Thaiszia - J. Bot., Košice, 16: 109-119, 2006
http://www.bz.upjs.sk/thaiszia/index.html

THAISZIA
JOURNAL OF
BOTANY

Examination of the soil-plant relations on the Galgahévíz peaty meadow (Hungary), effects of nature conservation measures on the vegetation

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VONA M., FALUSI E. & PENKSZA K. (2006): Examination of the soil-plant relations on the Galgahévíz peaty meadow (Hungary), effects of nature conservation measures on the vegetation. – Thaiszia – J. Bot. 16: 109-119. – ISSN 1210-0420.

Abstract: The studied area of the fen meadow is situated in the Central Hungarian Region, 46 km East of Budapest, in the vicinity of Galgahévíz and Hévízgyörk villages. Continuous botanical and pedological investigations have been made here and the area has been mowed regularly since 2004 as part of the conservation management methods. As a result of regular mowing, even if practiced only for two years so far, reed area has shrunk from the most valuable association stands and the amount of invasive plant species has also decreased. The area has constantly been enlarged at the expense of reed and changes of vegetation have been followed up with regular series of monitoring by authors. During observations at landscape scale influential components of the surroundings are also estimated.

Keywords: wetland, soil-plant relation, nature conservation, relative ecological indicator.

Introduction

Our target area is situated on a peaty meadow of Galgahévíz. The peaty areas of Hungary and along the Galga River are shrinking, so the one in Galgahévíz bears high value. In the 1950's, 1960's and 1970's the Galga River was regulated (VIZITERV 1972), straightened and its lower section was forced between embankment. These regulations were reasonable because they

protected human properties, forced the water to run off quickly from the areas close to the river, established the possibility of arable farming and protected the land from undesirable water. Thanks for the regulations, the number and the area of wetlands and water effected habitats reduced significantly. Along the Galga River the large and contiguous peaty meadows are partitioned, in many cases disappeared. Most of them are ditched, thus its aridification is forced (FVM 2002).

Meanwhile, caused by arable farming, intensive erosion, nutrient loss and sedimentation can be measured and modeled (BARCZI ET AL. 1995, CENTERI 2003) on the hill slopes of the Galga watershed (CENTERI & CSÁSZÁR 2005). Regulated riverbeds, ditches along the river and its side waters, increased nutrient load from agricultural areas, even appearing in the sediment and in the soil water caused drying and intensive area growth of reed. The reed is taking areas from the vegetation with high nature protection value (BARCZI 2003). During the examination of the change in the surface cover (HELFRICH 2005) the growth of the reed area and the diffuse agricultural pollution (ÁNGYÁN 2004, CENTERI & PATAKI 2003) and the lack of mowing can be detected (MALATINSZKY & PENKSZA 2004, MALATINSZKY 2004).

Our purpose was to fully reveal the botanical, pedological and landscape potential data of the area and to monitor the changes caused by handling in the last five years. Based on the results our purpose is to outline a plan for handling that secure the future viability of the peaty meadow.

The undisturbed fen meadow taking up 15 hectares in the Galgahévíz area is known to researchers since 1998 (PINTÉR 2001). The fen meadows of the Gödöllő rolling country were investigated by KOVÁCS (1955, 1957), KOVÁCS & PRISZTER (1956), MÁTHÉ (1956) and FEKETE (1965). Nevertheless, the area and its vicinity described in our work is scarcely mentioned (MÁTHÉ 1956, KOVÁCS 1955).

Material and methods

The settlement Galgahévíz lies in Hungary, Pest county, 46 km eastwards from Budapest in the Gödöllő rolling country. Here botanical surveys are carried out regularly since May 1998, and nature protection measures are undertaken since 2004. The area is being mowed regularly. During the botanical surveys species lists and coenological investigations are prepared. The surveying is done in investigation units of a size of 4x4 meters in the characteristic associations. For the 4 most widespread associations that are most typical of the area 5-5 coenological investigations were carried out giving basis to comparative analysis. The relative ecological indicators (ZÓLYOMI ET AL. 1967) and the nature protection value, according to Simon (SIMON 1988), of the associations were measured.

