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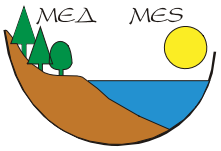

IV КОНГРЕС НА ЕКОЛОЗИТЕ НА МАКЕДОНИЈА СО МЕЃУНАРОДНО УЧЕСТВО И ОДБЕЛЕЖУВАЊЕ НА 40 ГОДИНИ ОД ФОРМИРАЊЕТО НА МАКЕДОНСКОТО ЕКОЛОШКО ДРУШТВО

Охрид, 12-15 октомври 2012 година

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IV КОНГРЕС НА ЕКОЛОЗИТЕ НА МАКЕДОНИЈА СО МЕЃУНАРОДНО УЧЕСТВО И ОДБЕЛЕЖУВАЊЕ НА 40 ГОДИНИ ОД ФОРМИРАЊЕТО НА МАКЕДОНСКОТО ЕКОЛОШКО ДРУШТВО

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Секции на конгресот

1. Популации, заедници и еколошко моделирање
2. Структура и функционални карактеристики на копнени екосистеми
3. Водни екосистеми - под закана (во коорганизација со Македонското лимнолошко друштво - Охрид)
4. Биодиверзитет и заштитени подрачја на Балканот (можности за соработка и влијанија од и на економскиот развој)
5. Агроеколошки и силвикултури системи
6. Животна средина, загадување и климатски промени
7. Пределна екологија за одржлив развој
8. Урбана и хумана екологија
9. Повеќестепена еколошка едукација

Congress sections

1. Populations, communities and ecological modelling
2. Structure and function of terrestrial ecosystems
3. Aquatic ecosystems - under threat (co-organized by the Macedonian Limnological Society, Ohrid)
4. Biodiversity and protected areas across Balkans (cooperation perspectives and economic development impacts)
5. Agro-ecological and Silvicultural Systems
6. Environment, pollution and climate change
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Proceedings of the 4th Congress of Ecologists of
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Ohrid, 12-15 October 2012
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AFFORESTATIONS IN CONDITIONS OF GLOBAL CLIMATE CHANGE IN BULGARIA – PROBLEMS, INVESTIGATIONS AND ADAPTATION MEASURES

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Abstract

Raev, I. (2013). Afforestations in conditions of global climate change in Bulgaria – problems, investigations and adaptation measures. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

Significant research activities have been carried out during the last 20 years in Bulgaria to study the influence of global climate changes on afforestation activities success, as well as on adaptation of forests to new ecological conditions. During these investigations it was established that main reason for the decay of coniferous plantations in low parts of the country is their improper introduction out of their natural habitat. High interception and evapotranspiration of conifers do not correspond to ecological conditions in low part of the country. Another research reveals that consequences of periodic droughts can be a good analogue for the effect of future climate changes. The analysis shows that in the area above 800-900 m a.s.l. air temperature has increased by 1,0-1,4°C in the drought period 1982-1994 and precipitations have decreased by 12.0-15.9%. In the lower part of the country temperature has increased by about 2.0°C and precipitations have decreased by 24.9-28.7%. As a result, 18.5% of newly established coniferous plantations out of their natural habitat have decayed. New stage of these investigations is the development of climatic scenarios for the territory of the country in the 21st century. Increasing of the air temperature with 2 to 5°C is expected, as well as decreasing of precipitations with 10 to 30%. On this basis, 5 zones of vulnerability of forest ecosystems are determined depending also on altitude above sea level. For each zone of vulnerability, specific measures for adaptation of forests and success of forest plantations are suggested. On the basis of zones of vulnerability, new classification of types of forest sites is suggested, as well as instruction for determination and mapping of forest sites, which is of big importance for the success of afforestation activities in Bulgarian forests.

Key words: afforestations, global climate changes, climatic scenarios, zones of vulnerability, adaptation measures.

Introduction

Afforestations or establishment of new forests is powerful tool for sustainable development of ecosystems and for creating of favourable environment for human life. But the success of this creative activity depends mainly on the environment, including young plants – first of all from the soil-climatic complex. If we accept that soils are relatively constant for a certain territory, climate changes are leading factor for the survival of new forests.

