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Phytosociological Method for the Evaluation of the Biodiversity and Medicinal Plants

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Abstract

Today sustainable management of natural resources and especially of the aromatic and medicinal plants is the key issue policy of the economic development particularly on the remote areas. It is a bridge concept connecting society, economics, ecology and ethics. The sustainable management of vegetational natural resources, calls for the expansion of land use planning, including specific functions of ecosystems as biodiversity conservation and ecosystem services. Among the research, works in the field of inventory and evaluation of biodiversity will be prevailing. Series of important factors are assigned to biodiversity as function of ecosystem and inventory of it leads to the determination of the degree in which the function is present and of the ecosystem's ability to fulfill the given function. In this work, beside the inventory of medicinal plants, α and ɤ diversity are estimated. For the space distribution of vegetation types and plant species, including medicinal plants, remote sensing techniques are used. Before the evaluation of the natural resources and biodiversity a phytosociological study is conducted on the territory of Skrapari's Municipality (as case study) in order to identify the plant association and their species list (phytosociological table). Twentyone vegetation communities were defined by the application of TWINSPAN (Juice 7.0) and SYNTAX 2000, as classification and ordination techniques. For the space distribution of the plant associations and medicinal plants a coordinative grid (1 x 1 km) is implemented (in total 830 points), from which 157 releves are randomly selected for phytosociological analyses. As the result of the analyses different aspects of specific (α) and ecologic (γ) biodiversity are estimated and mapped.

Keywords: Inventory, natural resources, medicinal plants, biodiversity, phytosociology, TURBOVEG.

1. Introduction

Biodiversity conservation on the framework of Sustainable Management of ecosystems is becoming a priority of the regional policies [7]. On the national level this derives from the Strategy of the Biodiversity and Action Plan [1], on regional level, from Pan-European Strategy for the Biological and Landscapes Diversity [5] and on global level from Convention of Biological Diversity [26]. The EU and global biodiversity targets for 2020 call for an enhanced capability of monitoring, reporting and assessing progress in the thematic area of biodiversity.

The sustainable management of vegetational natural resources, calls for the expansion of land use planning, including specific functions of ecosystems as biodiversity conservation [13, 21]. Sustainable Management means "*the development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" [24]. Referring CDB [26], three are the fondamental component for the sustainable management, which are at the same time, the background of this study: (i) environmental protection, (ii) economic growth and (iii) social equity. At the Rio+20 Conference the discussion was focused on how we can reduce poverty, advance social equity and ensure environmental protection. Whittaker [31] described three terms for measuring biodiversity over spatial scales: alpha (α), beta (β), and gamma (γ) diversity. Alpha diversity refers to the diversity within a particular area or ecosystem, and is usually expressed by the number of species (i.e., species richness) in that ecosystem. β is the ratio between regional and local species diversity and γ diversity is a measure of the overall diversity for the diferent ecosystems within a region. Hunter [31] defines γ diversity as a "*geographic-scale species diversity*".

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Plant communities play an important role in sustainable managements by maintaining biodiversity and conserving the environment [14]. Quantitative analysis, especially quantitative classification methods and ordination techniques, has been widely used to indicate the ecological relationships between vegetation and environment [33]. Moreover, floristic studies are not only important to know the variety of plants present in an area, but also socio-economically significance. They provide food, medicinal plant and everything for the human being. Medicinal plants (fruits, vegetables, herbs, etc.) are a source for a wide variety of natural products, such as phenolic acids and flavonoids, which are very interesting for their antioxidant properties [32].

The aim of this work is to establish a methodology for the evaluation of the biodiversity on the framework of the natural resources inventory. The main objectives of the present work were to identify the common plant communities with medicinal plants in the different habitats of Skrapari Municipality area. Such studies may help in policy making and sustainable management of medicinal plants in their prevailing habitats (*in situ*). Phytosociological databases are most often designed for vegetation classification and as a source of information on the spatial distribution of vegetation or habitat diversity, as required by the nature conservation agencies or forest management institutions .

2. Material and Methods

As the definition we have use this of Rio Convention [26] in which "*Biological diversity*" means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity (i) within species, (ii) between species and (iii) of ecosystems". Biodiversity is a very complex concept, including α, β and γ biodiversity [31].

On the figure below the element of the biodiversity which are studied are represented (in red color).

