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Floristic composition, ecological characterisation and land-use history of submontane forests in the north-western Caucasus

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Abstract

In the present work mesophytic deciduous mixed forests with *Fagus orientalis*, *Quercus petraea* und *Carpinus betulus* from the north-western Caucasus (Russia, Republic of Adygeâ) are portrayed. On the basis of vegetation relevés following Braun-Blanquet and the flanking investigation of site parameters two syntaxa could be distinguished and characterised: the *Euphorbio squamosae-Carpinetum betuli* ass. prov. and the *Festuco drymejae-Abietetum nordmannianae* (submontane expression). Several subassociations and variants are subdividable. Classification, characterisation and nomenclature of the syntaxa are provisional due to the relatively small number of relevés.

The forest communities occur in altitudes between 600 and 950 m a.s.l. on eastern and western exposed slopes and are geographically and floristically intermediate between drier colline forests dominated by *Quercus* sp. and montane Oriental Beech and Oriental Beech-fir-forests. Tree layer as well as shrub layer and ground vegetation are species-rich. The two associations were assigned to the order of European species-rich mesophytic deciduous forests (*Fagetalia sylvaticae*) and its subunits (*Fagion sylvaticae*, *Carpinion betuli*) because of a significant number of supraregional and regional character species.

Characteristic structural elements of the forests derive mainly from their land-use history. Two of the structural land-use types indirectly illustrate their usage in the pre-Russian time (before 1864). They originate directly from successional forests on abandoned Adygè pastures. The structure of the remaining stands is already transformed by more or less intense logging activities, particularly from the clearcut period of 1965 – 1980.

Zusammenfassung

Vegetationszusammensetzung, ökologische Charakterisierung und Nutzungsgeschichte submontaner Waldgesellschaften im Nordwestkaukasus – In der vorliegenden Arbeit werden mesophytische Laubmischwälder mit *Fagus orientalis*, *Quercus petraea* und *Carpinus betulus* aus dem Nordwestkaukasus (Russland, Republik Adygeâ) vorgestellt. Anhand des aufgenommenen Materials und der flankierenden Erhebung von Standortparametern konnten zwei Pflanzengesellschaften, das *Euphorbio squamosae-Carpinetum betuli* ass. prov. sowie das *Festuco drymejae-Abietetum nordmannianae* (submontane Ausprägung) unterschieden und charakterisiert werden. Mehrere standörtlich bedingte Subassoziationen und Varianten sind ausscheidbar. Die Abgrenzung und Benennung der Syntaxa ist aufgrund der relativ geringen Aufnahmezahl als vorläufig zu verstehen.

Die Gesellschaften vermitteln standörtlich und floristisch zwischen den eichendominierten, trockeneren Mischwäldern der kollinen Stufe und den montanen Buchen- bzw. Buchen-Tannen-Wäldern. Sie zeichnen sich durch einen hohen Artenreichtum der Gefäßpflanzen in Baum-, Strauch- und Krautschicht aus. Sie treten an Ost- und Westhängen in Höhen zwischen 600 und 950 m ü. NN auf. Die Zugehörigkeit der angetroffenen Gesellschaften zur Ordnung der europäischen artenreichen mesophytischen Buchen- und Laubmischwälder (*Fagetalia sylvaticae*) und ihren Untereinheiten (*Fagion sylvaticae*, *Carpinion betuli*) ist wahrscheinlich, da sie eine größere Zahl überregionaler und regionaler Kennarten dieser Ordnung aufweisen.

Die charakteristischen Strukturmerkmale der Wälder sind zum großen Teil auf ihre Nutzungsgeschichte zurückzuführen. Nur in zwei strukturellen Nutzungstypen ist indirekt die Nutzung in der vorrussischen Zeit (bis ca. 1864) noch abgebildet. Es handelt sich hierbei um direkt aus adygischen Weiden aufgewachsene sekundäre Wälder. Die übrigen Bestände sind vom Holzeinschlag, vor allem während einer intensiven Kahlschlagsperiode (1965 – 1980), bereits »überprägt«. Hier lässt sich die Entstehungs- und Nutzungsgeschichte nur noch bis zu dieser Periode zurückverfolgen.

Резюме

Растительность, экологическая характеристика и история использования горных лесов Северо-Западного Кавказа – В настоящей публикации описаны мезофитовые смешанно-лиственные леса Северо-Западного Кавказа (Россия, Республика Адыгея). Яркими представителями этих лесов являются *Fagus orientalis*, *Quercus petraea* и *Carpinus betulus*. На основании собранного материала и благодаря возвышению на фланге их местанахождения стало возможным выделение и характеристика двух растительных сообществ: *Euphorbio squamosae-Carpinetum betuli* ass. prov. с одной и *Festuco drymejae-Abietetum nordmannianae* (субмонтанная экспрессия) с другой стороны. Многие субассоциации и их варианты можно выделить по условиям их местонахождея. Четкое разграничение и наименование подразделений в их таксометрической иерархии на основе относительно незначительного числа наблюдений следует понимать как предварительное.

Эти сообщества являются экологическими и видовыми посредниками между сухими смешанными, с преобладанием дуба, лесами холмистого пояса и буковыми или буково-еловыми лесами гор. Их отличительной чертой является большое видовое богатство растений в древесном, подлесково-кустарниковом и в припочвенно-травянном ярусах. Они встречаются на восточных и западных склонах на высотах между 600 и 950 м. Принадлежность наблюдаемых сообществ к порядку мезофитовых многовидовым буковым и смешанно-лиственным лесам встречающихся в Европе (*Fagetalia sylvaticae*) и его подпорядкам (*Fagion sylvaticae*, *Carpinion betuli*) вероятна, так как они обладают большим количеством региональных и надрегиональных дифференциальных видов этого порядка.

Характерные структурные признаки лесов обусловленны в значительной степени историей их использования. Только в двух структурных типах косвенно отображены черты использования лесов в дороссийском времени (прим. до 1864). Речь при этом идет о выросших непосредственно на пастбищях Адыгов вторичных лесах. Остальные лесные массивы несут следы заготовок, особенно те, которые попали под сплошную

вырубку в 1965 – 1980 годах. В этом случае прослеживание истории возникновения и их использования возможна лишь до этого периода.

Keywords: Adygeâ, Braun-Blanquet approach, *Fagus orientalis*, mesophytic forests, *Quercus petraea*

1. Introduction

European species-rich deciduous mesophytic forests (*Fagetalia sylvaticae* Pawł. et al. 1928), their phytosociological communities as well as their respective site conditions are well investigated, particularly in Western Europe (NOIRFALISE 1968, HORVAT et al. 1974, ELLENBERG 1996, WILLNER 2002, MATUSZKIEWICZ 2003a). However, rather little information exists on the most eastern European deciduous mesophytic forests in the green forest belt of the Great Caucasus Mountains.

