteristic species of *Vaccinio myrtilli-Rhododendrion caucasici*											
Vaccinium myrtillus	.	+1	+1	.	+1	+1	.	.	.	.	II
Solidago virgaurea subsp. alpestris	.	+1	+1	.	.	.	+1	+1	.	.	II
Rhododendron caucasicum	+1	+2	.	.	.	.	.	.	+1	.	II
Characteristic species of *Daphno-Festucetea*											
Myosotis lithospermifolia	.	.	.	+1	.	.	+1	+1	.	+1	II
Characteristic species of *Fagetalia sylvatica*											
Sanicula europaea	.	.	+1	+1	.	.	.	+1	+1	+1	III
Oxalis acetosella	+1	.	.	.	.	.	.	.	.	.	I
Calamintha grandiflora	.	.	.	.	.	.	.	.	.	+1	I
Galium odoratum	.	+1	.	.	.	.	.	.	.	.	I
Characteristic species of *Querco-Fagea and Querco-Fagetea* (*)											
Corylus avellana var. avellana	+1	+1	.	.	+1	+1	+2	+1	.	+1	IV
*Carex sylvatica**	.	+1	+1	.	.	.	+1	+1	.	.	II
Fragaria vesca	.	.	+1	.	.	+1	.	+1	+1	.	II

Lapsana communis subsp. intermedia	.	+1	+1	.	.	.	.	+1	+1	.	II
Clinopodium vulgare subsp. vulgare	.	+1	.	+1	+1	+2	.	.	.	.	II
Teucrium chamaedrys subsp. trapenzuntinus	.	.	.	+1	+1	.	.	.	.	.	I
Cerasus avium	.	.	.	.	.	+1	.	.	.	+1	I
*Athyrium filix-foemina**	.	.	.	.	.	.	+1	.	.	+1	I
Brachypodium sylvaticum	+1	.	.	.	.	.	+1	.	.	.	I
Geranium robertianum	+2	.	.	.	.	.	+2	.	.	.	I
Poa nemoralis	+1	.	.	.	.	.	.	.	+1	.	I
Salvia glutinosa	.	.	.	.	.	+1	.	.	+1	.	I
Epilobium montanum	.	.	.	.	.	+1	.	.	.	.	I
*Mycelis muralis**	.	.	.	.	.	+1	.	.	.	.	I
*Blechnum spicant**	.	.	.	.	.	+1	.	.	.	.	I
Characteristic species of *Salicetea herbaceae*											
Carex caucasica	+1	.	.	.	.	+1	+1	.	.	.	II
Polygala alpestris	+1	.	.	.	+1	.	.	+1	.	.	II
Veronica gentianoides	.	+1	.	.	+1	.	.	.	+1	.	II
Trifolium ambiguum	.	+1	.	.	.	.	+1	.	+1	.	II
Gentiana septenfida	.	.	.	+1	.	.	+1	.	+1	.	II
Gentianella caucasea	.	.	+1	.	.	.	.	.	.	+1	II
Phleum alpinum	.	.	.	.	.	.	.	.	.	+1	II
Companions											
Alopecurus aequalis	+1	+1	.	+1	.	.	.	+1	.	+1	III
Scabiosa columbaria	+2	+2	.	.	+2	.	.	+2	.	+2	III
Hypericum perforatum	+1	.	.	+1	.	.	+1	.	.	+1	II
Origanum vulgare subsp. vulgare	+1	+2	+1	.	.	.	.	.	.	+1	II
Rumex acetocella	+1	.	+1	+1	.	.	.	.	.	+1	II
Geranium ibericum subsp. jubatum	+2	.	+2	.	.	+2	.	.	.	.	II
Helianthemum nummullarium subsp. tomentosum	.	.	.	+2	.	.	+1	.	.	+2	II
Rumex crispus	.	.	.	.	+1	+1	.	.	+1	.	II
Carex divisa	.	.	.	.	+1	.	.	.	.	+1	I
Epilobium angustifolium subsp. angustifolium	.	+1	.	.	.	.	+1	.	.	.	I
Geranium pyrenaicum	.	+2	.	.	.	.	.	.	+2	.	I
Poa pratensis	+1	.	.	.	.	.	+1	.	.	.	I
Silene vulgaris var. vulgaris	.	.	.	+2	.	.	.	.	.	+2	I
Urtica dioica	.	+2	+2	.	.	.	.	.	.	.	I
Valeriana alliariifolia	.	.	.	.	.	+1	+1	.	.	.	I
Betula recurvata	.	+1	.	.	.	+1	.	.	.	.	I
Rosa montana subsp. woronowii	.	+1	.	.	.	.	.	+1	.	.	I
Viburnum lantana	+1	.	.	.	.	.	+1	.	.	.	I
Campanula lactiflora	+1	.	.	+1	.	.	.	.	.	.	I
Alchemilla sintenisii	.	.	.	.	.	.	.	+2	.	.	I
Campanula rapunculoides subsp. cordifloia	.	.	.	.	.	.	.	+1	.	.	I
Lamium tomentosum var. alpestre	.	.	.	.	.	.	+1	.	.	.	I

***-Nomenclatural type relevé**

Localities of relevés:
1: Düzenli forest E739252 N4589359; 2:Düzenli forest E739683 N4590155;
3: Düzenli forest E740401 N4589241; 7:Efeler forest E748194 N4586447;
9: Efeler forest E747241 N4586750; 11: Gorgit forest E742661 N4586967;
12: Gorgit forest E746976 N4586683; 17: Gorgit forest E747288 N4585040;
18: Düzenli forest E739942 N4589714; 20: Uğur forest E755701 N4595144.

subsp. *orgyalis* (Boiss.) Grierson, (Asteraceae), *Rhododendron smirnovii* Trautv. (Ericaceae), *Papaver lateritium* Koch (Papaveraceae), *Lilium carniolicum* Bernh. ex W.Koch subsp. *ponticum* (C.Koch) P.H.Davis, and Hend. var. *artvinense* (Miscz.) P.H.Davis and Hend. (Liliaceae).