Biological diveersity	**Genetic Diversity**	**Organism's Diversity**
Biomes		Kingdom
Bioregions		Phylum's
Landscapes		Families
Ecosystems		Genera
Habitats		Species
Sites		Subspecies
Populations	**Populations**	**Populations**
	Individuals	
	Chromosomes	
	Genes	
	Nucleotids	

Figure 1. The component of the biodiversity

Concerning α biodiversity there are estimated species, gender, family richeness, variability in chorological and biological forms, richness in endemic and rare species as well as the species with specific values.

The plant family concept is based on Cronquist [27, 28], which has been also commonly used in the published floras of comparable geographic areas.

γ diversity of plant communities at the level of landscapes has been traditionally documented by relevés, i.e. species lists with simple estimates of abundance-dominance (A-D). Species richness for each vegetation group was calculated as the average number of species per stand. Relative evenness or equitability (Shannon $-\Sigma s\ i=1\ Pi\ (\log Pi)$, where: s is the total number of species and Pi is the relative importance value (relative cover) of the i^{th} species.

For the purpose of the phytosociological classification, the concept of association has been formulated as an abstract and basic entity, defining the necessary attributes of a specific plant assemblage. From a qualitative point of view, the association represents a plant community with a concrete species composition (floristic criterion), having spatially isotropic structure (physiognomic criterion of homogeneity), confined to a certain position in environmental space (ecological criterion) [2,6].

As the unit for data collection a sample plot designe system is established through a coordinative 1 x 1 km grid. 830 quadrant are provided and pre-evaluated through remote sensing techniques [8], in

total. Randomly 157 verification plots are selected as well as the survey points (relèves) in terms of phytosociological method. Vegetation relèves were recorded by using the Braun-Blanquet seven-degree scale of abundance and dominance [28]. A total of 267 releves are inventoried and entered them into the TURBOVEG database [9]. The releves size is calculated based on the "mimnimal area" and all the floristic list is inventoried using A-D index (Braun Blanquet sensu strictu). The phytosociological analysis of vegetation in the territory of the municipality of Skrapar was done according to the method of Braun Blanquet [2]. Numerical vegetation analysis was done with the help of the TWISPAN program [11]. The systematic interpretation was based on the European Vegetation Classification [17]. Ecological characterization was carried out through Ellenberg's ecological indicators, Raunkier's biological form [23, 24] and SHANNON-WEAVER [10]. Data editing and relève analysis were managed in the JUICE 7.0 program [25] and comparatibely SYNTAX 2000 multivariate statistical program package [19, 20]. Only vascular plants were considered, as other plant groups play an insignificant role in the studied vegetation. We calculated relative Euclidean (chord) distance for square-rooted percentage cover data and applied the β-flexible clustering method with $\beta = -0.25$. Five clusters at the highest hierarchical level are accepted, which roughly corresponded to the following phytosociological syntaxons. By the floristic list of each plant community using A-D index, medicinal plants and their coverage as well as potential production are identified.

2.1. Study area

The study area is located in South-East Albania, between the coordinates: in nord (512765.92 E; 4454985.41 N), South: (509936.72 E; 4430201.79 N); East (520743.74 E; 4444693.05 N); and West (490459.64 E; 4449448.81 N). The total area of Skrapari's Municipalitz is c.a. 83.140 ha. The altitude achieve from 400 m to 1593 m over the sea level. It is characterized by a mountainous terrain and a wide altitudinal stretch from the Typical Mediterranean evergreen sclerophyllous forest and shrub vegetational belt (Bogove) up to high mountainous vegetation (dwarf and grass species) ever-blistering Mediterranean forests of the xerofite shrubland to the high mountain pastures (Tomorri Mountain). Study area is caracterised also by a geologic and soil variability. The soil naturally resemble the function of the capacity and the quality is specific to any type of soil. This concept includes two distinct but interrelated parts: (i) stable texture and (ii) variable quality (dynamic). Characteristics related to texture, mineralogy, etc., are the natural qualities of soil determined by soil-formation processes, climate, topography, vegetation, rock and time factor. Together these determine the sustainable quality of a land. They serve to compare one soil to another and to evaluate soils for particular uses.

Climate is an essential factor in terms of the spread of vegetation types on the ground. Significantly, the climate is represented by the rainfall/temperature report. Based on the ration between the average perennial monthly rainfall (P) and the average perennial monthly temperatures (T), the drought index of Bagnouls-Gaussen is estimated and presented $IG = P/T$ (Figure 3). When $IG \leq 2$ means drought period.