The very comprehensive study of GRUDZINSKAÂ (1953), concerning the forests of the north-western Caucasian foothills, follows the Russian School of vegetation classification, which uses the Dominant Principle (ALEKSANDROVA 1973, MIRKIN 1987, MASING 1991). Compatibility with the western European vegetation classification system of BRAUN-BLANQUET (1928), which is based upon character species with restricted geographical validity and which emphasises the importance of complete relevés, is not given.

The first published phytosociological works on Caucasian forests according to the school of Braun-Blanquet concern central Caucasian oak-hornbeam forests and Oriental Beech forests (PASSARGE 1981a, b). At the same time the Braun-Blanquet system was first utilised in the Soviet Union for investigation and classification of western Caucasian montane Oriental Beech-fir forests (GREBENŠIKOV et al. 1981, KOROTKOV & BELONOVSKAÂ 1987). A few years later the results were published again in a compilation (BELONOVSKAÂ 1990), alongside with a first syntaxonomical work on mixed oak forests of the western Caucasus (GREBENŠIKOV & BELONOVSKAÂ 1990). Recently FRANCUZOV (2004) further contributed to the classification of western Caucasian montane Oriental Beech and Oriental Beech-fir forests.

Considering the few works on Caucasian oak-hornbeam and Oriental Beech forests, it is not surprising that their syntaxonomical classification is unclear. A detailed and coherent syntaxonomical examination of Caucasian oak-hornbeam forests (with *Quercus petraea, Q. robur, Carpinus betulus* in the north-western Caucasus) is lacking up to now (DOLUHANOV 2003a), whereas the existing classification attempts concerning Caucasian Oriental Beech forests (with *Fagus orientalis*) are controversial. According to DOLUHANOV (2003b) the Oriental Beech forests' syntaxonomy is still based on the *Rhododendro pontici-Fagion orientalis* Horvat, Glavač & Ellenberg 1974, established by HORVAT et al. (1974). In its original meaning this alliance encompasses the floristically distinct Euxinian Oriental Beech forests with Colchic elements like the evergreen shrubs *Rhododendron ponticum* and *Vaccinium arctostaphylos*, which appear in the very humid coastal regions around the Black Sea. Passarge ignored this original frame in his emendation of the alliance (PASSARGE 1981a). He widened the scope of the alliance to all mesophytic Oriental Beech forests on fertile and base-rich soils. He even suggested two »Caucasian« orders (*Rhododendro pontici-Fagetalia orientalis* (Soó 1964) Passarge 1981, *Lathyro-Carpinetalia caucasicae* Passarge 1981) within an own class *Carpino-Fagetea orientalis* (Zohary 1973) Passarge 1973. Despite certain analogies between *Fagus orientalis* forests and corresponding middle European *Fagus*

sylvatica associations, he saw a preponderance of the separating elements (PASSARGE 1981a). As a basis for his estimation serve the authors' own sparse material and a comparison with existing material of Soviet authors, e.g. GRUDZINSKAÂ (1953) – which is a difficult task due to the different schools of phytosociology and classification (s. a.).

The other extreme position in this discourse is held by Korotkov, co-author of the alliance *Abieti-Fagion orientalis* Korotkov & Belonovskaâ 1987, which encompasses western Caucasian montane Oriental Beech and Oriental Beech-fir forests. KOROTKOV (1992) comes to the conclusion that the associations of the *Abieti-Fagion orientalis* should better be assigned to the *Fagion sylvaticae* Pawł. 1928, either as suballiance(s) or associations. He argues that the diagnostic species of the *Carpino-Fagetea* are merely linked to a few relevés (e.g. *Lonicera caucasica*), or, alternatively, share a wider distribution (e.g. *Festuca drymeja, Tamus communis*). Moreover all species with distributional focus in the *Fagion sylvaticae* could be found in Caucasian Oriental Beech forests (e.g. *Viola reichenbachiana*, *Galium odoratum*).

This syntaxonomical ambiguity evokes the need for a thorough floristic investigation of the whole regions' mesophytic and xerophytic forests. In the presented paper a first attempt to classify a small section of the north-western Caucasian mesophytic forests is made. It was found necessary to provide a number of flanking site and stand parameters for a more precise ecological characterisation of the forest communities. As detailed accessible information on the past is lacking, i.e. the land-use history of the investigated forest stands is not well documented, a three-step analysis of land-use history was undertaken, using literature and field evidence as well as oral history.

2. Materials and methods

Study area – The study area comprises the hilly wooded surroundings of the village of Novoprohladnoe (44.1381664°N, 40.2891210°E), Republic of Adygeâ (Russia) in the submontane foreland of the north-western part of the Great Caucasus range. It is located in a depression-like section between two higher lateral chains (Skalistyj Hrebet, Peredovoj Hrebet) of the Great Caucasus and features elevations between 600 and 1000 m a.s.l. In this transitional area zonal colline oak forests (*Quercus petraea*, *Q. robur*, *Q. hartwissiana*) are gradually replaced by montane Oriental Beech and Oriental Beech-fir forests (*Fagus orientalis*, *Abies nordmanniana*). Typically oak-hornbeam and Oriental Beech-hornbeam forests occur. The local distribution of forest types is rather complex and deviates from the general altitudinal scheme, chiefly due to relief features and secondarily due to different bedrock: montane oak forests on southern aspects occur as well as – mainly northern exposed – colline Oriental Beech and mixed deciduous forests (GRUDZINSKAÂ 1953). In the study area southern exposed dry open oak forests and north-facing mesophytic Oriental Beech forests occupy one hill's slopes. This phenomenon occurs mainly on limestone bedrock. On argillaceous bedrock summer water famine and drought are less expressed and therefore stand compositional contrasts between northern and southern slopes are less sharp.

Annual precipitation in the study area averages 804 mm at 600 m a.s.l., the rainfall maximum being in June (102 mm). The mean annual temperature is 9.0 °C and ranges from –2 °C (January) to 19.6 °C (July) (data from the nearest meteorological station in Dahovskaâ, Spravočnik po Klimatu SSSR 1966, 1968). Generally rainfall is evenly distributed throughout the year, but not uncommonly, years with very humid vegetation periods alternate with years with very dry summers. The period of May to August 2005, in which the field work of this

study was carried out, represented such an extremely dry summer. In general the climate is humid with warm summers and cold winters, providing ideal growth conditions for a number of tree and shrub species. Geologically the area is shaped by surficial Jurassic sediments, mainly argillaceous shale, which weathers to more or less smooth forms. Only where limestone or older and harder rocks like granite reach the surface, geomorphological forms are less denudated. On certain patches surficial conglomerate rock appears. It weathers to base-rich, little differentiated lightly coloured soils. The study area is widely forested; only small patches outside the village – former settlements or pastures – are open land. A trend toward succession and reforestation can be observed on these patches (s. a. OTTE 2007, in this issue). All of the area has been intensely harvested, particularly between 1960 – 1985, when most of the area was affected by clearcutting. Therefore, it mainly features dense single-age class stands (Maksimen, Maksimenkina, pers. comm.; own observation). Primary forests are non-existent in this altitudinal belt.

