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INVASIVE ALIEN PLANT SPECIES MONITORING ON MEADOW HABITATS SHELTERING MEDICINAL AND AROMATIC SPECIES IN PIATRA CRAIULUI NATIONAL PARK

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Abstract: *Traditionally, the meadows surrounding Piatra Craiului were managed as hayfields. Starting with 2003 many hayfields were abandoned, favoring the invasion of alien plant species. In the hayfields on Bârsa Valley, there were identified over 500 plant species, 26 of them used as medicinal and aromatic plants. There were recorded, as well, 11 invasive alien plant species. The study conducted from 2005 to 2010 in 10 permanent monitoring plots, highlighted the species with the highest invasive potential: Erigeron anuus, Solidago canadensis, Impatiens glandulifera and Reynoutria japonica. In order to conserve the plants diversity, the resources of wild medicinal and aromatic plants, and to prevent the expansion of alien invasive species, the land must be mowed annually after the end of July.*
Keywords: *invasive alien plant species, medicinal plants, aromatic plants, monitoring, Piatra Craiului Mountain.*

1. INTRODUCTION

There are still many scientific debates regarding the meaning and the definition of alien invasive plant species. According the Convention of Biological Diversity (CBD), invasive alien species (IAS) are species whose introduction and/or spread outside their natural past or present distribution threatens biological diversity [22]. In the same way, the European Union defines "Invasive Alien Species" as those that are, firstly, outside their natural distribution area, and secondly, threaten biological diversity [20].
IAS occurs in all taxonomic groups, including animals, plants, fungi and microorganisms, and can affect all types of ecosystems [22].
Invasive species are one of the leading causes of global ecological change [8]. It is considered that 256 vertebrate extinctions with an identifiable cause, 109 are known to be due to biological invaders, while 70 are known to be caused by human exploitation [8], [2].
The invasive alien species has as common characteristics: rapid reproduction and growth, high dispersal ability, phenotypic plasticity and ability to survive on various food types and in a wide range of environmental conditions. A good predictor of invasiveness is whether a species has successfully or unsuccessfully invaded elsewhere [7], [3], [18], [22].
The ecosystems modified by humans are, in general, more sensitive to alien invasions because there is less competition from native species [22]. Under the predicted climate change, the ecosystems became even more vulnerable to IAS [12].
Researches show if a species' new habitat is similar enough to its native range, it may survive and reproduce. For an alien species to become invasive, it must arrive, survive and thrive [22].
The ways in which non-native species affect native species and ecosystems are various and in general irreversible. There are may documented cases, all over the world when horticultural varieties and zoological novelties have become invasive and destructive [19].
The problem of alien invasive species became a general issue, since the high globalisation, species introduction being usually vectored by human transportation and trade. This imposes an enormous cost on agriculture, forestry, fisheries, and other human enterprises, as well as on human health [5].
Thaking into acocount the danger of IAS, the Convention on Biological Diversity (CBD) requires Parties to

prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species, according Article 8 [4]. According the specific Decision and Guiding Principles 11 adopted in 2002, the CBD Conference of the Parties, the Parties, other governments and relevant organizations must prioritise the development of IAS strategies and action plans at national and regional level and to promote and implement the CBD Guiding Principles [4].
Starting whith 1980 the Council of Europe, asked the memeber stats to prohibit the introduction of non-native species into the natural environment, to take preventive measures against accidental introductions and to take remedial measures if possible. In 1997 the Standing Committee of the Bern Convention adopted a recommendation regarding the introduction of organisms belonging to non-native species into the environment, which included a full survey of measures for controlling introductions of alien species to be taken by governments and other social actors [4].
Under these circunstances there was developed an "European Strategy on Invasive Alien Species" in the framework of the the guidelines adopted in 2002 by the 6th Conference of the Parties of the Convention on Biological Diversity [4]. This strategy is a usefull tool to help contries to develope their own strategies in order to diminishe the threats of IAS to biodiversity and economy.
The danger of IAS is very present in Romania, as well. The land abandonment favors the extension of IAS over large territories. In Romanian Flora there were recoded 435 allien plant species [1], many of these having the potential to become naturalised and then invazive.