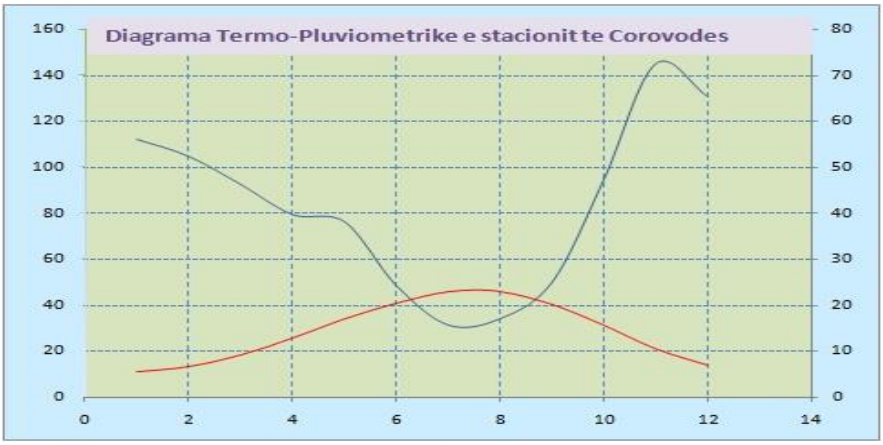

Figure 2. Thermo-Pluviometric diagram of Bagnouls-Gaussen

The main economic activities on this municipality are the agriculture, husbandery and medicinal plants.

3. Results and Discussion

From the data elaboration resulted as follow:

3.1. α Biodiversity

Territory of the municipality is a reach area on floristic species because the location, morphological and edaphic variability and very large distribution in altitude (from 400 to 1593 m over the sea level). During the field work there are inventoried 647 vascular plants, distributed in 111 families, as Fabaceae (59), Compositae (56), Poaceae (56), Lamiaceae (43), Rosaceae (33), Brassicaceae (25), Scrophullariaceae (24), Caryophyllaceae (20), Ranunculaceae (19), Rubiaceae (12), Campanulaceae (11), Liliaceae (11) etc. On the graph below (Figure 3) the richness in families is presented.

A high variability represents α biodiversity on Biological forms [22, 23]. On the graph below Biological spectrum is presented (Figure 4).