Sampling design and methods – In the study area 39 study plots of each 400 m^2 (20 x 20 m) were established on eastern and western exposed slopes. This sampling design was chosen in order to eliminate effects on vegetation implied by exposure. Thus a closer look at the differentiation of vegetation by other site conditions like bedrock, pH, soil moisture etc. was possible. Furthermore only the steeper slopes in this region provide sites where the influence of logging on woody and ground vegetation is not too great for studying plant communities. The study plots are characterised by inclinations of 15 to 38°, the in-plot inclination should not vary by more than 5°. Other pre-conditions for the selection of the study plots were homogeneous bedrock and stand structure. The altitude varies between 570 and 920 m a.s.l.

In each plot detailed phytosociological relevés were carried out according to BRAUN-BLANQUET (1928), using an extended cover-abundance scale by REICHELT & WILMANNS (1973). Plots were visited at least two times, in spring and summer, to incorporate different aspects such as spring geophytes. Botanical nomenclature chiefly follows the online version of the Flora Europaea (PANKHURST 1996); species not covered here are found in the online database »Vascular Plants of Russia and Adjacent Countries as of 26.10.96« (CZEREPANOV et al. 1996). Woody plants' nomenclature is according to SCHMIDT (2003 – 2006).

Stand structure was documented by mapping all woody plants and determining the respective species. For all trees taller than 5 m the structural parameters height and $d_{1.3}$ (diameter at 1.3 m height) were identified. $D_{1.3}$ was classified in the field in 5 cm-grades. Additionally the stem number per tree was recorded in order to reveal the percentage of multi-stemmed individuals. Dead wood (uprooted trees and snags) was also recorded, classified in two classes each; 3 – 15 cm diameter (weak) and > 15 cm diameter (strong) $d_{1.3}$. Cut stumps in the study plots were mapped as a sign of land-use and disturbance of the natural stand structure. A soil profile was sampled in every plot and a number of soil parameters were recorded, like soil unit and soil type, pH, and soil moisture (all according to AG Boden 1994).

The interpretation of the gathered data focused on floristic and phytosociological aspects and an analysis of the underlying land-use patterns. As individual regional land-use types are not derivable from literature, they were inductively ascertained from the current stand structure. The structural parameters of the study plots – canopy cover as the percentage cover of all trees > 10 m height, stems/ha, mean diameter of all measured trees > 5 m height, maximum height (height of the tallest tree in the stand), stumps/ha and percentage share of multi-stemmed individuals – were used to differentiate the land-use types. They were

confirmed partly by information abstracted from literature, partly by informal interviews with local experts, i.e. older inhabitants of the village who recalled the in situ land-use history.

Phytosociological table work was performed by use of the programme TAB for Windows 4.04 (PEPPLER-LISBACH 2005). The classification of vegetation types with character and differential species follows the methodological recommendations of BERGMEIER et al. (1990) and DENGLER & BERG (2000), using the criterion of the latter for the definition of differential species. Accordingly a differential species is a species which attains – in a certain plant community – at least twice the percentage constancy as in the compared similar plant community. Names of the described associations, subassociations and variants must be regarded as provisional, as a coherent regional syntaxonomical system of north-western Caucasian forest communities into which they could fit is still lacking. Moreover the record of vegetation relevés is of local character and rather small – although it fulfils the recommendations of the International Code of Phytosociological Nomenclature (WEBER et al. 2000).

Additionally a distributional analysis was performed to generate a spectrum of the geographical distribution of the participating plant species. The intention was to reveal the degree of peculiarity of the investigated plant communities. As detailed distributional information lacks for a part of the recorded species, the rather rough geographical scheme of BRUMMIT (2001) was applied.

For author's citations of the taxa mentioned in the text see the complete species list in Appendix 1 in this volume.

3. Results

Land-use history and land-use types – The land-use history of the north-western Caucasian foothills can be reconstructed on a regional and local level back to 1864, the beginning of the Russian colonisation, but is arguable for the earlier Adygè period. The Adygè people lived in tribes in small settlements (so-called auls) and engaged themselves mainly in livestock farming. Several authors assume that the relation of forested to non-forested land amounted to 1 : 9 in those times, while after the Caucasian war and banishment of the major part of the Adygè people this relation turned into the reverse (IVANOV et al. 2000, s. Fig. 1). Consequently one may conclude that most of the foothill forests are of secondary origin (s. a.

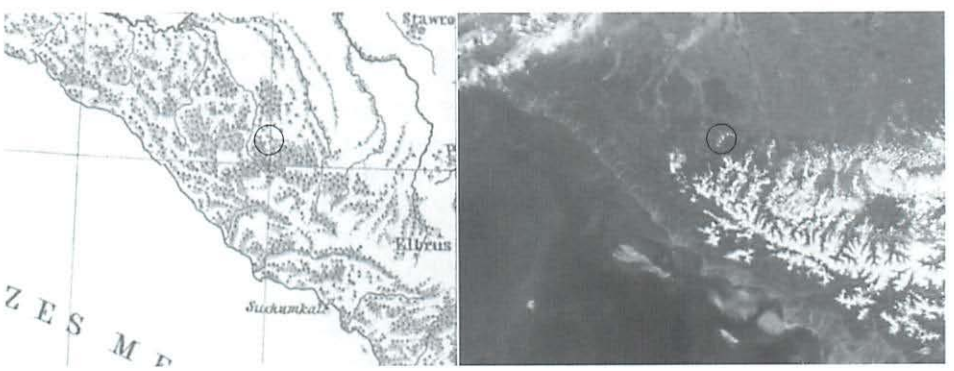

Fig. 1 Afforestation of the western Caucasus around 1874 and present. Circle indicates approximate location of the study area. On the left detail of »Verbreitung der Wälder Kaukasiens« by A. Petermann, 1 : 7 500 000, from Radde 1874, modified; on the right detail of a true-colour image from 2001 (NASA 2001; sensor MODIS) see also App. 2, Fig. A2-42

OTTE 2007, in this issue). Local people of the village of Novoprohladnoe refer to their own memory and to the stories of their senior relatives that several hills around the village nowadays densely forested used to be covered entirely by meadows. When exactly the process of abandonment of pastures and subsequent progressive forest succession in the study area started is not reconstructable. It could have been a multistage process as follows:

1864 – 1917: time of Russian settlement and decrease of livestock impact on meadows and pastures (number of livestock per family: 15 – 20); increase of forest fraction,

1917 – 1943/44: installation of a collective dairy farm (kolhoz) in the village, collectively organised work to remove emerging shrubs and trees on remaining pastures; stagnation of the increase of forest fraction,

1943/44 – present: constant decline of livestock farming in the village, abortion of collective pasture care; increase of forest fraction.