Soil examinations were done by the Pürckhauer type soil core sampler (FINNERN 1994) and by full soil profile descriptions (STEFANOVITS 1992). The core sampling gave possibility to take several samples and examine the depth of layers, pH, color, soil physical type, carbonate content, soil type. It gives possibility to draw coarse borders of soil types and prepare a genetic soil map,

too. During the sampling we examined 250 sampling points.We mowed the grass 3 or 4 times in the summer and autumn and we burned the area under control in the winter (HAWKE & JOSÉ 2002).

Results

Pedological examination

The soils of the peaty meadow are extremely mosaic with varying soil types and textures even in the parent material. The typical soil type of the area is the peaty meadow soils and fluvic meadow soils.

Tab. 1: Some soil parameters of typical soil types on the peaty meadow

No.	Genetic soil layer	Depth (cm)	Soil physical type	$CaCO_3$	Soil type
1.	A	0-31	loam	+++	Peaty meadow soil
	B	31-78	clayey loam (with sand)	+++	
	C	78-90	sand (with clay)	+++	
	D	90-100	loam	+++	
2.	A	0-50	loam	+++	Peaty meadow soil
	AC	50-65	clayey- loam	+++	
	D_1	65-95	loam	0	
	D_2	95-100	clayey- loam	++	
3.	A	0-37	clayey loam (with sand)	0+	Histosol
	C	37-76	clay	0+	
	D_A	76-80	loamy-sand (clay)	+	
	D_C	80-100	clay	0+	
4.	A	0-40	loam	++	Peaty meadow soil
	B	40-93	clayey-loam	+	
	C	93-100	clayey-loamy (with sand)	0+	
5.	A_0	0-45	loam	+++	Fluvisol
	C	45-75	loam	++	
	C_2	75-90	clayey-loam	++	
	C_3	90-100	sand	+	
6.	A_{tilled}	0-20	clayey loam	+++	Vertisol
	AB	20-64	clay	+++	
	BC	64-94	clay	+++	
	C	94-100	loamy sand	+++	

We found buried peaty layers at the depth of 60 and 90 cm. These two layers could be clearly separated based on the 250 core samples. The textures were greatly varying beginning from coarse sand as far as clay and even clay and

sand were mixed up in several samples. The clayey loam, loam, sandy loam and sand textures prove that the area was greatly effected by watercourses as the older Galga River and the Sósi-creek. There are several old riverbeds that can be seen on aerial photographs as well. Both water courses were meandering and leaving varying sediments in smaller spots. The heterogeneity of the relief of the peaty meadow area can be explained from the varying riverbeds. There are higher sandy areas and lower clayey spots.

Differences in the depth of the buried peaty layers at 60 and 90 cm prove the theory of big sediment movement. The original peaty surface was covered by sediment and soil formation started again. This is what we see today on the peaty meadow.

In the soil samples there are only a few examples that prove present day peat formation. The present day peat is raw and very shallow, 1-5 cm deep. We found the soil types described in Tab. 1. We prepared the 1:5000 scale genetic soil map of the area, too. On the soil map we can find the following soil types: peaty meadow soil, histosol, fluvisol, vertisol.

Coenological results

Previously the area was mowed regularly. In recent years mowing has been limited to small patches of land. The owners decided to do burning once a year during the spring, which has greatly degraded the area. After burning the reed gained ground significant, suppressing the associations characteristic to fen meadows. It can be concluded that while the mowing in early winter is beneficial from cleaning and handling point of view but it does less damage to the vegetation as springtime burning which is an entirely unacceptable treatment solution. By having the area mowed in the spring (May) and possibly in summer (August) as well, reed can be quickly forced out allowing the vegetation of the fen meadow to reconquer the fields.

***Juncetum subnodulosi* Koch 1936 association (JUN SUB)**

The *Juncetum subnodulosi* association can be found at the lowest and most humid point of the Galgahévíz area. Certain parts are submerged around the year, thus it is not surprising that among the studied associations the diagram of the *Juncetum subnodulosi* association (Fig. 1) is shifted the most in a way that it indicates water habitat. However, the year 2000 result of 65% share of the species from category 9 is now halved and also diminishing can be observed concerning the species connected to very humid areas (type 10). The categories with lower relative water demand as category 7 show an increase in species count and percentage share, these two happenings indicate the drying of the area.