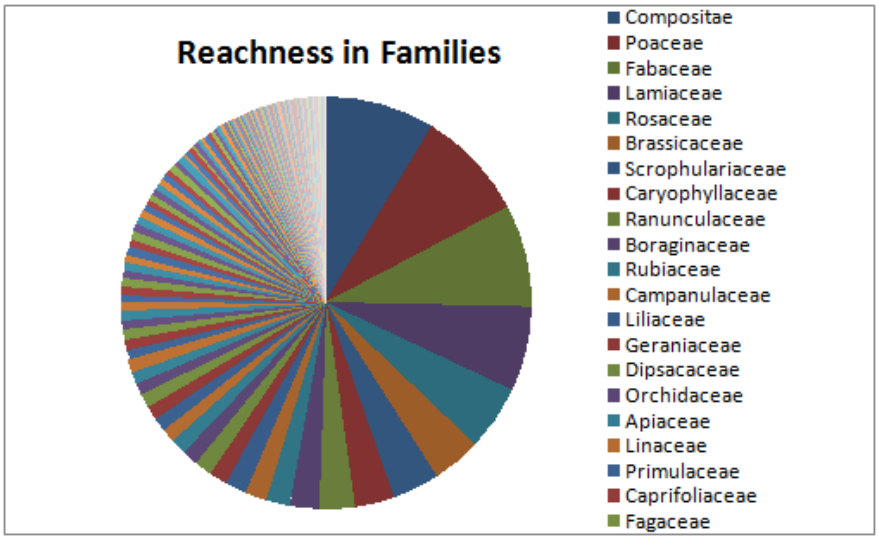

Figure 3. Family richeness

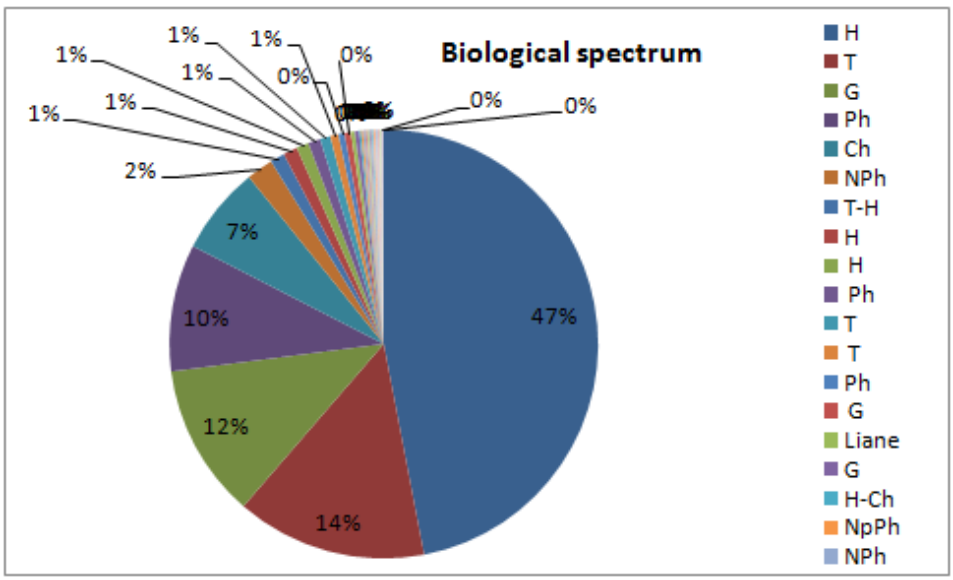

Figure 4. Biological spectrum

Very interesting is represented the variability of α biodiversity in Chorological forms. Chorological spectrum is presented on the graph below (Figure 5).

The presence of the species with specific status shows four categories:

Endemic: 6 endemic species are located mostly on Tomorri Mountain: *Arabis tomorensis* Markgr

(Brassicaceae), *Arenaria cikaea* F.K Meyer (Caryophyllaceae), *Astragalus autranii* Bald (Fabaceae), *Campanula aureliana* Bogdanović, Rešetnik, Brullo & Shuka (Campanulaceae), *Euphorbia cikaea* F.K. Meyer (Euphorbiaceae) and *Onosma mattirolii* Bald. (Borraginaceae) [27, 28].

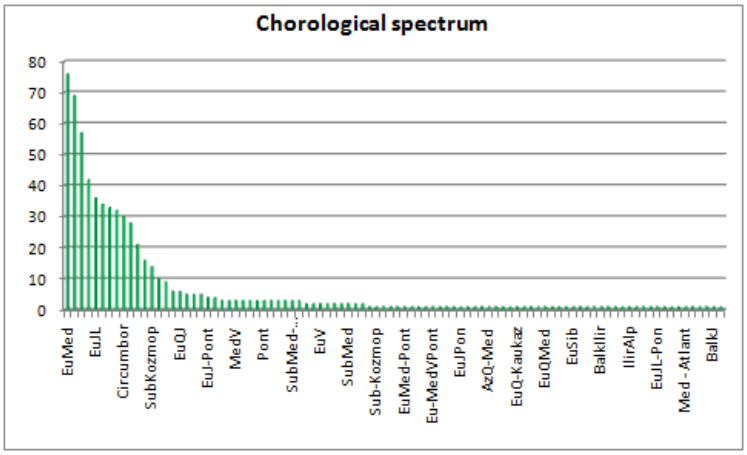

Figure 5. Chorological spectrum

Sub-endemic: 12 sub-endemic species as *Arenaria gracilis* W. K. Pl (Caryophyllaceae), *Asperula chlorantha* Boiss. & Heldr. (Rubiaceae), *Campanula hawkinsiana* Hausskn. & Heldr. (Campanulaceae), *Centaurea epirota* Halcsy (Compositae), *Edraianthus australis* (Wettst.) Lakusic (Campanulaceae), *Herniaria parnassica* subsp. *parnassica* Chaudhri (Caryophyllaceae), *Lilium chalcedonicum* L. (Liliaceae), *Nepeta spruneri* Boiss. (Lamiaceae), *Pedicularis graeca* Bunge (Scrophullariaceae), *Pterocephalus perennis* subsp. *bellidifolius* Coulter (Caprifoliaceae), *Valeriana crinii* Orph. ex Boiss. (Valerianaceae) and *Viola albanica* Halacsy (Violaceae) are identidied during the field work [27, 28].

