



Arnica montana in the Apuseni mountains, Romania – endangered or protected by utilization?

Arnica montana - a traditional medicinal plant

Goethe had had a high opinion of *Arnica*. After a cardiac infarction he used *Arnica* tea internally and felt better. Since this time *Arnica* is famous. In traditional medicine preparations *Arnica* flower heads were applied to treat haematomas, contusions, sprains, rheumatic diseases and inflammations of the skin. Since Goethes days Wild-collection has a vital role to get the raw material.



"*Arnica von der man jährlich einen Pferdekarren voll sammet und in Apotheken bringt*"
J. W. Goethe



Arnica montana - an endangered species

The present habitats are suited in typical cultural landscapes. They are made by man. Changing land use (fertilization, fallow) modify or destroy the habitats. *Arnica montana* is listed in EC Habitats, Fauna and Flora Directive. The international trade is regulated by CITES.



Introduction

This study is an analysis of the status of *Arnica montana*. The species is protected by law in Romania. In 2001, 20 000 kg (!) dried flower heads were permitted to collect and harvested from the wild in the district of Cluj.

This study:

- describes the habitats
- estimates the biomass of flower heads from different plant communities
- calculates the economic value

€Economic value

The quality and in consequence the price of *Arnica* flower heads on the market depends on the composition and the amount of the chemical constituents. On sale, an average price of 75 € per kg dry weight is assumed.



The people collecting *Arnica* flower heads receive 1,10 € per kg dried flower heads.

Material and methods

50 sites representing different habitat conditions were studied. For each site a phytosociological releve was made using the Braun-Blanquet approach. The data were analysed statistically and classified by species composition. The data set contains 50 relevés with 143 plant species. The standard procedure according to WLDI (1989) was applied to these data:

- Histogram transformation was applied to the cover values to transform the extreme right skewed distribution to an equal distribution.
- Species with highest variance were selected which represent 95% of total variance to reduce random variation in the data.
- Correspondence analysis was applied to identify outliers. Sample 48 and 50 were omitted. They represent the only fens.
- The remaining 48 samples were classified using minimum variance classification with normalised variables based on the similarity ratio.
- The number of groups was chosen as 4.
- The species were classified with minimum variance classification with normalised variables based on the chord distance.
- An ANOVA with Monte Carlo significance test was applied to distinguish between characteristic and indifferent species. 25 species were found to significantly differentiate between the 4 vegetation types at a probability level of 1%.
- Concentration analysis was applied to order the groups.
- Correspondence analysis was used to show the gradients within groups.

The stems of *Arnica* were counted in plots (n=256) of 30m x 2m ("stripes") for each site. The flower heads per stem were counted. Fresh and dry weight of flower heads were measured. The biomass in kg per ha was calculated for each site.

Results and Discussion

Plant communities with *Arnica montana* and their differential species ***Festuca nigrescens-Agrostis tenuis-Grassland*** (« mesic ») (Group 1 with *Calluna album*, *Antirrhyn vulgaris*, *Plantago media*, *Polygala comosa*, Group 2 with *Lycnis flos-cuculi*, *Hieracium aurantiacum*, and species from acidic grasslands)

Nardus stricta-Vaccinium myrtillus-Grassland ("acidic") (Group 3 with *Picea abies*, *Homogyne alpina*, *Melampyrum sylvaticum*, Group 4 with *Antennaria dioca*)

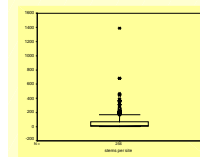


Harvested *Arnica* population in the Apuseni mountains. Only the stems remain.

name no.	21222 12 2 1 2	344 4 443 3	41122221114	13433
name	11111111111111111111	222222222222222222	444444444444	33333
Calluna album				
Antirrhyn vulgaris	1a	1	1	1
Plantago media s.str.	1	1	1	1
Polygala comosa	1	1	1	1
Lycnis flos-cuculi	1	1	1	1
Hieracium aurantiacum	1	1	1	1
Picea abies	1	1	1	1
Homogyne alpina	1	1	1	1
Melampyrum sylvaticum	1	1	1	1
Antennaria dioca	1	1	1	1

Central Tendency and variation, box-and-whisker plot:

The lower boundary of the box is the 25th percentile, the upper boundary is the 75th. percentile. The box represent 50% of the observations. The thick horizontal line inside the box represents the median. 50% of the cases have values below the median and 50% of the cases have values above the Median. The length of the box corresponds to the inter quartile range (IQR), which is the difference between the 75th and the 25th percentiles. It gives information about the variation of the observed values.



Cases with values more than 3 box-length from the upper or lower edge of the box are called extreme values. They are designated with an asterisk (*). Cases with values that are between 1,5 and 3 box-lengths are called outliers and are designated with a circle. Lines are drawn from the ends of the box to the largest and smallest observed values which are not outliers.

1 flower head 0,27g 2695 flower heads 1 kg

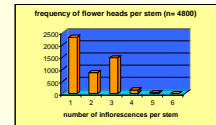
The average weight of a dry flower head was calculated by weighting 2290 flower heads.

Drying reduce 2 kg of fresh flower heads to 1 kg

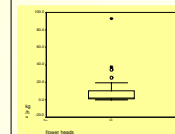
ratio is 2:1

Based on 25 samples fresh and dry weight were measured and the ratio was calculated.

In average 2 flower heads per stem

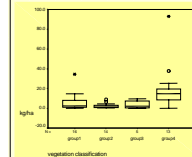


Tendency 2 kg flower heads per ha range from 0 to 93 kg per ha



Mean	8.25
Median	2.23
Variance	223.02
Stan. dev.	14.93
Minimum	.02
Maximum	92.93
IRQ	9.60
Skewness	4.13

Biomass and market price of Arnica flower heads



Biomass (kg dry weight per ha) and vegetation type.

The groups differ significantly Kruskal-Wallis-Test was calculated to test the significance: P = 0.016

Group	Median	Minimum	Maximum	IQR
1	2.45	.15	34.10	8.13
2	1.57	.36	8.73	2.67
3	2.17	.02	9.40	8.19
4	14.76	.12	92.12	17.47

Group 1 and 2: *Festuca nigrescens-Agrostis tenuis-Grassland*
Group 3 and 4: *Nardus stricta-Vaccinium myrtillus-Grassland*

Market price (in €) per ha and vegetation type

Group	Median	Minimum	Maximum	IQR
1	183.44	11.30	2557.16	609.99
2	117.75	27.24	654.67	202.20
3	162.57	1.46	705.20	614.03
4	1107.23	8.79	6908.17	1310.2955

Strategy Protection by Utilisation



Firstly Determining where and how much *Arnica* is in the region.

The IKONOS satellite image is an aid for this mapping.

The yellow arrow indicates the plot with the highest frequency of *Arnica* flower heads in the data set.

Secondly Developing strategies to promote the people to use *Arnica* in a sustainable way.



Finally Production