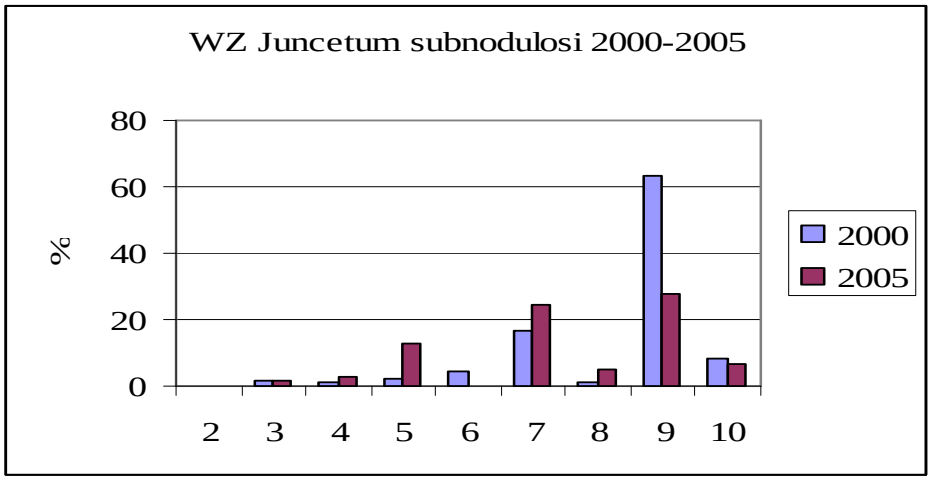

Fig. 1: Changes on distribution based on relative water demand (JUN SUB)

The surveying of the nature protection values according to Simon (Fig. 2) shows that the proportion of the accompanying species indicating natural state (K) is the highest and increasing still (60.4%). The proportion of the edificatory species (E) is dropped to half, because continuous mowing suppressed the *Phragmites australis*. The protected species of the association are the *Orchis laxiflora subsp. palustris, Epipactis palustris, Gentiana pneunomonanthe*. From the weeds indicating degradation (GY) only one species, the *Equisetum palustre* is present.

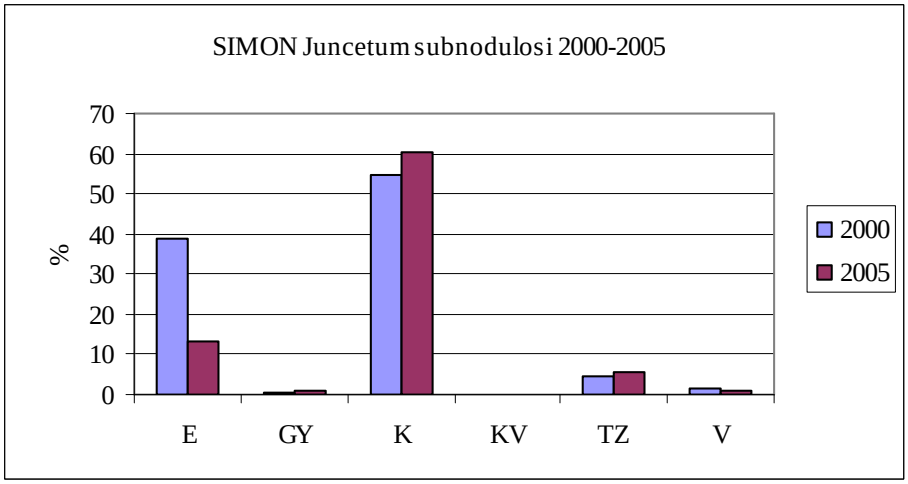

Fig. 2: Changes on distribution based on nature protection values (Simon) (JUN SUB)

***Caricetum davallianae* Dutoit 1924 association (CAR DAV)**

This is the most valuable type of association in the examined area at Galgahévíz. It is very rich in species as the coenological surveys show 40 species. From these the characteristic species of the association according to KOVÁCS (1962) are the *Carex davalliana, Carex panicea, Eleocharis quinqueflora*. In the survey of 2000 in the *Caricetum davallianae* association the relative water demand category 9 was still dominating with 43.19% (Fig. 3), but the *Carex davalliana* that represents significant mass in the category had disappeared from the area. Both the disappearing of the associative species and the advancement of species from category 7 and 8 show the gradual drying of the area. The ratio of dry habitat species is already around 5%.