Balkanic and sub-balkanic species: Balkan and sub-Balkan species are an important element of the country's flora [15]. In the studied area we encounter 44 Balkan and 28 sub-Balkan species, which make up respectively about 7.0% and 4.0% of the site flora, and c.a. 29% of the rare and threatened flora list. C.a. 20 of them are also included in the list of endangered species.

Species with endangermend status. In this category the species of the red list of Albania, based on IUCN categorization are given [29]. There are determined 59 species, which represent 11% of the total determined species. On the graph below the weight for each IUCN category [16] is given.

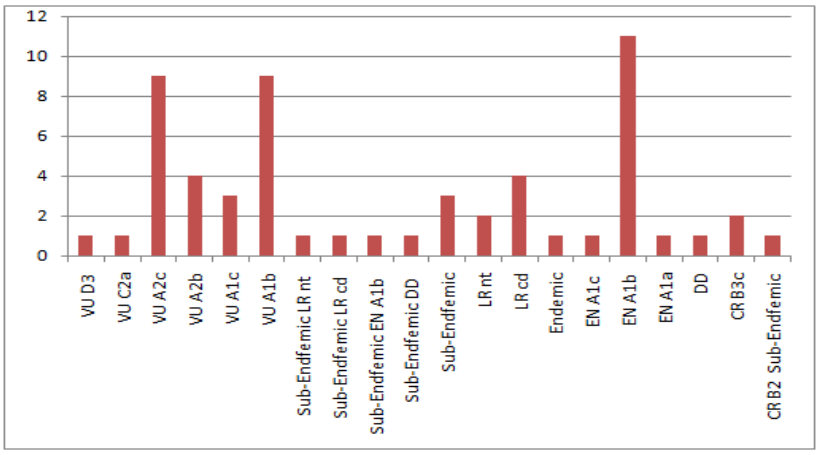

Figure 6: The weight of the species with endangerment status (IUCN)

During the field work there are identified c.a. 102 medicinal and aromatic species as well as economic value species. As most important and most distributed value species are *Thymus* sp. Div, *Hypericum* sp.div., Sideritis raeseri, *Satureja montana*, *Gentiana lutea*, *Achilea millefolium*, *Primula veris*, *Juniperus sp.*,

Cholchicum sp.div., Plantago sp., Salvia officinalis, Salvia sclarea, Verbascum sp.div., Crategus monogyna, Rosa cannina, Origanum vulgare, Rubus sp., Sambucus nigra, Erythrea centaurium, Centaurea cyanus, Mentha pipereta, Matricaria cammomila, Papaver rhoeas, Malva sylvestris, Urtica dioica [27, 28]. More information about the space distribution and coverage are given on the chapter 2.3 (About γ Biodiversity).

3.2. γ Biodiversity

A high variability and very interesting represents γ biodiversity. γ biodiversity, based on the phytosociological methodology and analyse, the vegetation types (Braun Blanquet *sensu strictu*) is defined. On the table and figure below the space distribution and area size for each vegetation types is presented. Using Juice 7.0 [4] and SYNTAX 200, twentyone plant communities are identified, as on the syntetic table, using European Vegetation Classification [30]. Not all vegetation types are classified up to association level because the limited areas of its distribution. For the syntaxonomic nomenclature to the alliance, order and class levels, European Vegetation Classification is used [17]. See syntethic table on the annexes of papper.

The variability of γ biodiversity (vegetation groups) on the map of vegetation types is presented.

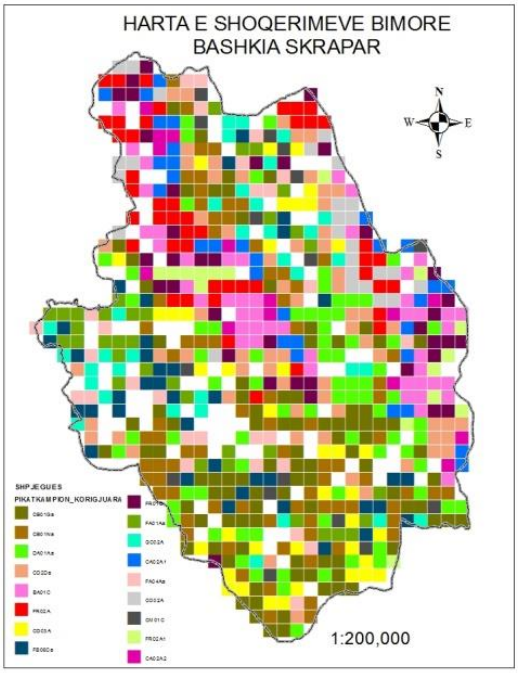

Figure 8. Map of vegetation types (Braun Blanquet sensu strictu). The distribution area (in %) per plant community (associations) on the graph below is given.