During the last 20 years too much facts and evidences appeared for the disturbing trend for accumulation of carbon dioxide in the atmosphere and gradual climate change. The increasing of temperature and changes in precipitations regime lead to serious change in the environment. Process of thawing of forest soils and increased growth has begun in Alaska and Siberia (Sedjo 1991; Jacoby 1993; Lloyd et al. 2003). Forest tree species occur to the north in the tundra (Sedelnikov et al., 1997). Tree line in the Alps and high mountains in Europe increases (Walter & Grundman, 2001).

Besides these results, intensive investigations were carried out in many countries for modelling of future processes of climate change, whose aim is preventive measures for adaptation of forest tree vegetation (Strain & Thomas 1993; Sykes & Prentice 1996; Bolliger 2002; Broadmedow et al. 2005; Gessler et al. 2007; Koling et al. 2007).

The aim of this report is to present the results from investigations on climate changes and prob-

lems occurring for the success of afforestation activities in Bulgaria, as well as measures for adaptation of forest tree vegetation to unfavourable changes in the environment.

Stages in the process of establishment of new afforestation strategy in climate change conditions in Bulgaria

Large-scale programme for accelerated afforestation of new forests was in progress in Bulgaria in the period after the Second World War until 1985. About 1,200,000 ha of new forests have been established in the country in this period (1945-1985), which is nearly 1/3 of the forest fund. As a result of this intensive activity, entire areas have been changes, like Eastern Rhodopes for example, as well as almost every settlement in the country. Average annual wood increment increases from 6.1 million m^3 in 1955 to 14,0 million m^3 in 2008 and the total stock – from 245 million m^3 to 590 million m^3.

But during this accelerated activity and especially from the beginning of the 1980s, disturbing process of withering of newly established plantations was determined, especially in the lower area of the country. In 1988 and 1993 two investigations were carried out in the entire territory of the country to reveal the reasons for withering of forests in Bulgaria. It was established that mainly coniferous monoplantations in the lower area of the country wither. The belt for optimal development of conifers in the country is from 900 to 1600 m a.s.l. (Raev, 1983). During the studied period, however, conifers have covered from 95.5 to 68,3% of new plantations and, in addition, afforested areas are predominantly under 700-800 m a.s.l., i.e. out of their natural habitat (Figure 1).

It was established that the main reason for the incapability of conifers to survive in low parts of Bulgaria is their improper water balance connected with high values of interception (holding of precipitations in the crowns) and high total evaporation (Table 1). Due to this reason they survive in regions with higher precipitations and lower evaporation, i.e. the belt above 800-900 m a.s.l. Therefore, improper introduction of coniferous tree species in the area out of their natural habitat is the main reason