Of high relevance for the understanding of the plots' stand structure is furthermore the period of 1969 – 1985, when almost all forests of the region were affected by extensive clearcutting.

The in-plot land-use history is not extractable from maps or other literature sources. It can only be derived from the study of stand structure. In the study plots a total of 2599 trees and shrubs were recorded and mapped. 1394 trees taller than 5 m were measured with $d_{1.3}$, exact height and number of stems. The chosen structural parameters of the plot stands – maximum height, canopy cover (trees > 10 m height), stems/ha, mean diameter, percentage of multi-stemmed individuals, number of sawn stumps – could be classified into 4 land-use types. Also considered were the general stand structure, knowledge about local and regional land-use history and peculiarities of the land-use types.

The following table provides an overview of the land-use types and their characteristics (Tab. 1). The four superior types are »IL« (intense logging), »SL« (selective logging), »CF« (community forest), and »FP« (former pasture). The first three mentioned are more or less influenced by removal of timber, while the latter constitutes the only land-use type apparently not affected by harvesting for decades. It represents a type of progressive forest succession on abandoned grassland.

Seven former clearcuts are representative of the type »IL«. They are characterised mainly by the highest number of stems/ha of all types (average 2514 n/ha), the lowest mean $d_{1.3}$ (average 14.5 cm), the highest number of sawn stumps (75 – 225 n/ha) and a diminishing share of shade-intolerant pioneer trees (*Salix caprea*, *Populus tremula*, *Betula pendula*).

Less extensively harvested is land-use type »SL«. It can be classified into three subtypes: »shade-intolerant«, »shade-tolerant« and »indirect (erosion)«. Their only common attributes are the lack of trees of higher diameter classes (with the occasional exception of crooked or forked individuals with poor economical value) and – in contrast to type »FP« – the low share in snags. Depending on the sub-type no stumps or 25 – 100 n/ha stumps occur. The absence of stumps in subtype »shade-tolerant« may be due to a faster rotting of the wood, while in subtype »indirect« an indirect impact on the plots by erosion from uphill logging sites is likely. Shade-tolerant »SL« stands share a dense canopy cover with an average cover of 92.6 % and the highest maximum stand height of all land-use types and subtypes with 36.6 m. *Fagus orientalis* is the dominant species in the canopy. »SL indirect« stands are characterised by a low number of stems/ha, and an open canopy cover of trees averaging 59 % (and accordingly a dense canopy cover of shrubs).

Theoretically the land-use type »CF« or community forest could also be treated as a selective logging-type. But as it is protected by law from regular harvesting, and only dead wood is allowed to be removed from the forest (a rule sometimes violated), the stand structure is very peculiar: old oaks of a diameter > 100 cm with low-attached branches (1.5 – 3 m height) form a loose canopy layer. They are surrounded by a dense understorey of primarily *Fagus orientalis*. The oak trees could be estimated to an age of about 140 years by means of an annual ring count of a near-by found cross section of an oak tree from a comparable site. It is very likely that these trees are remnants of the first generation of trees on abandoned pastures and fields after banishment of the local Adygè people around 1864.

Tab. 1 Characteristics of the local land-use types derived from structural parameters taken in the study plots. Values represent the arithmetic mean, with the exception of h_{max} (maximum value) and stumps/ha (range).

superior type	subtype	stand structure	CaCo [%]	NS/ha [n]	$d_{1.3}$ [cm]	h_{max} [m]	multi-stemmed [%]	tree structure	stumps/ha [n]	other features	study plots
IL		even-aged young stand; partly higher cover of shrubs, partly pioneer trees occurring	69.0	2514	14.5	21.6	15.8		75 – 225	highest share in uprooted dead wood < 15 cm	A07, H01, H02, H04, H07, U02, U03
SL	shade-intolerant	$d_{1.3}$ mostly < 50 cm, only forked stems thicker; few snags	80.5	1578	20.9	24.8	9.1		25 – 100	normally no dominant tree species	A01, A08, U08, U10, U12, U13, U14, U18
	shade-tolerant		92.6	1297	22.7	36.6	2.3		no	*Fagus orientalis* dominant/most abundant canopy species	A04, H09, H10, U01, U07, U15 U16, U19
	indirect (erosion)		59.0	1065	21.8	26.2	5.4		no	uphill logging; consequent strong erosional effects in the study plots	A05, A06, H05, U05, U17
CF		characteristic structure with differing tall canopy trees and understory, change in forest composition	92.8	1370	28.2	32.2	3.4	canopy trees with > 1 m $d_{1.3}$, low-branched	0 – 75	location near the village/ settlement	A02, A03, U04, U11, U20
FP		no dominant species in the canopy; relatively high share in snags	68.2	2033	16.6	23.3	8.3	low-branched older oaks, tree groups with medium $d_{1.3}$	no	near-by forest edge or small-scale change of open and forested land near-by	H03, H06, H08, H11, U06, U09

IL – intense logging, SL – selective logging, CF – community forest, FP – former pasture, CaCo – canopy cover, NS – number of stems, $d_{1.3}$ – diameter in 1.3 m height, h_{max} – maximum stand height

As already mentioned, the fourth land-use type, »FP« or »former pasture«, presumably is the only forest stand type not disturbed by logging in the recent decades. In all probability FP stands were in an early (forest) successional stage during the high period of harvesting and clearcutting 45 to 20 years ago (1960 – 1985). Therefore they were spared. In addition many of the stems of this land-use type are of minor economical value because of their crooked growth. This growth form mainly derives from the stand structure: trees often grow in peculiar groups of one species (mainly *Quercus petraea* and *Carpinus betulus*) in this land-use type and try to evade the crown shadows of the near neighbours. Moreover trees of higher diameter classes – which are without exception *Quercus petraea* – show a characteristic of former open stand growth. They branch in about 2 – 3 m height and the lowest branches are dying or are already dead due to present light conditions. Furthermore a high amount of snags is remarkable. FP only occurs on shallow rendzinas on dry limestone. Nearby either a forest margin and adjacent open areas or a small-scale change of forested and non-forested land are observable.

Vegetation – A total of 223 taxa was recorded in the relevés. Of those 14 taxa (e.g. *Anemone blanda*, *Colchicum umbrosum*, *Paeonia daurica* ssp. *coriifolia* and a number of orchids) are registered in the Red Data book of Adygeâ (KMRA 1997) and/or in the Red Data book of Russia (Krasnaâ Kniga Rossii 2005). With 21 tree species and 19 shrub species the woody plant species diversity is high. All genera are widespread and non-endemic (*Fagus*, *Quercus*, *Acer*, *Tilia*, *Cornus* etc.).

The distributional spectrum reveals that a rounded 18 % of the two associations' species belong to the Caucasian-western Asiatic flora and 11 % are of south-western European-western Asiatic distribution. However, most of the plants share a wider European-Asiatic distribution. Many species of the eu- and sub-middle European floristic element according to WALTER & STRAKA (1970) are present in the investigated forests, such as *Viola reichenbachiana* and quite a number of trees (*Quercus petraea*, *Carpinus betulus*, *Acer pseudoplatanus* etc.).