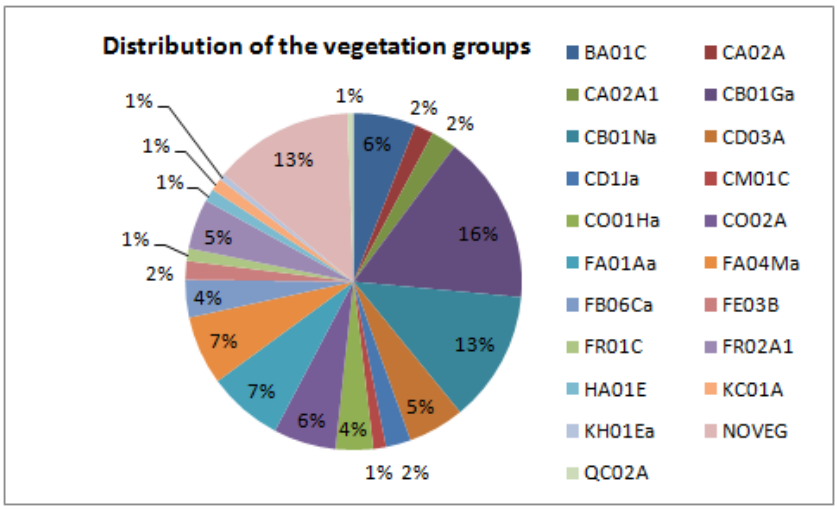

Figure 9. Distribution of vegetation groups (associations)

From the phytosociological analyse, biodiversity point of view, results that most richnest vegetation groups are Juniperion nanae Fk 1960, Pinion pallasianae Korzhenevsky 1998, Seslerio – Pinetum leucodermis Vangjeli 1984, Pistacio lentisci-Juniperetum oxycedri Allegrezza, Biondi, Formica & Ballelli 1997, Cytision oromediterraneo-scoparii

Rivas-Mart. et al. 2002, Arbuto- Quercetum ilicis Br Bl 1938 etc., as on the graph below is presented.

On the graph below (Figure 11) the Shannon-Wiener Index per plant community is givenis given.