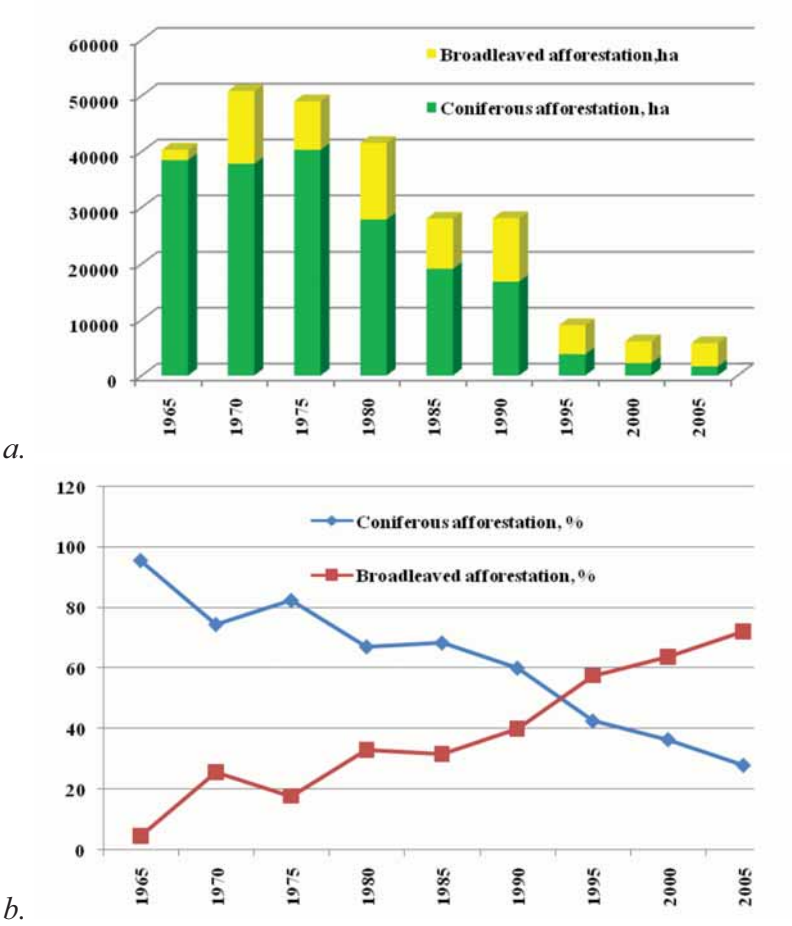

Fig. 1. Afforestation in Bulgaria for the period 1965-2005 (a - in ha, b – in %)

Tab. 1. Water balance in cerris oak and Austrian black pine forests under comparable conditions in North-eastern Bulgaria, 1976-1984

No.	Components of the water balance	Cerris oak		Austrian black pine	
		mm	%	mm	%
1	2	3	4	5	6
1.	Precipitation above the crowns	505.0	100.0	505.0	100.0
2.	Precipitation to the soil	444.5	88.0	340.5	67.4
2.1.	Precipitation under the crowns	423.1	83.8	318.9	63.1
2.2.	Stem flow	21.4	4.2	21.6	4.3
3.	Interception (1-2)	60.5	12.0	164.5	32.6
4.	Soil evaporation	118.4	23.4	127.1	25.2
5.	Transpiration	326.1	64.6	213.4	42.2
6.	Total evaporation (3+4+5)	505.0	100.0	505.0	100.0
7.	Infiltration (1-6)	0.0	0.0	0.0	0.0

for the decay of newly established coniferous plantations in Bulgaria (Raev, 1995).

In the period 1993-1996, Bulgarian researchers participated in the international project together with other 55 countries for the investigation of influence of climate changes on forests. For the conditions of Bulgaria it was established that this influence depends a lot on the altitude above sea level, as well. In the lower area of the country (under 800 m a.s.l.) this influence is strongest and critical level of survival in forests is reached, while in upper parts of the mountains conditions are more favourable. Depending on this, some measures are suggested for adaptation of forests to climate changes (Raev et al. 1995, 1996; Raev 2001).

Besides stable trends of air temperature increase and precipitations decrease, there are recurrent drought periods in South-Eastern Europe. In 20th century these durable droughts were in 1904-1908, 1945-1953 and 1982-1994. According to existing models of climate change, considerable increase of air temperature and unfavourable course of precipitations could be expected, i.e. something similar to what happens in drought periods. In this case, consequences during the big drought in 1982-1994 can be indicative of forthcoming warming in the 21st century. The experience from the last drought could be quite useful for the preparation of action plans aiming to decrease negative consequences of climate changes.

This hypothesis is in the base of an investigation carried out by several institutes of BAS together with researchers from the University of Sofia and the Academy of Medicine in the period 1998-2002. The aim of this investigation is to reveal natural, economic and social consequences from the big drought in Bulgaria in 1982-1994 and on this base to suggest measures for adaptation of ecosystems and society to climate change. In the field of forest sector, air temperatures increase with about 2^{o}C was determined in the lower parts of the country in 1982-1994 and in forests above 800 m a.s.l. this increase was from 1,0 to 1,4^{o}C. And, while precipitations decrease in the lower area was from 24,9 to 28,7%, in higher parts it was from 12,0 to 15,9%. Due to this reason, almost no consequences for the forest vegetation were revealed in the higher parts and in the lower forest vegetation area there was considerable precipitations deficit with consequences for the forest plantations. In the area below 800 m a.s.l., 163,000 ha or 18.5 % of the newly established coniferous plantations in Bulgaria decayed (Raev, et al. 2003; Knight et al. 2004). Towards 2008 these losses reach 217989 ha or 22.4 % of the new forests (Raev 2009).