As a result of the phytosociological table work two associations could be distinguished along a pH gradient. The *Euphorbio squamosae-Carpinetum betuli* ass. prov. appears on calcareous bedrock while the *Festuco drymejae-Abietetum nordmannianae* Francuzov ined. (submontane form) is restricted to slightly acidic, non-calcareous bedrock. The associations could be subdivided into subassociations and variants along gradients of soil and air moisture, light consumption and assumed degree of soil nitrate. The complete classified table is attached to this issue (Tab. 2). An overview of the species composition of the syntaxa provides the synoptic table (Tab. 3). The syntaxonomical incorporation of the described syntaxa was done as follows:

1. Class: Querco-Fagetea Br.-Bl. & Vlieger 1937
2. Order: *Fagetalia sylvaticae* Pawł. et al. 1928
   3.1 *Carpinion betuli* Issler 1931
      3.2 *Fagion sylvaticae* Pawł. 1928
         3.1.1 *Euphorbio squamosae-Carpinetum betuli* ass. prov.
            3.1.1.1 *E. s.-Carpinetum betuli caricetosum michelii* subass. prov.
            3.1.1.2 *E. s.-Carpinetum betuli asperuletosum taurinae* subass. prov.
         3.2.1 *Festuco drymejae-Abietetum nordmannianae* Francuzov ined.

Tab. 3 Synoptic table of the classified plant communities *Euphorbio squamosae-Carpinetum betuli* ass. prov. and *Festuco drymejae-Abietetum nordmannianae* Francuzov ined.

	no. of column	1	2	3
tree layer				
CAL *Carpinion betuli*				
	Carpinus betulus	100	86	94
DA	*Cerasus avium*	60	6	10
DA	*Acer campestre*	20	46	5
DA	*Ulmus minor*	80	26	15
DA	*Fraxinus excelsior*	80	66	5
CAL *Fagion sylvaticae* (eux.-cauc.)				
DA	*Fagus orientalis*	60	40	100
E. s.-Carpinetum asperuletosum taurinae				
D	*Ulmus glabra*		46	15
D	*Acer platanoides*		53	10
variant with *Sanicula europaea*				
D	*Quercus robur*		6	26
CO *Fagetalia sylvaticae* (eux.-cauc.)				
	Acer cappadocicum	60	46	47
	Tilia dasystyla	20	40	15
	Pyrus caucasica	40	33	26
CC Querco-Fagetea				
	Quercus petraea	100	46	52
others				
	Sorbus torminalis	40		68
shrub layer				
CAL *Carpinion betuli*				
	Carpinus betulus	100	53	89
	Acer campestre	60	46	36
	Cerasus avium	40	20	26
CAL *Fagion sylvaticae* (eux.-cauc.)				
DA	*Fagus orientalis*	60	53	100
DA *E. s.-Carpinetum betuli*				
DA	*Cornus mas*	100	93	36
DA *F. d.-Abietetum nordmannianae*				
DA	*Rhododendron luteum*			26
D *E. s.-Carpinetum caricetosum michelii*				
D	*Ulmus minor*	80	33	15
D *E. s.-Carpinetum asperuletosum taurinae*				
D	*Sambucus nigra*		26	
D	*Euonymus* spec.		26	5
D	*Viburnum lantana*		13	
CO *Fagetalia sylvaticae* (eux.-cauc.)				
	Acer cappadocicum	60	33	47
	Cornus sanguinea ssp. *australis*	60	80	42
	Pyrus caucasica	40	13	26
	Tilia dasystyla		26	31
	Abies nordmanniana	60		5
others				
	Corylus avellana		40	31
	Fraxinus excelsior	40	46	5
	Acer platanoides	40	13	21
	Crataegus spec.	40	60	47
	Acer pseudoplatanus	40	6	
	Ulmus glabra	20	46	26
herbaceous layer				
E. s.-Carpinetum betuli				
CA	*Euphorbia squamosa*	80	86	31
CA	*Paeonia daurica* ssp. *coriifolia*	80	86	26
DA	*Physospermum cornubiense*	100	53	5
DA	*Lithospermum purpurocaeruleum*	80	40	
DA	*Ligustrum vulgare*	60	33	
DA	*Ulmus minor*	80	40	10
DA	*Cyclamen coum*	40	66	26
DA, CAL	*Helleborus caucasicus*	100	86	21
DA, CAL	*Lilium monadelphum*	100	60	10
DA, CAL	*Serratula quinquefolia*	80	60	5
DA, CAL	*Primula veris* ssp. *macrocalyx*	100	40	10
DA, CAL	*Polygonatum glaberrimum*	100	86	36
DA, CAL	*Veronica peduncularis*	100	73	36
DA, CAL	*Campanula rapunculoides*	100	66	42
DA *F. d.-Abietetum nordmannianae*				
DA	*Festuca drymeja*	20	6	57
DA	*Lathyrus aureus*		6	68
DA	*Rhododendron luteum*			57
DA	*Epipactis* spec.	40	13	57
DA	*Lathyrus laxiflorus*	20	6	42
DA	*Luzula pilosa*		20	57
E. s.-Carpinetum caricetosum michelii				
D	*Carex michelii*	100		
D	*Clinopodium vulgare*	100	13	15
D	*Laser trilobum*	100	13	