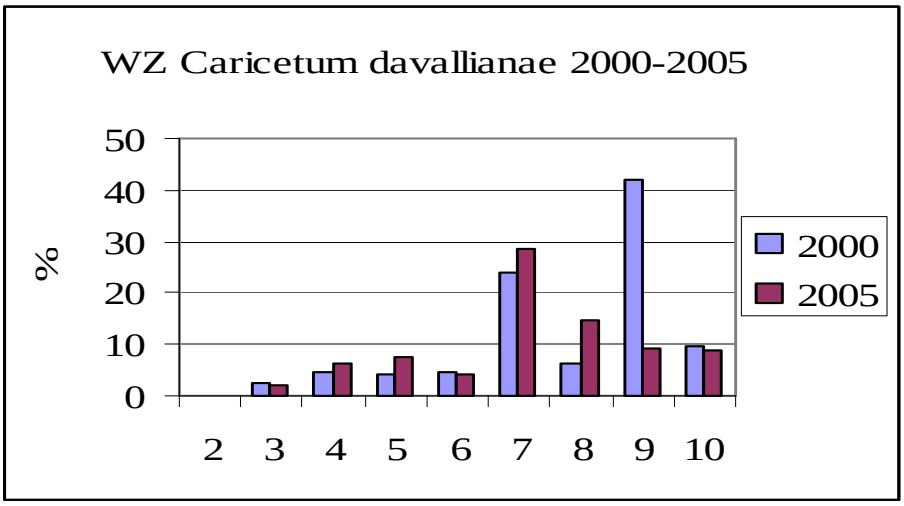

Fig. 3: Changes on distribution based on relative water demand (CAR DAV)

In consequence of the gradual disappearing of the *Carex davalliana* the ratio of the accompanying species (K) in the association is decreasing, while in parallel the ratio of disturbance-tolerating species (TZ) and weeds (GY) (*Equisetum arvense, Ononis spinosa, Pulicaria dysenterica*) are increasing, showing the gradual degradation of the area (Fig. 4). The ratio of protected species (V) is the highest in this association (5.2%) consisting the *Carex nigra,* the *Gentiana pneumonanthe* and the *Epipactis palustris*. Among the highly protected species (KV) the *Iris sibirica* is present with an increasing stand. Besides the protected species also there are the rare and potentially endangered *Carex buekii*, the *Carex nigra*, and the *Blysmus compressus.*

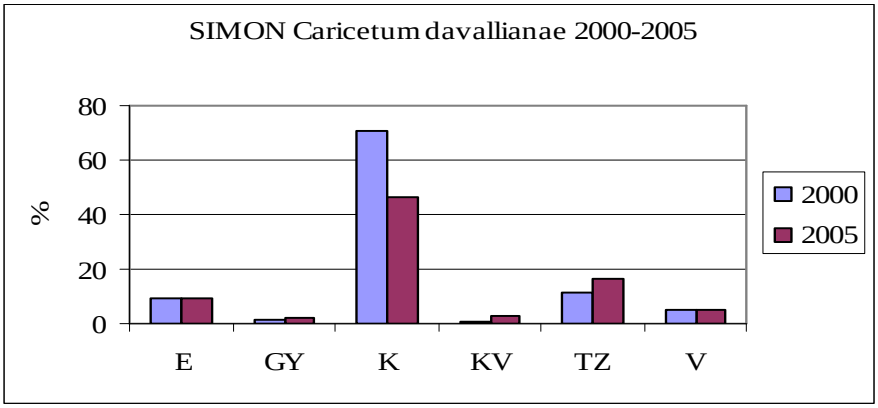

Fig. 4: Changes on distribution based on nature protection values (CAR DAV)

Deschampsietum caespitosae Horvatić 1930 association (DES CES)

The following characteristic species are present in this association *Festuca arundinacea, Lathyrus pratensis, Sanguisorba officinalis*. The relative water demand of the *Deschampsietum caespitosae* association shows its maximum value in category 7 with 62%. Species from categories 8-9-10 have relatively large share as well, but the species of arid categories are much more numerous (Fig. 5).