For the forests from the lower part of the country (below 800 m a.s.l.), the strategic aim of forestry is determined as "campaign for adaptation of forests to climate warming, for protection of forests from worsened ecological conditions". For the forests from higher parts of the country (above 800 m a.s.l.), where conditions are more favourable, higher aims of forestry are suggested: biodiversity conservation, sustainable development of ecosystems, multifunctional utilisation, and development of protected territories system.

For the stable solving of the problem of climate changes impact on forestry sector in Bulgaria, including directions of afforestation activities and adaptation of forests to unfavourable climatic conditions, a team of researchers from the Forest Research Institute, University of Forestry and National Institute of Meteorology and Hydrology, together with experts from the forestry administration, carried out an investigation in 2010-2011, whose main purpose was to suggest measures for adaptation of the forestry sector in the 21st century. On the base of global circulation models for the atmosphere in the 21st century using data about Bulgaria, it was established that an increase of average air temperature from 2 to 5^{o}C in Bulgaria can be expected. In the same time precipitations are expected to decrease from 10 to 30% and this decrease will be higher during growing period and less during cold part of the year. Increase of temperature and precipitations extremes is expected. This should be taken into account during

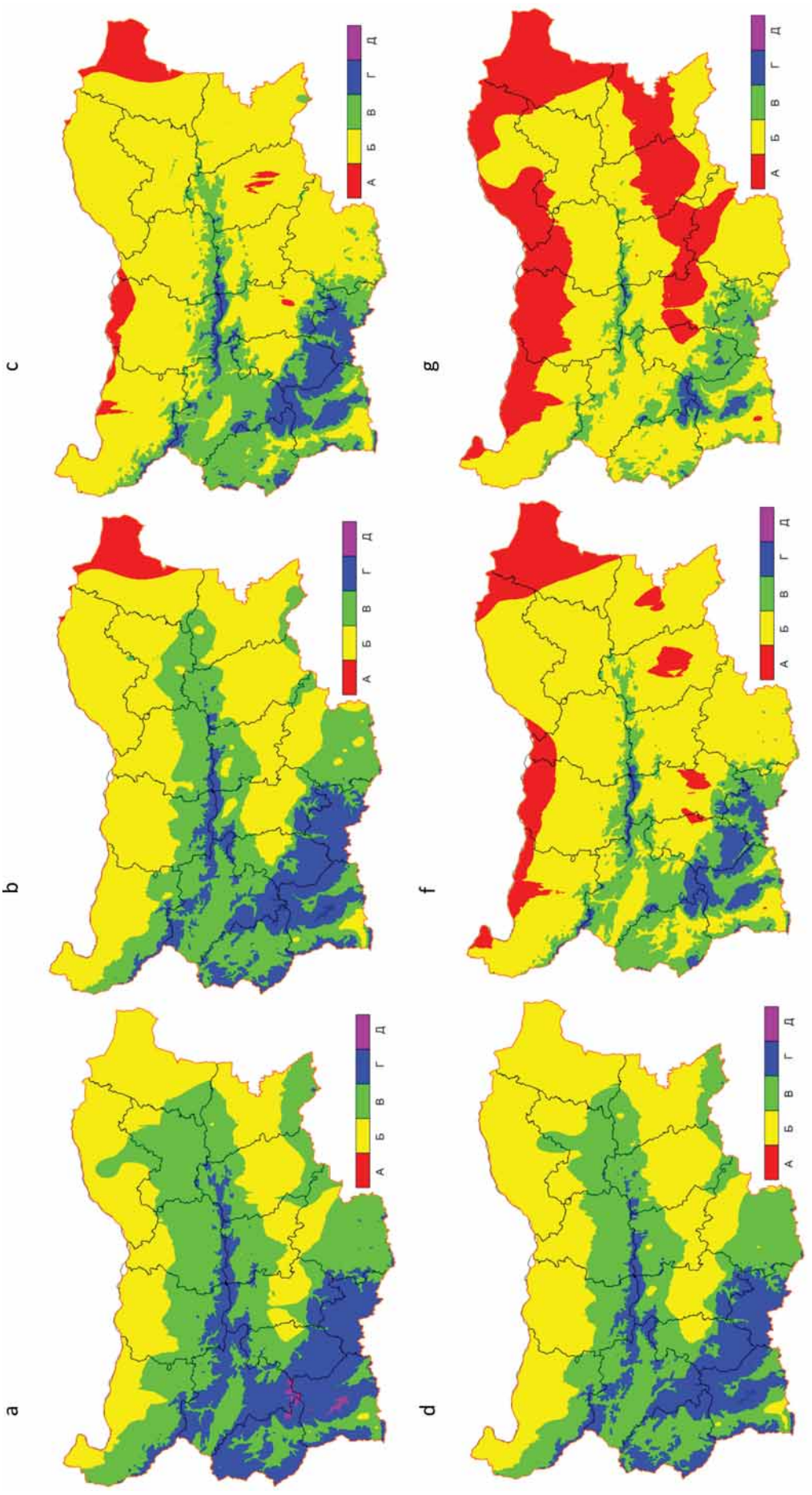

Fig. 2. Vulnerability zones of the forest ecosystems in Bulgaria : a- contemporary climate (1961-1990); b- 2020 realistic scenario; c- 2050 realistic scenario; d- 2080 optimistic scenario; f- 2080 realistic scenario; g-2080 pessimistic scenario Zone A – very high vulnerability; Zone B (Б) – high vulnerability; Zone C (В) – moderate vulnerability; Zone D (Г) – low vulnerability; Zone E (Д) – very low vulnerability

future afforestations in the country. Through climatic scenarios, "vulnerability zones" of forest tree vegetation in Bulgaria to unfavourable climate change were determined.