continued

	no. of column	1	2	3
D	*Orchis mascula*	80	13	
D	*Carex* cf. *Montana*	80	6	
D	*Betonica officinalis*	80		5
D	*Trifolium medium*	80		
D	*Sedum telephium* agg.	80	13	5
D	*Coronilla coronata*	60	6	5
D	*Campanula alliariifolia*	60		
D	*Achillea biserrata*	60		5
D	*Hieracium* spec.	60		
D	*Tanacetum corymbosum*	60		
D	*Melica uniflora*	60		
D	*Dictamnus albus*	60	6	
D	*Pimpinella saxifraga*	40		
D	*Seseli transcaucasicum*	40		
D	*Brachypodium pinnatum*	40		
D	*Seseli peucedanoides*	40		
D	*Ajuga genevensis*	40		
E. s.-Carpinetum asperuletosum taurinae				
D	*Asperula taurina*		60	
D	*Arum italicum* ssp. *albispathum*		86	36
D	*Convallaria majalis*	20	46	10
D	*Anemone ranunculoides*		46	
D	*Scilla siberica*		40	5
D	*Asarum europaeum* ssp. *caucasicum*		40	
D	*Geranium robertianum*		73	21
D	*Galium aparine*		66	15
D	*Viburnum lantana*		60	15
D	*Sambucus nigra*		33	5
D	*Calystegia silvatica*		33	5
D	*Torilis japonica*		33	10
variant with *Myosotis sparsiflora*				
D	*Myosotis sparsiflora*		33	
D	*Asplenium scolopendrium*		46	
D	*Impatiens noli-tangere*		26	
D	*Corydalis caucasica*		20	
D	*Alliaria petiolata*		40	
D	*Sedum stoloniferum*		46	10
D	*Orobanche laxissima*		33	
D	*Anemone blanda*		20	
D	*Scutellaria altissima*	20	33	
variant with *Sanicula europaea*				
D	*Sanicula europaea*	40	46	36
D	*Quercus robur* juv.		13	26
D	*Prunella vulgaris*	20	6	26
D	*Geum urbanum*	20	33	31
D	*Solidago virgaurea*	60	33	36
D	*Lapsana communis*	60	20	31
D	*Salvia glutinosa*	60	20	31
D	*Rosa* spec.	80		36
D	*Carex sylvatica*	40	26	26
D	*Carex depressa* ssp. *transsilvanica*	40	6	21
D	*Ajuga reptans*	20	6	21
D	*Festuca gigantea*	20	6	15
D	*Viburnum opulus*		20	31
D	*Lathyrus roseus*	60		15
D	*Frangula alnus*	40	13	10
CAL *Fagion sylvaticae* (eux.-cauc.)				
(D)	*Polygonatum orientale*	20	93	78
(D)	*Paris incompleta*		60	68
CAL *Carpinion betuli* (south-east Europ.-cauc.)				
(D)	*Lonicera caprifolium*		66	78
CO *Fagetalia sylvaticae* (south-east Europ.-cauc.)				
	Cardamine quinquefolia	60	100	100
	Vincetoxicum scandens	80	40	63
CO, CC *Fagetalia sylvaticae*/Querco-Fagetea				
	Galium odoratum	40	80	78
	Viola reichenbachiana	40	60	57
	Lamium galeobdolon		66	26
	Lathyrus vernus	80	73	78
	Neottia nidus-avis	60	46	42
	Tamus communis	80	93	68
others				
	Fragaria vesca	80	100	84
	Viola alba	100	73	84
	Euonymus spec.	60	100	52
	Rubus fruticosus agg.		60	89
	Dryopteris filix-mas	20	80	57
	Moehringia trinervia		46	57

1 *Euphorbio squamosae-Carpinetum betuli* ass. prov. *caricetosum michelii* subass. prov.
2 *Euphorbio squamosae-Carpinetum betuli* ass. prov. *asperuletosum taurinae* subass. prov.
3 *Festuco drymejae-Abietetum nordmannianae* Francuzov ined.

CA – association's character species; CAL – alliance's character species; CC – class character species; CO – order's character species; D – differential species; (D) – subassociation's differential species, also occuring in other association; DA – associations's differential species; *E. s.-Carpinetum betuli – Euphorbio squamosae-Carpinetum*; *F. d.-Abietetum nordmannianae – Festuco drymejae-Abietetum nordmannianae*; *E. s.-Carpinetum – Euphorbio squamosae-Carpinetum*; eux.-cauc. – Euxinian-Caucasian; juv. – juvenile; south-east. Europ.-cauc. – south-eastern European-Caucasian

Both associations share a number of common species like the regional *Fagetalia sylvaticae* character species *Cardamine quinquefolia* and *Vincetoxicum scandens*, but also several mesophytic forest species with a middle European distribution centre such as *Galium odoratum, Lathyrus vernus*, *Neottia nidus-avis* or *Viola reichenbachiana*.

The *Euphorbio squamosae-Carpinetum betuli* occurs, as already mentioned, exclusively on limestone in the study area. Soil units are rendzina soil, brown earth-rendzina soil and terra rossa-like soil with a thick clayey horizon of dark red colour. The pH varies from 6.2 to 8.4 with an average of 7.3 (s = 0.5). Aspects of the relevés range between 60° to 140° eastern exposure and 260° to 290° western exposure on slopes inclined 19° to 35°.

The *Euphorbio-Carpinetum* represents a floristically species-rich (average 57.2 n/400 m^2) plant community. *Quercus petraea* and *Carpinus betulus* are dominant species in the tree layer, but a number of other trees and shrubs are admixed (*Fraxinus excelsior*, *Ulmus minor*, *U. glabra*, *Tilia dasystyla* amongst others). In some relevés *Fagus orientalis* plays a more or less expressed role in the tree layer. In the case of intense disturbance of the canopy by harvesting, the development of a dense shrub layer of *Cornus mas* and, on more humid soils, *Corylus avellana* can be observed.

In spring the ground flora is dominated by geophytes like *Cardamine quinquefolia* and *Cyclamen coum*, and, in subassociations and variants, *Anemone blanda*, *A. ranunculoides*, *Corydalis caucasica* and *Scilla siberica*. In early summer the aspect is formed by a dense cover of lush blooming *Polygonatum glaberrimum*, *P. orientale*, and *Paeonia daurica* ssp. *coriifolia*. The latter and the eponymous *Euphorbia squamosa* are considered preliminary character species of the association. According to literature *Paeonia daurica* ssp. *coriifolia* is a colline-submontane taxon that occurs in broadleaved and mixed forests on different bedrock (Hong & Zhou 2003) – which means it is not limited to limestone. Further research is required to determine the taxon's occurrence and abundance in other syntaxa.

The *Euphorbio-Carpinetum* is subdivided into two subassociations and several variants. The *Euphorbio squamosae-Carpinetum betuli caricetosum michelii* subass. prov. was found on westerly exposed slopes of mount Šibaba (1022 m a.s.l.) in altitudes between 680 – 780 m. Generally the *E. s.-Carpinetum caricetosum* is marked by plants common in thermophytic to xerophytic forests of the *Quercetalia pubescentis* Klika 1939, and a number of (southern) European edge species which often have their distributional focus in arid grasslands, such as *Carex michelii*, *Clinopodium vulgare*, *Laser trilobum* or *Orchis mascula*. Although this subassociation is only documented by five relevés, a differentiation into a permanently earth-moist and a summer-dry variant is possible. The summer-dry variant is apparently too dry for the growth of *Fagus orientalis*, while in the permanently earth-moist variant with its diagnostic species group (e.g. *Sanicula europaea*, *Solidago virgaurea*, *Geum urbanum*) *Fagus orientalis* is admixed in the canopy layer. This variant also appears in the other subassociation of the *Euphorbio-Carpinetum*. A similar variant with the relatively best species expression is found in the *Festuco drymejae-Abietetum nordmannianae*.