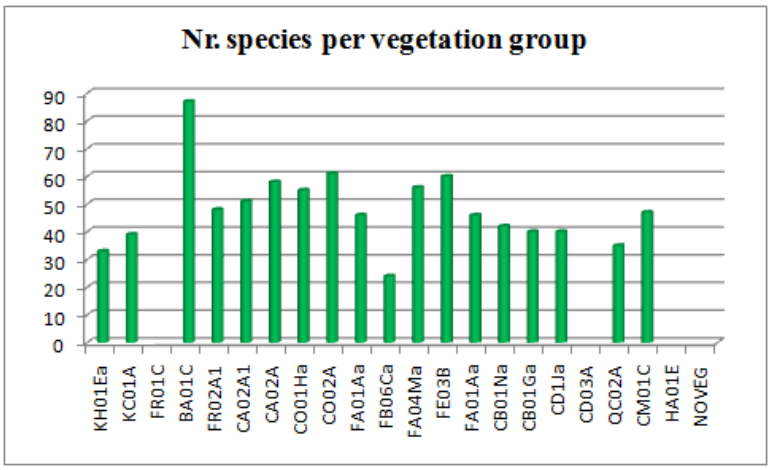

Figure 10. Species richeness per vegetation groups

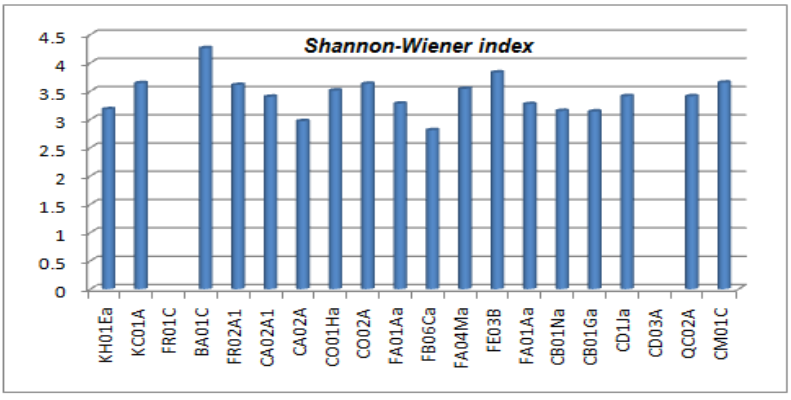

Figure 11. Shannon-Wiener Index per plant community

3.3. Medicinal plants richness

Vegetation of Skrapari Municipality muast to be considered very reach in medicinal plants, a big potential for economic development and poverty eradication on the remote areas. From the phytosociological analzse, based on the floristic cortege and per each plant community, the table of medicinal plants is edited and presented below. For the evaluation of the production, certain areas are tested and different collectors are asked (questioner) [18].

4. Conclusions

Phytosociological method can be used efficiently as the methodological tool for the inventory of natural resources and evaluation of the biodiversity.

The territory of Skrapary Municipality is very rich related to α biodiversity represented by 647 vascular plants, distributed in 111 families. A high variability represents α biodiversity on the Biological forms, Chorological forms and in species with specific status like endemisms (6 species), Sub endemisms (12 species), Balkanic (44 species), sub balkanic (28 species) and endangerment species based on IUCN categorisation (59 species).

The territory of Skrapary Municipality related to γ biodiversity so far, numbering twentyone plant communities or vegetation groups, due to the big differences in altitude, variability of the soils and the high climate and micro-climate variability.

With a high economic values there are the presence of 102 medicinal, aromatic and food interest species which can contribute to the economic development and eradication of the people living in remote areas of this Municipality.

Table 1. Distribution of the Main medicinal plants on Skrapari's Municipality

Nr	Plant name	Area (ha)	Coverage (%)	Production (ton)
1	*Thymus striatus*	3.700	4	10
2	*Thymus longicaulis*	32.000	5	100
3	*Satureja montana*	12.500	3	50
4	*Vaccinium myrtillus*	2.000	10	5
5	*Gentiana lutea*	500	2	2
6	*Achillea millefolium*	10.000	5	20
7	*Primula officinalis*	16.000	3	45
8	*Sideritis raeseri*	13.500	4	15
9	*Salvia officinalis*	7.000	15	100
10	*Juniperus communis*	23.000	25	100
11	*Juniperus oxycedrus*	42.500	25	150
12	*Colchicum autumnale*	2.000	2	0.5
13	*Orchis sambucina*	1.000	2	1
14	*Cornus mas*	33.000	7	500
15	*Rubus sp.div.*	28.500	10	75
16	*Corylus avellana*	3.500	30	80
17	*Malus sylvestris*	3.500	5	150
18	*Rosa canina*	29.500	15	100
18	*Tussilago farfara*	7.000	20	20
20	*Atropa bella-dona*	2.000	3	2
21	*Crataegus monogyna*	31.000	15	200
22	*Origanum vulgare*	29.000	10	100
23	*Teucrium pollium*	19.500	20	50
24	*Cotynus coggygria*	18.000	30	10
25	*Cistus sp div*	12.500	25	100
26	*Cicorium intybus*	7.500	5	10
27	*Centauriu erythrea*	12.000	3	10
28	*Hypericum perforatum*	27.000	4	30
29	*Fraxinus ornus*	35.000	7	50
30	*Taraxacum officinalis*	7.000	15	15
31	*Centaurea cyanus*	3.500	3	15
32	*Papaver rhoeas*	2.500	5	3
33	*Malva sylvestris*	3.000	20	20
34	*Plantago sp. div*	12.500	20	15
35	*Trifolium pratense*	4.500	25	10
36	*Matricaria cammomila*	1.000	25	3
37	*Fragaria vesca*	11.500	35	35
38	*Melisa officinalis*	1.500	25	60
39	*Ruscus aculeatus*	4.500	5	10
40	*Sambucus nigra*	1.500	5	20
41	*Urtica dioica*	3.000	25	20
42	*Verbascum sp.div.*	9.500	10	50

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Annex 1: The Syntetic table of Plant communities