2. MATERIAL AND METHOD

The study area is included in Piatra Craiului National Park. The national park is located in the Southern Carpathians, covering a surface of 14,773 ha. The semi natural meadows cover 2,357.43 ha [12], offering favorable conditions for a high diversity of plant species.
The monitoring study of the invasive alien species used the stratified sampling approach according to the habitat type, as recommended in the literature [11]. There were initially selected permanent sample plots of 100 m², placed in the meadow located on Bârsa Valley in the north-eastern sector of Piatra Craiului National Park. For each sample plot the geographic coordinates of the corners were recorded using a Trimble high-resolution GPS. In order to allow a better identification in the field, permanent markers were placed. The sample plots location was marked on the GIS map as well.
Among the initial 20 monitoring plots, only 10 permanent plots (abandoned by the land owners for 6 years) were investigated consistently for the entire period of the study.
The cover of the invasive alien plant species related with the period of hay field abandonment was analyzed in 10 permanent monitoring plots.
The size of the permanent sample plots was chosen taking into account the concepts of minimum area and species-area curves [6].
Cover was estimated by eye. Cover is defined as the area within a quadrate which is occupied by the above-ground parts of each species when viewed from above. Cover is usualy estimated as percentage. Sometimes, stratification or multiple layering of vegetation could result in total cover values of over 100% [6]. In order to estimate the cover more accurate, each 100 m² was divided in 25 quadrates of 4 m² each.

3. RESULTS AND DISCUSSIONS

The meadow habitats of Piatra Craiului, located from 700 to 1400 m altitude, have mainly a secondary origin following forest (spruce or spruce-beech forest) clear cutting, hundreds of years ago [12]. Traditionally, these rich plant species meadows, on limestone, were managed as hayfields, mowed yearly in late July. The late mowing favored the seeds dispersal of the majority of plant species, thus promoting the high biodiversity.
For a short time, each year, the hayfields were used as pastures (from early spring to the end of May and from the beginning of September to the beginning of November). This favored the enrichment of soil fertility do to the income of manure from sheep and cows. The increased soil fertility favored, as well the high plant biodiversity.
During the researches, conducted from 2005 to 2010 in the hayfields on Barsa Valley, traditionally managed in the above-mentioned system, there were identified over 500 plants species (taking into account as well the bushes and wet land sectors inside the hayfields) [12].
There was identified, as well an impressive number of medicinal and aromatic plants. The most abundant are the following 23 species: *Achillea milefolium, Hypericum perforatum, Carum carvi, Daucus carota, Cichorium inthybus, Prunella vulgaris, Centaurium erythraea, Taraxacum officinale, Equisetum arvense, Galium vernum, Salvia pratensis, Thymus pulegioides, Plantago lancelolata, P. major, P. media, Rumex crispus, Primula veris, Filipendula vulgaris, Potentilla argentea, P. erecta, P. reptans, Alchemilla xantochlora* and *Viola tricolor.*

These plant species are important resources, being traditionally and still consistently used by the local communities to treat various ailments as highlighted in previous researches [10], [13], [14]. There were recorded, as well, 11 invasive alien plant species, wide spread in the studied area (table 1)

Table 1: The alien invasive plant species identified on Bârsa Valley (Piatra Craiului National Park)

No.	Species	Family
1	*Erigeron anuus*	Asteraceae
2	*Solidago canadensis*	Asteraceae
3	*Helianthus tuberosus*	Asteraceae
4	*Xanthium italicum*	Asteraceae
5	*Impatiens glandulifera*	Tropaeolaceae
6	*Reynoutria japonica*	Polygonaceae
7	*Partenocyssus inserta*	Vitaceae
8	*Echinocystis lobata*	Cucurbitaceae
9	*Asclepias syriaca*	Asclepiadaceae
10	*Acer negundo*	Aceraceae
11	*Robinia psedacacia*	Fabaceae

The botanical investigations in the 10 selected monitoring plots placed on Bârsa Valley (figure 1), were focused on measuring the cover of the 11 identified alien plant species, correlated with the period of hay field abandonment.