Five vulnerability zones were determined (Figure 2) (Raev et al. 2011):

Zone A (A): It is characterised by permanent deficit of moisture supply, leading to disintegration of ecosystems. This zone is absent in the current climate. In 2020 it occurs in North-East Bulgaria. Towards 2050 it spreads along the Danube river to Svishtov and in 2080 grows from the Back Sea to Tutrakan and from Svishtov to Vidin;

Zone B (Б): Permanent disturbances in moisture supply are typical. In current climate this zone includes considerable territories with an altitude from 0 to 200 m a.s.l. in the northern half of the Danube plain, South Dobrudzha, part of the Thracian plain and Black Sea coast. In 2020 the zone covers almost entire Danube plain, West Dobrudzha, almost entire Thracian plain, Petrich-Sandanski region, Southern Black Sea coast and other areas below 300 m a.s.l. In 2050 zone B reaches up to 600 m a.s.l. and covers the Danube plain, Dobrudzha, Fore-Balkan, Thracian plain, Eastern Rhodopes, big part of Sredna Gora Mt., Strandzha Mt., Struma and Mesta river valleys. In 2080 it covers big part of the territories from 200 to 900 m a.s.l.;

Zone C (B): Disturbances in moisture supply only in certain years. Covers huge territories from 200 to 800 m a.s.l. in the southern part of the Danube plain, Fore-Balkan, Sredna Gora Mt., fields of West Bulgaria, Struma and Mesta river valleys, Eastern Rhodopes and Strandzha Mt. In 2020 covers the territories from 300 to 900 m a.s.l.; in 2050 – from 600 to 1000 m a.s.l. and in 2080 – from 900 to 1500 m a.s.l.;

Zone D (Г): This is the zone of optimal forestry production in Bulgaria with best moisture supply. Now it covers considerable part in mountains from 800 to 2000 m a.s.l. In 2020 this zone is expected to begin from 900 m and to reach up to the highest parts of mountains. In 2050 it shifts above 1000 m a.s.l. and in 2080 probably will begin above 1500 m a.s.l.;

Zone E (Д): This is the zone of overmoisturing, which is unfavourable for forests. This zone exists only in conditions of current climate. It covers areas above 2000 m a.s.l.