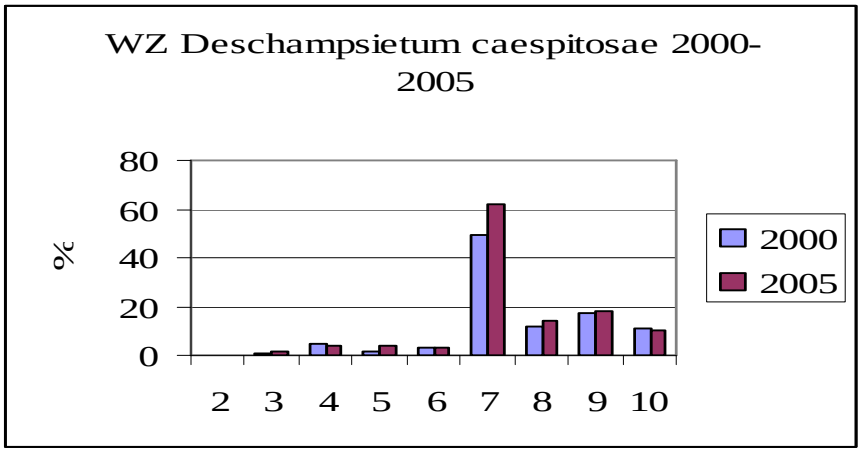

Fig. 5: Changes on distribution based on relative water demand (DES CES)

In the *Deschampsietum caespitosae* association also the accompanying species (K) have the biggest share (82%) and the *Deschampsia caespitosa* is giving half of this (Fig. 6). The share of the edificatory species (E) did not change (*Phragmites australis* and *Carex distans*). The 10 species of disturbance-tolerating types (e.g.: *Festuca arundinacea, Vicia cracca*) show a ratio of 19.94%. The share of weeds (GY) is insignificant, as can be observed in the whole area. The ratio of protected species (V) is around 1% (*Carex nigra, Epipactis palustris*). Among the highly protected species (KV) the share of *Carex appropinquata* increased to 2%.

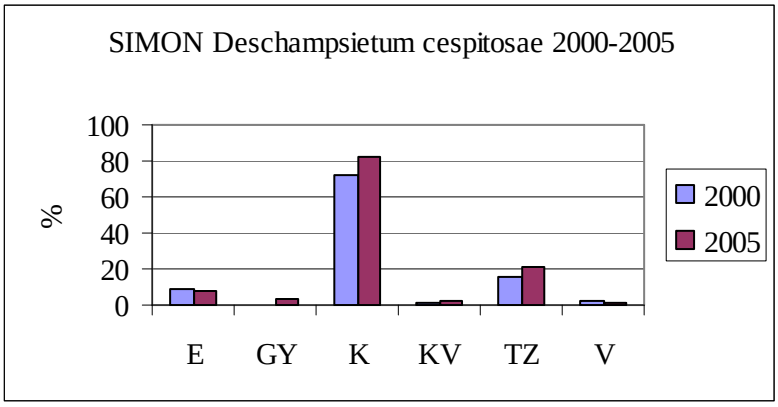

Fig. 6: Changes on distribution based on nature protection values (DES CES)

Succiso-Molinietum hungaricae /Komlódi 1958/ Soó 1969 association (MOL HUN)

On the highest point of the area the *Succisio-Molinietum hungaricae* association is dominating. Its characteristic species are KOVÁCS (1962): *Molinia hungarica, Selinum carvifolia, Succisa pratensis, Taraxacum palustre, Dianthus superbus*. The maximum of the species from the *Succisio-Molinietum hungaricae* due to a single species (*Molinea hungarica* 59%) falls into the water demand category indicating moist habitat (5) (Fig. 7). The spreading of this species is supported by the regular mowing done in appropriate times. The position of the association results in the gradual advancement of the species typical of dryer areas, and the non-existence of species from category 9. In this association, the *Festuca pseudovina* and the *Scabiosa ochroleuca* characteristic to dry habitat (2) are showing up by a small, yet increasing share (1.43-2.8%).