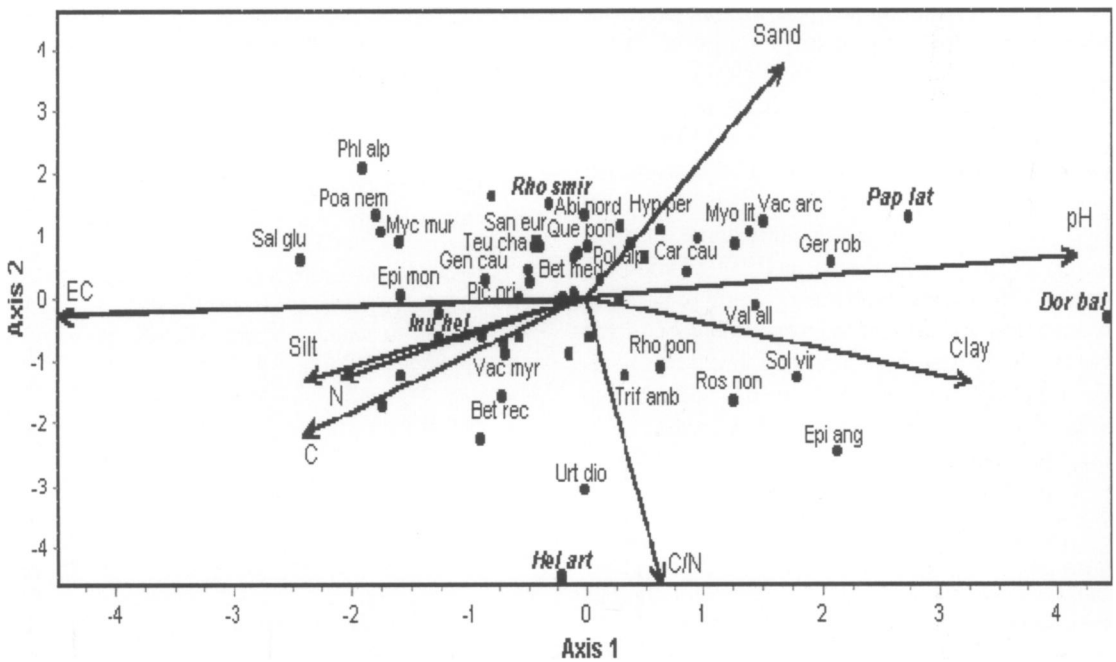

Fig. 2. The CCA ordination diagram showing the relationships between species and soil factors. For species codes see Table 1. C:; N: nitrogren content; C/N: carbon to nitrogen ratio; Clay: proportion of clay; Sand: proportion of sand; Silt: proportion of silt; EC: electrical conductivity.

The northeastern Anatolia region has a unique flora and is a relictual refuge for many plant species that are remnants of the ancient Mediterranean flora such as *Periploca graeca* L. var. *graeca* (Asclepidaceae), *Cistus creticus* L. (Cistaceae), *Laurus nobilis* L. (Lauraceae), *Trachomitum venetum* (L.) Woodson (Apocynaceae) and *Olea europaea* L. var. *europaea* (EMINAĞAOĞLU & ANŞIN 2004). Several taxa have a disjunct distribution between the Caucasus, the Mediterranean and Western Europe, such as *Picea orientalis* (L.) Link, *Abies nordmanniana* (Stev.) Spach. subsp. *nordmanniana*, *Betula medwediewii* Regel, *Quercus pontica* C.Koch, *Epigaea gaultherioides* (Boiss. and Bal.) Takht., *Osmanthus decorus* (Boiss. and Bal.) Kasaplıgil, *Rhododendron ungernii* Trautv., *R. smirnovii* Trautv. and *Ruscus colchicus* P.F.Yeo. These species are specific for the Colchic habitat. Outside the Colchic section these species are disappearing relicts, whereas they are progressive relicts in the Colchic ecosystem (GEGECHKORI 2000).

The flora of the study area includes many relict species, which have been preserved and inherited from warmer and more humid periods. Although the study area is well-protected owing to its inaccessibility, species richness and evenness were found to be lower compared to the western part of the Black Sea region (Euxine province) and to other studies that reported species diversity and evenness ranging from 1.54-7.12 and 1.19-3.43, respectively (YALÇIN *et al.* 2004). This is very likely due to the high abundance-dominance of tree and shrub species. As a result, photosynthetically active radiation (PAR) is remarkably reduced in the understorey (HIROSE *et al.* 1988). The eastern forests of the Black Sea region are more common old-grown forests with a lower species diversity as compared to the western part of the Black Sea region (KURDOĞLU 1996).

More remaining habitats in the Caucasus hotspot need to be formally protected to ensure the long-term survival of the region's biodiversity. Transborder protected areas are not found in the Caucasus. A joint initiative from Turkey and Georgia could make a difference. A Transborder protected area is to be set up between Turkey and Georgia to cooperate in the ecoregion Conservation Initiative for the Caucasus (EMINAĞAOĞLU & ANŞIN 2004). Development of joint projects in order to strengthen the conservation of Colchic Forests in border areas and transborder projects are important conservation priorities in the region to protect species on the verge of extinction.

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