On this base, detailed measures for adaptation to climate changes of forest tree vegetation in Bulgaria were developed. These measures are conformed to the vulnerability zones for the country's conditions and institutions, necessary funds and terms for their realisation are determined. Total 116 measures were forecasted, 50 of them in zone A, 26 – in zone B (Б), 19 in zone C (B) and 11 in zone D (Г). Most of them are directly connected with the afforestation activities in the country. The development was accepted by the Ministry of Agriculture for introduction in the forestry sector of Bulgaria.

On the base of this development and especially of determined vulnerability zones, new "Classification scheme of forest site types in Republic of Bulgaria" and new "Instructions for determination and mapping of forest site types and determination of dendrocoenoses composition in Bulgaria" were developed in 2011 (Raykov et al. 2011). They will be the base of forest management planning in Bulgaria. Thus, all future activities in forestry sector of the country will be conformed to climate changes and adaptation of forests, as well as mitigation of climate changes impact on them. These two documents were improved by the Ministry of Agriculture and Food in Bulgaria in 2011 and are already applied in practice.

Conclusion

Investigations carried out so far in the field of climate changes influence on activities in afforestation and forestry sector in Bulgaria, as well as measures for adaptation of forest ecosystems to these changes in the environment, could be divided in the following stages:

Stage I: Investigation of reasons for decay of coniferous plantations in Bulgaria (1988-1993)

Stage II: Participation of Bulgaria in a big international investigation on climate change and adaptation of forests.

Stage III: Investigation on consequences of big drought period 1982-1994 as an analogue for future climate changes in Bulgaria and development of hypothesis for adaptation of forests.

Stage IV: Development of climatic scenarios for climate change in Bulgaria in the 21st century, definition of vulnerability zones of forest tree vegetation; determination of detailed measures for adaptation of forests to new conditions conformed to vulnerability zones in forests.

Stage V: Establishment of new classification scheme for forest sites types and new instruction for determination and mapping of forest sites types, as well as determination of dendrocoenoses composition in Bulgaria, developed on the base of vulnerability zones in forests in the 21st century.

It should be outlined that there is a good synchrony between scientific research in the field of climate changes and practical activities of forestry administration, which is important for the future success of afforestation activities in Bulgaria.

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РЕВИТАЛИЗАЦИЈА НА ОПОЖАРЕНИ ШУМСКИ ЕКОСИСТЕМИ ПРЕКУ ПРИРОДНО ОБНОВУВАЊЕ

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Апстракт

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Шумските екосистеми се еден од најзначајните столбови на растителниот и животинскиот биодиверзитет, но нивната стабилност и одржливост често пати е загрозувана од различни биотски, антропогени или абиотски фактори. Во одредени случаи настанува и до целосно уништување на одреден шумски екосистем. Во таквите случаи многу чест и многу сериозен причинител се шумските пожари, кои за кусо време опожаруваат големи шумски површини и значително го нарушуваат или целосно уништуваат шумскиот екосистем. Сепак, способноста за природно обновување како карактеристика на шумската дендрофлора е значаен фактор за повторно воспоставување на шумска вегетација на опожарените шумски површини и целосна ревитализација на шумскиот екосистем. Целта на овој труд е да се утврдат основите природни сукцесивни процеси на шумската дрвенеста вегетација кои се појавуваат некоку години по силен шумски пожар од кој целосно е уништен шумскиот екосистем. Со проучувањето на појавата, развитокот, квалитативните и квантитативни карактеристики на единките од природната обнова се добиени податоци за можноста и успешноста на ревитализацијата на опожариениот шумски екосситем. За таа цел извршени се теренски истражувања преку директни мерења и проучувања на природната обнова со методот на пробни површини. Добиените резултати укажуваат на тоа дека опожарената шумска површина постепено се ревитализира, првенствено со пионерски видови од шумската дендрофлора, но за целосна ревитализација на шумскиот екосистем е потребен долг временски период.

Клучни зборови: шумски екосистем, ревитализација, природна обнова, шумска дендрофлора, пионерски видови.