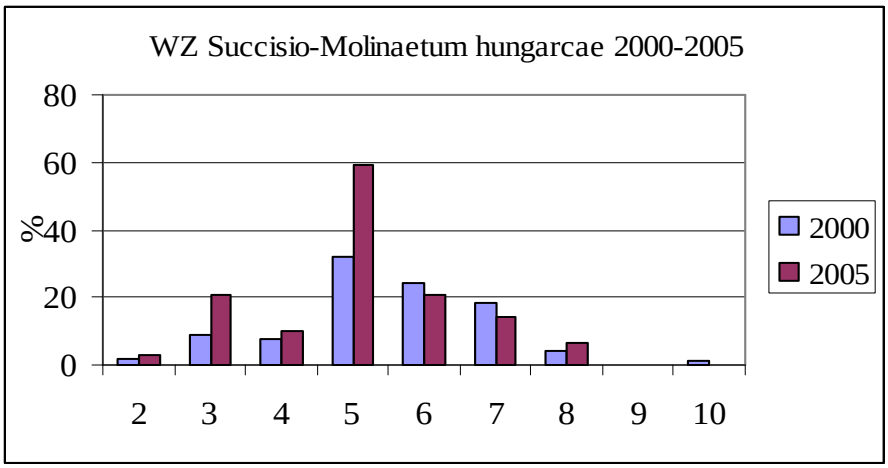

Fig. 7: Changes on distribution based on relative water demand (MOL HUN)

In the *Succisio-Molinietum hungaricae* association the highest share (87.4%) is also given by the accompanying species (K) consisting 17 species, among them the *Molinia hungarica* (Fig. 8). The share of weeds (GY) is the highest in this association (6.2%) among all associations examined. This is caused by the large numbers of 3 species, namely the *Equisetum arvense*, the *Taraxacum officinale* and the *Ononis spinosa*. From the protected species (V) the *Dianthus superbus* and the extremely rare *Koeleria javorkae* are present. Due to the regular mowing the number of species and the ratio of protected species is large, but there are also parts of the association with poorer species count caused by the neglectance of mowing in the past years.

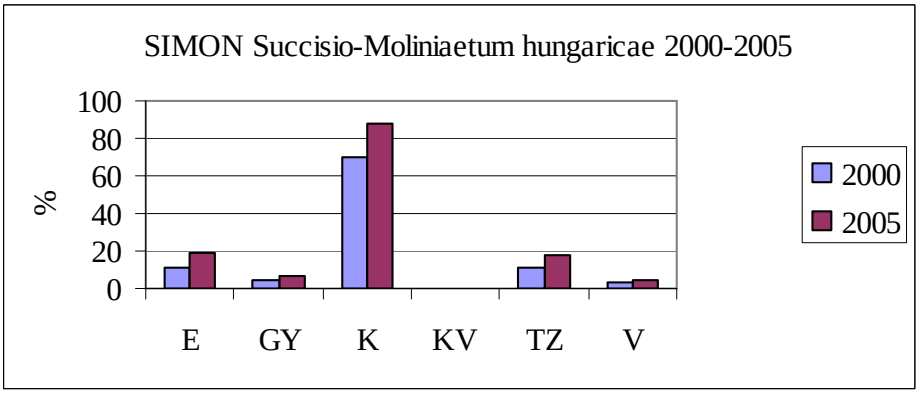

Fig. 8: Changes on distribution based on nature protection values (Simon) (MOL HUN)

Summary

The distribution of species based on relative water demand is the largest in the category for wet and water habitat in every examined association. The permanent and continuous water level with a significant thickness of 50 cm is confirmed by soil samples as well. During the researches carried out up to now in the two areas 153 species of plants were recorded, out of that 13 species are protected (*Iris sibirica, Dianthus superbus, Eriophorum angustifolium, Koeleria javorkae*) and 2 potentially endangered. Based on the nature protection value categories this area can be regarded valuable from nature protection point of view. This is underpinned by the fact that the share of accompanying species is the highest in all four associations. The ratio of weeds is insignificant and the protected and highly protected species are present in all examined associations, making these associations even more valuable.

The regular and for a short time (2 years) ongoing mowing activities resulted a suppression of reed in the most valuable associations and the number of invasive species is decreasing. The area being mowed is continuously increased at the expense of reed and the vegetational changes are constantly followed up by regular series of observations. Moreover, in regional-level investigations the landscape formation factors of the area are evaluated as well. Based on our experience, mowing can fundamentally influence the associations of fen meadows, in consequence of the treatments the *Molinia* meadows gain ground. From the plow-lands surrounding the area adventive and among them invasive weeds endanger the valuable parts of the area (or rather the weeds turn up where some signs of degradation can already be discovered).

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Received: August 25th 2006
Revised: January 1st 2007
Accepted: January 1st 2007