K - Vegetation of the rock, crevices and screes

KC - Asplenietea trichomanis (Br.-Bl. in Meier et Br.-Bl. 1934) Oberd. 1977

KC02 - Potentilletalia caulescentis Br.-Bl. in Br.-Bl. et Jenny 1926

KC01A - Asplenio scolopendrii-Geranion robertiani Ferrez 2010

F - Vegetation of the mediterranean zone

FR - Daphno-Festucetea Quézel 1964

FR01 - Daphno-Festucetalia Quézel 1964

FR01C - Stipo pulcherrimae-Morinion persicae Quézel 1964

FE - Cytisetea scopario-striati Rivas-Mart. 1974

FE03 - Spartio juncei-Cytisetalia scoparii Mucina ordo nov. hoc loco

FE03B - Cytision oromediterraneo-scoparii Rivas-Mart. et al. 2002

FR02 - Saturejo spinosae-Scutellarietalia hirtae Dimopoulos et al. ex Bergmeier 2002

FR02A - Astragalion cretici Bergmeier 2002

C - Vegetation of the nemoral forest zone [3]

CA - Carpino-Fagetea sylvaticae Jakucs ex Passarge 1968

CA02 - Fagetalia sylvaticae Pawłowski 1928

CA02A - Aremonio-Fagion (Horvat 1950) Borhidi in Török et al. 1989

CA02A1 - Asperulo odoratae-Fagetum Sougnez et Thill 1959

CA02 - Fagetalia sylvaticae Pawłowski 1928

CA02A - Aremonio-Fagion (Horvat 1950) Borhidi in Török et al. 1989

CB - Quercetea pubescentis Doing-Kraft ex Scamoni et Passarge 1959

CB01 - Quercetalia pubescenti-petraeae Klika 1933

CB01G - Carpinion orientalis Horvat 1958

CB01Ga – Querco carpinetum submediterraneum Wrb. 1954

CB01N - Quercion confertae Horvat 1958

CB01Na – Querco – conferta cerris (Knapp 1944)Rud 1946

CD - Crataego-Prunetea Tx. 1962 nom. conserv. Propos

CD02 - Paliuretalia Trinajstić 1978

CD02D - Buxo-Syringion P. Fukarek ex Diklić 1965

CD2Da – Buxo Juniperetum Horv. 1954

CD03 - Pyro spinosae-Rubetalia ulmifolii Biondi, Blasi et Casavecchia in Biondi et al. 2014

CD03A - Pruno spinosae-Rubion ulmifolii O. de Bolòs 1954

CM - Molinio-Arrhenatheretea Tx. 1937

CM01 - Arrhenatheretalia elatioris Tx. 1931

CM01C - Cynosurion cristati Tx. 1947

CO - Erico-Pinetea Horvat 1959

CO02 - Pinetalia pallasianae-kochianae Korzhenevsky 1998

CO02A - Pinion pallasianae Korzhenevsky 1998

CO01 - Erico-Pinetalia Horvat 1959 nom. conserv. propos.

CO01H - Pinion heldreichii Horvat 1946

CO01Ha - Seslerio – Pinetum leucodermis Vangjeli 1984.

F - Vegetation of the mediterranean zone

FA - Quercetea ilicis Br.-Bl. ex A. Bolòs et O. de Bolòs in A. Bolòs y Vayreda 1950

FA01 - Quercetalia ilicis Br.-Bl. ex Molinier 1934

FA01A - Quercion ilicis Br.-Bl. ex Molinier 1934

FA01Aa - Arbuto- Quercetum ilicis Br Bl 1938

FA04 - Pistacio -Rhamnetalia alaterni Rivas-Mart. 1975

FA04A - Ericion arboreae Rivas-Mart. 1987

FA04Aa – Pistacio lentisci-Juniperetum oxycedri Allegrezza, Biondi, Formica & Ballelli 1997

FB - Ononido-Rosmarinetea Br.-Bl. in A. Bolòs et Vayreda 1950

FB06 - Cisto-Ericetalia Horvatic 1957

FB06C – Cisto-Ericion Horvatic 1957

FB06Ca – Cisto ericetum arboreae Horvatic 1957

H - Alluvial forests and scrub

HA - Alno glutinosae-Populetea albae P. Fukarek et Fabijanić 1968

HA01 - Populetalia albae Br.-Bl. ex Tchou 1949 nom. conserv. propos.

HA01E - Platanion orientalis I. Kárpáti et V. Kárpáti 1961

Q - Anthropogenic vegetation

QC - Chenopodietea Br.-Bl. in Br.-Bl. et al. 1952

QC02 - Chenopodietalia Br.-Bl. in Br.-Bl. et al. 1936

QC02A - Chenopodion muralis Br.-Bl. in Br.-Bl. et al. 1936