Abstract

Velkovski, N., Acevski J., Vasilevski K. & Simovski B. (2013). Rehabilitation of burned forest ecosystems by natural regeneration. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

The forest ecosystems are one of the most important foundations of the biological diversity concerning flora and fauna, but forest's natural balance and sustainability are often on impact and influence by wide spectra of biotic, anthropogenic or abiotic factors. In specific circumstances, some of the forest ecosystems can be totally destroyed. Namely, the wildfires, in particular forest fires can cause enormous consequences and devastating impact on forest ecosystems; for short period of time forest fires can burn large forest mass and make the forest ecosystem an erasure. Even so, the forest vegetation has a very important and essential ability- the dendrofloral capacity for natural regeneration, both vegetative and by seed, and for a period of time to re-establish and implicitly rehabilitate, i.e. to grew up and become a forest as it once was. The main purpose of this scientific paper is to determine and note the basic natural succession processes of the forest dynamics after forest fire, particularly the natural regeneration of the forest woody species. Thus, determination of the appearance, development, qualitative and quantitative characteristics of the individuals in a natural regeneration process were made and the data base was analyzed to see the possibility and efficiency of the rehabilitation of the burned forest ecosystem. Therefore, field examinations were made using direct measurements and research of the presence of the natural regeneration; the method of the sample plats

was used. The results indicate that burned forest area gradually and progressively regenerates, primarily with pioneer species of the forest dendroflora. After all, for complete rehabilitation of the forest ecosystem there is a need of a long period of time; eventually, the forest regenerates slowly, but assuredly.

Keywords: forest ecosystem, rehabilitation, natural regeneration, forest dendroflora, pioneer species.

Вовед

Една од најголемите опасности за шумските екосистеми, која во последните децении е сè поизразена и за краток временски рок уништува големи површини под шума се шумските пожари. Според податоците од инспекторатот при Министерството за земјоделство, шумарство и водостопанство на Република Македонија за периодот 2000-2011 година, на територијата со која управува ЈП „Македонски шуми“-Скопје биле регистрирани 3131 шумски пожар во кој е опожарена површина од 128187,45 ha и се изгорени 1251687,90 m³ дрвна маса. Во многу голем број случаи на местото на опожарените шумски екосистеми се вршат пошумувања, кадешто по вештачки пат се создаваат услови да се подигне и воспостави нов шумски екосистем. Сепак, оваа активност е недоволна за целосна ревитализација на опожарените екосистеми. Во процесот на ревитализација на шумскиот екосистем голема улога има способноста на шумските видови дрвја за самостојно природно обновување, кое може да биде од генеративно и/или вегетативно потекло. Одредени видови дрвја имаат посилни биоеколошки карактеристики од аспект на нивната способност за населување на опожарени шумски површини во однос на другите (Колевски и др. 2009). Во тој контекст, многу важна е градбата и големината на семето, како и начинот на негово разнесување. Најдобри предиспозиции за разнесување на поголеми растојанија од матичните насади имаат видовите дрвја кои располагаат со поситно семе, како и семе кое има крилца со што се олеснува разнесувањето на семето со помош на ветар на поголеми растојанија. Покрај тоа, од големо значење се и природните услови, пред сè педолошките, рељефните и климатските услови, кои имаат ограничувачка улога врз распространувањето и адаптацијата на сите видови на одредено подрачје. Истражувањето на природните- еколошките услови е особено важно, бидејќи од нив во голема мера зависи појавата, развитокот и опстанокот на природната обнова од шумските дрвја, а од суштинско значење за опстојувањето и трајниот одржлив развиток на шумските екосистеми е нивното природно обновување (Велковски и др. 2008).

Шумските пожари како природен феномен претставуваат многу сериозен и опасен фактор кој во краток временски интервал може да уништи големи површини од шумските екосистеми. Во тој поглед посебно се загрозени шумските екосистеми кои се составени од иглолисни видови дрвја, бидејќи поради нивниот состав, структура и голема количина на лесно запалив горлив материјал во многу случаи тие најчесто страдаат од шумски пожари. Таков шумски пожар, кој за кратко време од само неколку часови уништи голем шумски комплекс се случи на 24.07.2007 година на локалитетот „Паркач“ (Сл. 1), со кој стопанисува ШС „Малешево“ од Берово, во состав на ЈП „Македонски шуми“-Скопје.