The *Euphorbio squamosae-Carpinetum betuli asperuletosum taurinae* subass. prov. was encountered in 580 – 730 m a.s.l. on eastern and western exposed, 19° to 35° inclined slopes. The tree layer is polydominant with *Carpinus betulus*, *Quercus petraea*, *Acer cappadocicum*, *Fagus orientalis* and other, less abundant species. The ground vegetation shows a specific species group with *Asperula taurina*, *Arum italicum* ssp. *albispathum*, and *Convallaria majalis*. A number of nitrophilous species like e.g. *Geranium robertianum* indicate that this

subassociation may be specified as nitrophilous. The occurrence of species such as *Galium aparine* or *Calystegia silvatica* possibly hints a disturbance of the community. A variant with a higher air moisture content appears on east-facing slopes on rendzina soils. This variant bears resemblance to ravine forests of the *Tilio-Acerion* Klika 1955, with co-dominant *Fraxinus excelsior* and higher abundance of other typical tree species like *Acer campestre*, *A. pseudoplatanus*, and *Tilia dasystyla* (corresponding species to middle European *Tilia* species) in the tree layer and *Asplenium scolopendrium* and *Corydalis caucasica* as indicator species in the ground vegetation. Other species with high abundances are *Myosotis sparsiflora*, *Sedum stoloniferum* and *Orobanche laxissima*.

The second forest community, occurring in similar altitude (570 – 920 m a.s.l.) with similar aspects and inclinations compared to the *Euphorbio-Carpinetum* is a less species-rich (average 42.9 n/400 m^2) syntaxon with predominant shade-tolerant *Fagus orientalis* in the canopy layer. It was assigned to the *Festuco drymejae-Abietetum nordmannianae* and evidently represents a submontane expression of this syntaxon which was recently first mentioned for the montane belt (FRANCUZOV 2004). Bedrock is either nutrient-rich argillaceous shale or conglomerate rock. Predominant soils (after AG Boden 1994) are clayey little differentiated pelosols. Also pararendzina-brown earths, shallow initial soils (»Lockersyrosem«) and gleyic soils were surveyed. The association typically occurs in the north-western Caucasian middle to high montane belt on drained, southern exposed slopes. The shared diagnostic species – apparently none of the species fulfils the requirements for character species – are *Festuca drymeja*, *Lathyrus aureus*, *Sanicula europaea* and *Solidago virgaurea*. The latter appear in the submontane expression only in the permanently earth-moist variant. Other diagnostic species of the syntaxon, like *Calamintha grandiflora* or *Galium rotundifolium*, share a montane distribution; they lack completely in the submontane expression. *Abies nordmanniana*, highly abundant in montane forests, is a mere sporadic understorey plant in submontane forests. Specific submontane differential species of the *Festuco-Abietetum* to the *Euphorbio-Carpinetum* are *Rhododendron luteum*, *Luzula pilosa*, and *Lathyrus laxiflorus*.

4. Discussion

Floristic and syntaxonomical matters – Generally spoken the concerned forest associations grow in a transitional belt between colline oak and montane beech forests. In this belt *Carpinus betulus* plays an important role in the second tree layer. Forests with a *Carpinus betulus* layer bear an ecological resemblance to oak forests as well as to beech forests (GRUDZINSKAÅ 1953). Zólyomi (1959, cit. in CSAPODY 1968: 75) describes such a transitional zone from Hungary and states: »The transition between beech [here: *Fagus sylvatica*] and sessile oak forests is graduated in a way a division of these two forest types often appears artificial and difficult, and sometimes is virtually not justified.« He points out that in these transitional zones beech forests are floristically only negatively, by the lack of character species, separated from forests with *Quercus petraea*, apart from differing abundances of dominant trees in the canopy layer. This observation can be confirmed from the study area. The *Euphorbio-Carpinetum* features a number of character and differential species on alliance and association level, and is subdividable into subassociations and variants. The *Festuco-Abietetum* on the other hand lacks any own character species in the submontane zone and is – except for a higher abundance and cover of *Fagus orientalis* in the canopy layer –

only differentiated from the *Euphorbio-Carpinetum* by a number of differential species. For example *Festuca drymeja* can only be regarded as a differential species of the *Festuco-Abietetum,* as it is character species of the illyric *Festuco drymejae-Carpinetum betuli* Vukelić 1990 (VUKELIĆ 1991). This northern Croatic *Carpinetum* appears on nutrient-rich bedrock (loess, clay etc.) like the Caucasian *Festuco-Abietetum* and encompasses the oak-hornbeam forests with the highest share of *Fagus sylvatica* in this region (VUKELIĆ 1991). Thus, *Festuca drymeja* characterises the beech-richest association in colline oak-hornbeam forests (northern Croatia), while in montane Oriental Beech forests (north-western Caucasus) it is bound to warmer, southerly exposed sites.

In the present work, the forests dominated by *Fagus orientalis* (*Festuco-Abietetum*) were placed in the *Fagion sylvaticae*, while the forests dominated by *Quercus petraea* (*Euphorbio-Carpinetum*) were placed in the *Carpinion betuli* Issler 1931. This is a highly discussable topic. Firstly, there are authors (e.g. KLÖTZLI 1968, ELLENBERG 1996) who call for a syntaxonomical separation of oak forests on sites which enable the growth of *Fagus* sp., and vice versa. Apparently the described Caucasian submontane forests would fit into such a group of »transitional forests« (s. a.), but so far a higher syntaxon has not yet been established on that core. Therefore I follow the »traditional« separation into a beech dominated (*Fagion*) and an oak and hornbeam dominated (*Carpinion*) system.

As already mentioned in the introduction, several different approaches exist to fit the Caucasian Oriental Beech forests into the European syntaxonomical system, on class rank as well as in a separate order or alliance. KOROTKOV (1992), who studied the montane *Fagus orientalis-Abies nordmanniana* mixed forests of the north-western Caucasus, holds the view that Caucasian *Fagus orientalis* forests are only a geographical vicariant type of western European *Fagus sylvatica* forests either at suballiance rank, or are mere associations in the *Fagion sylvaticae*. I followed this last proposition in the present work, for non-endemic, widely distributed European forest species prevail particularly in the *Festuco-Abietetum*. A few vicariant woody species, like *Fagus orientalis*, *Tilia dasystyla* or *Cornus sanguinea* subsp. *australis*, are not considered sufficient indicators for a floristic autonomy of the western Caucasian non-Colchic Oriental Beech forests. Consequently the species identified as possible diagnostic species of Caucasian Oriental Beech forests are regarded here as regional diagnostic species of the *Fagion sylvaticae*.