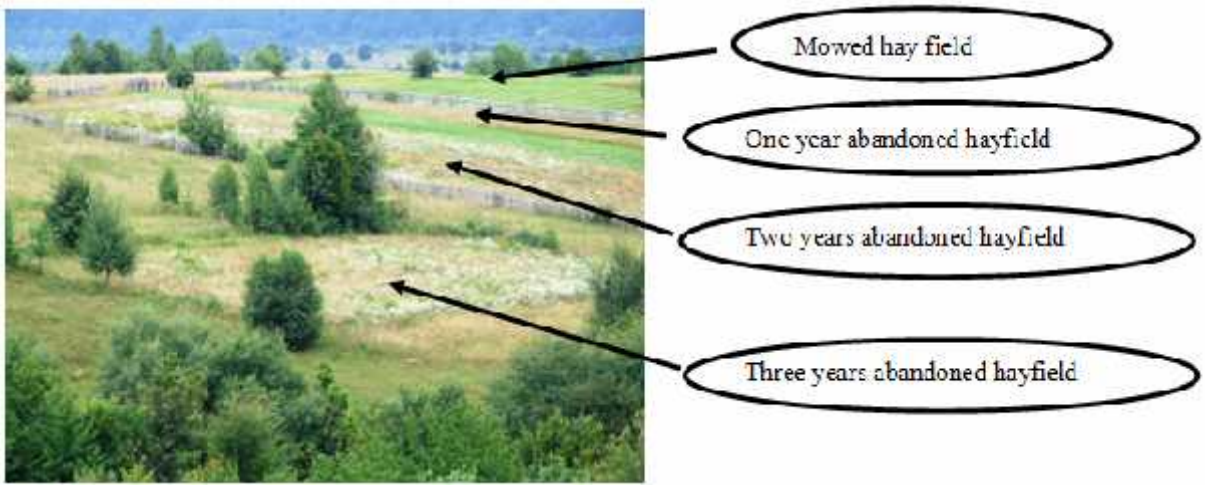

Figure 1: Permanent monitoring sample plots on Bârsa Valley

Analyzing the data, as a general observation, in all the 5 permanent monitoring plots placed in the higher area of the meadow (dry) the evolution patterns of invasive alien plant species were similar. In the same way, evolution patterns of invasive alien plant species were similar for the 5 monitoring plots placed in the lower area of the meadow (moist). Thus, in order to avoid redundant data we will not discuss separately the data from each monitoring plot. The data will be presented for each group of 5 monitoring plots (dry and moist) as an average (figures 2, 3).

In both types of monitoring plots, after the first year of abandonment (2005), the hayfield was gradually colonized by *Erigeron anuus* (average cover - 0.3% in dry areas, and 5% in moist areas).

After the second year of abandonment (2006), the monitoring plots located in the higher area of the meadow (dry) started to be colonized by *Solidago canadensis* (average cover -1%). In the same time, the monitoring plots located in the lower sectors of the meadow (moist), close to Bârsa River, were invaded by *Impatiens glandulifera* (average cover -10% compared with 5% in 2005).

After the third year of abandonment the cover and frequency of invasive species increased significantly, *Erigeron anuus* becoming dominant in all the monitoring plots located in the dry (average cover - 88% in 2010) and moist areas (average cover - 28% in 2010).

In the dry areas the cover of *Solidago canadensis* increased dramatically, as well, from 0% in 2005 to 50% in 2010.

In the moist areas the cover of *Impatiens glandulifera* increased from 5% in 2005 to 79% in 2010 and the cover of *Reynoutria japonica* from 0% in 2005 to 36% in 2010.

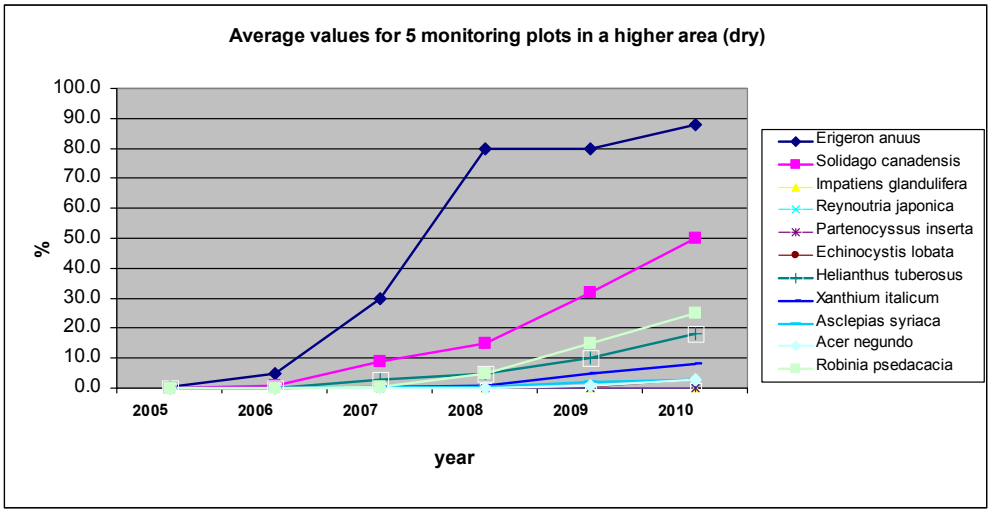

Figure 2: The average values of the cover for IAS for 5 monitoring permanent plots placed in a higher area (dry)