The stand structure of the *Euphorbio-Carpinetum* with an upper tree layer composed of *Quercus petraea* and *Fraxinus excelsior*, followed by a second and third layer of *Carpinus betulus*, *Acer platanoides*, *A. campestre* etc. is described as typical for near-natural oak-hornbeam forests (MATUSZKIEWICZ 2003b). Nevertheless supraregional character species of the *Carpinion betuli* are sparsely found in the north-western Caucasian *Euphorbio-Carpinetum*. Most of the middle European *Carpinion* species, like *Stellaria holostea*, *Melampyrum nemorosum* or *Galium sylvaticum* are either inabundant or do not occur in the Caucasus. A floristic gradient stretching from the middle European *Carpinion* via the species-rich and rich in endemics Illyric *Carpinion* (the »prototype of European oak-hornbeam forests« according to HORVAT et al. 1974) to the also species-rich Caucasian *Carpinion* is observable. Illyric and north-western Caucasian *Carpineta* share a diagnostic species, *Lonicera caprifolium*, but altogether, a higher floristic peculiarity of Caucasian oak-hornbeam forests is indicated. A number of provisionally displayed regional *Carpinion* character species (e.g. *Serratula quinquefolia*, *Polygonatum glaberrimum*) are endemic to the western Asiatic-

Caucasian region. PASSARGE (1981b), who studied some central Caucasian oak-hornbeam forests points out that *Carpineta* feature a distinctly higher regional floristic variance even in the Caucasus, compared to Oriental Beech forests. The character of the central Caucasian *Carpineta* is, according to their floristic composition, more xerophytic than that of the western Caucasian *Euphorbio-Carpinetum*. Mesophytic *Fagetalia* species like *Cardamine quinquefolia*, *Lathyrus vernus* or *Galium odoratum* and mesophytic-thermophytic species such as *Vincetoxicum scandens* or *Tamus communis* that are prevalent in the *Euphorbio-Carpinetum* are either completely lacking or less abundant in the submontane *Corno-Carpinetum caucasicae* Passarge 1981 (PASSARGE 1981b, *Carpinus caucasica* Grossh. being a synonym to *Carpinus betulus* according to recent literature like GOVAERTS & FRODIN 1998). Alternatively, they only occur in the submontane Oriental Beech forests (*Orobo-Fagetum orientalis* Passarge 1981).

Regional descriptions of submontane or colline Oriental Beech and oak hornbeam forests are available from GRUDZINSKAÂ (1953), who, due to a different methodological approach, distinguished plant communities by dominant species in the different layers and did not publish complete relevés. Regional oak-hornbeam forests are described mainly with *Quercus robur* and *Q. hartwissiana* from sites with more moist-soil conditions. A floristically similar forest association seems to be the »Mixed oak forests of limestone slopes« (GRUDZINSKAÂ 1953: 101 ff), distributed more westerly between the rivers Psekups and Belaâ on steep, shady, moderately moist limestone slopes. *Quercus petraea* occupies the upper tree layer, *Acer cappadocicum*, *Tilia dasystyla* and *Ulmus minor* a second and *Carpinus orientalis* and *Acer campestre* a third tree layer. Frequent taxa of the ground vegetation are *Euphorbia squamosa*, *Tamus communis*, *Vincetoxicum scandens*, *Lathyrus vernus*, *Paeonia daurica* subsp. *coriifolia* and *Lithospermum purpurocaeruleum*. A conspicuous feature, compared to the here described *Euphorbio-Carpinetum*, is the lack of *Carpinus betulus* or, in other words, its replacement by the more xerophytic *Carpinus orientalis*.

The only known records of submontane Oriental Beech forests in the region similar to the *Festuco-Abietetum* are also found in GRUDZINSKAÂ (1953). She describes two associations: one on deep non-calcareous moist soils with dominating *Cardamine quinquefolia* and *Cyclamen coum*, the other on drier less shady sites with a ground vegetation of *Festuca drymeja*, *Galium odoratum*, *Vincetoxicum scandens*, *Paris incompleta* etc. Both represent stand types with dominant *Fagus orientalis* showing no significant admixture of other tree species. Presumably the *Festuco-Abietetum* characterised in the present work takes a floristically and ecologically intermediate position between these two forest communities.

Matters of stand structure and land-use history – The investigated forest stands feature influences of different impacts, or non-impacts, on stand structure and composition, and could be arranged to an indirect time scale that traces the land-use history over the last 150 years. Again, the very likely secondary origin of all investigated forests must be emphasised. They probably originated from abandoned pastures or fields of the Adygè people. Therefore, the oldest land-use type (or the most recent, from the present point of view) is FP, the former pasture type. It is only found on rocky sites in the vicinity of sparsely grazed pastures where the combination of (low) impact of grazing cattle and site conditions not favourable for tree growth led to a delay in progressive forest succession of about 100 years compared to other sites. Low-branched and broad-crowned *Quercus petraea* trees refer to their initial growth in

an open environment. Trees develop individual stem and crown forms, depending on whether they grow in a dense forest, on a forest edge or in the open (OLIVER & LARSON 1996). Principally the development of an open-stand crown is also possible in primary forests on dry sites (MARKS & GARDESCU 2001), but the mesophytic character of the investigated forests and the dissimilar, »normal« in-forest growth form of younger trees in the same stand argue against such a possible explanation. The occurrence of peculiar tree groups of mainly *Quercus petraea* is another special feature of the FP type. GRUDZINSKAÂ (1953) found similar tree groups on abandoned fields in valleys and on river banks on limestone and attributed them to their secondary origin and recent germination from sporadically dispersed seed. KOLLMANN & SCHILL (1996) investigated successional patterns on abandoned calcareous grassland and attributed the observed colonisation of *Quercus petraea* and *Corylus avellana* to effective zoochorial dispersal by mice and jays. As often hoards of acorns are buried in one single place, the emergence of more than one sapling out of one spot is not unlikely.

The land-use type CM provides an insight view as to how some of the secondary forests in this region looked before the intense harvesting period of 1960 – 1985. As in FP, we find oak trees older than the average of the stand (here, depending on site conditions, *Quercus robur*) with signs of former open stand growth. They constitute the first tree generation on the abandoned grasslands as their age can be estimated to be about 140 years from a tree disc. Another explanation for their growth form, a former solitary stand in open land, is also possible due to the known land-use practice of the Adygè (KANTARIÂ 1989). GRUDZINSKAÂ (1953) discovered such former shade trees older than the turning point of 1864 in her regional forest study. In CM stands a change in forest composition is detectable. A dense, vital layer of *Fagus orientalis* saplings and a great number of young trees already emerging into the upper zones are observable, while the sparse *Quercus robur* saplings (< 1 m height) lack favourable light conditions for the beginning of vertical growth. However, a very low quantity of saplings is also described from near-natural *Quercus robur* forests in Croatia (LEIBUNDGUT 1993), which reveals a survival strategy different to that of shade-tolerant stands. Only the death of old individuals and the subsequent opening of broad windows in the canopy allow a quick start of *Quercus* sp. saplings into the upper tree layers (LEIBUNDGUT 1993, SCHERZINGER 1996). Thus, only long-term studies allow a good prognosis of the dynamical patterns of this forest type.

IL and SL are the two land-use types where prior stand history is already extensively transformed by impacts of the intense logging period of 1960 – 1985. In SL a few trees with peculiar growth forms were left standing. Hence an age dating to the probable emergence date of the forest could still be possible here. The characteristically high number of multi-stemmed trees of smaller diameter classes in the land-use type IL presumably refers to the lacking practice of thinning and removal of unusually formed trees in stands on clearcut plots.

5. Acknowledgements

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