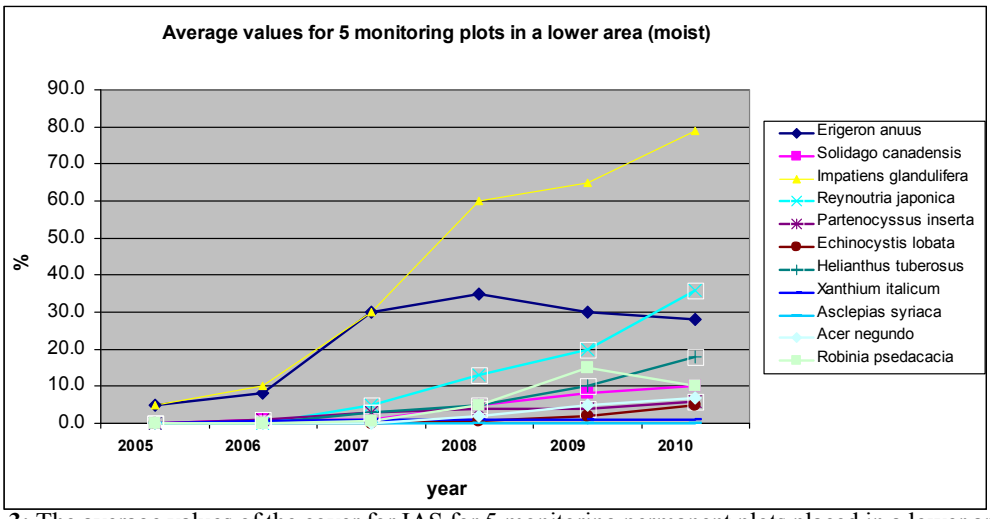

Figure 3: The average values of the cover for IAS for 5 monitoring permanent plots placed in a lower area (moist)

Starting with 2003 the traditional management of the hayfields became inconsistent, and many parcels of the meadow were abandoned. Since 2005, the hayfields abandonment increased, favoring the invasion of alien plant species.

The study results highlighted that the species with the highest invasive potential are *Erigeron anuus, Solidago canadensis, Impatiens glandulifera* and *Reynoutria japonica* (figures 2, 3). The increasing of the invasive species cover will lead cosequently to the dramatic reduction of the native species cover, with important changes in the characteristic structure of the meadow habitat. Thus, the resources of medicinal and aromatic plants will decrease, folowing the invasion of alien species and the reduction of the favourable meadow habitat.

Taking into account all the above-mentioned facts, there is obvious that the high plants diversity of the meadows is a result of the natural environment combined with the traditional land use, since hundreds of years ago. Traditionally, the medicinal and aromatic plants - rich meadows are mowed. Taking into account the secondary origin of meadow habitats in the area (following the forest clear cutting hundreds of years ago), the actual overall biodiversity could be considered as a response of the natural habitats to the human intervention.

Under these circumstances the resilience of semi-natural meadow habitats, sheltering rich populations of medicinal and aromatic plant species is determined by the continuity of traditional mowing.

In order to conserve the plants diversity and to prevent the expansion of alien invasive species, the land must be mowed annually after the end of July. In this respect, the "Piatra Craiului National Park Management Plan", enforced in the field by the Piatra Craiului National Park Administration, should contain special provisions related with the management of alien invasive species. There are included in the plan some general guidelines related with meadows management, but without pointing out the problem of invasive alien species.

4. CONCLUSIONS

Traditionally, the rich plant species meadows (from 700 to 1400 m altitude) of Piatra Craiului, were managed as hayfields, mowed yearly in late July. Since 2003 the traditional management of the hayfields became inconsistent. From 2005, the hayfields abandonment increased, favoring the invasion of alien plant species.
The hayfields on Bârsa Valley, shelter over 500 plant species (including 26 wide used medicinal and aromatic plants).
There were recorded, as well, 11 alien invasive plant species, wide spread in the studied area: *Erigeron anuus*, *Solidago canadensis*, *Impatiens glandulifera*, *Reynoutria japonica, Partenocyssus inserta*, *Echinocystis lobata, Helianthus tuberosus, Xanthium italicum, Asclepias syriaca, Acer negundo* and *Robinia psedacacia*.
The botanical study conducted from 2005 to 2010 in 10 permanent monitoring plots focused on measuring the cover of the 11 identified alien plant species, correlated with the period of hayfield abandonment, highlighted that the species with the highest invasive potential are *Erigeron anuus, Solidago canadensis, Impatiens glandulifera* and *Reynoutria japonica.*
The increasing of the invasive species cover will lead cosequently to the dramatic reduction of the native species cover, with important changes in the characteristic structure of the meadow habitat. Thus, the resources of medicinal and aromatic plants will decrease, folowing the invasion of alien species and the reduction of the favourable meadow habitat.
Under these circumstances the resilience of semi-natural meadow habitats, sheltering rich populations of medicinal, aromatic and alimentary plant species is determined by the continuity of traditional mowing (annually after the end of July).
It is compulsory, to be included in the "Piatra Craiului National Park Management Plan", special provisions related with the management of alien invasive species.

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