Како последица на овој шумски пожар е опожарена шумска површина од 924 ha, од кои 458 ha под квалитетни црнборови и белборови шум-

Сл. 1. Момент од шумскиот пожар (2007)
Fig. 1. The forest fire (2007)

Сл. 2. Состојба после пожарот (2008)
Fig. 2. Situation after the forest fire (2008)

ски насади со возраст од 50 години и дрвна маса од повеќе од 60000 m³ (Посебен план за стопанисување со шумите од ШСЕ „Брегалница“-Берово, 2005-2014). Опожарените шуми биле настанати по природен пат преку населување на пионерски видови дрвја, пред сè црн бор (*Pinus nigra* Arn.) и бел бор (*Pinus silvestris* L.), на напуштени пасишта преку природно обновување. Во овие шумски насади во минатото се преземани шумско-одгледувачки мерки во два наврати- кастрење на гранки и изведување на прореди со слаб до умерен интензитет. Како резултат на тоа беше создаден еден стабилен, квалитетен и одржлив шумски екосистем во кој беа создадени и услови за негово самостојно обновување, како во однос на флората така и на фауната. Сепак, шумскиот пожар целосно го уништи овој шумски екосистем со што е направена голема штета на целокупниот растителен и животински биодиверзитет на подрачјето (Сл. 2 и 6).

Во првите две години од опожарувањето на шумскиот екосистем од страна на ШС „Малешево“ од Берово се извршени санитарни сечи и расчистување на опожарените површини, како и спроведување на шумски ред со што се создадени поволни предуслови за природно обновување (Сл. 3 и 4). По пет години од опожарувањето, на теренот е забележливо бројно присуство на единки од некои видови дрвја, грмушки и тревна вегетација. Меѓутоа, забележливо е отсуството на некои претставници од грмушестата дендрофлора, како што е синатa смрека (*Juniperus communis* L.), коишто вообичаено се појавуваат по необраснатите терени.

Набљудувајќи и следејќи го овој процес на постепено природно обновување, кое веќе 5 години се одвива на споменатите терени, решивме да извршиме теренски истражувања со цел да се утврди како се одвива процесот на природно обновување и во која насока ќе се движи природната сукцесија на шумската дендрофлора.

Материјал и методи

За проучување на ревитализацијата на опожарени шумски екосистеми преку природно обновување на локалитетот „Паркач“ се поставени 14 пробни површини со правоаголна форма и различни димензии. Во зависност од густината и големината на природната обнова, пробните површини се поставувани со дијаметри од 3x3 m, 4x4 m и 5x5 m. Пробните површини се поставувани на репрезентативни места според маршрутната метода и тоа: 4 пробни површини на северна експозиција, 3 на источна, 2 на западна, 2 на јужна и 3 на рамен терен. Во рамките на пробните површини извршени се биометриски мерења на обновата при што се утврдени височините и дијаметрите како основни биометриски показатели, од кои понатаму согласно методологијата на Шафар одредени се и развојните стадиуми на природната обнова. Во текот на мерењето извршена е и оцена на квалитетот и виталноста на единките од природната обнова. Сите измерени единки во пробните површини се групирани во три групи и тоа: I група се категоризирани сите единки кои се здрави и витални, имаат право стебленце и правилно развиена крошна. Во II група се категоризирани сите единки кои според своите квалитативни карактеристики заостануваат зад единките од прва категорија, но се во добра здравствена состојба, а во III група се категоризирани единките кои имаат лоша здравствена состојба, криво или усукано стебленце, неправилна крошна или други оштетувања поради што се со слаб квалитет и слаба виталност. Добиените податоци се запишувани во формулари, а потоа се математички обработени. Бројноста на обновата на 1 ha е одредена како производ од количникот помеѓу бројот на единките во пробната површина и големината на конкретната пробна површина помножен по големината изразена во квадратни метри содржани во 1 ha. Од добиените податоци за се-

Сл. 3. Изведување на санитарни сечи (2008)
Fig. 3. Forest sanitary cuts (2008)

Сл. 4. Спроведување на шумски ред (2008)
Fig. 4. Forest clean implementation (2008)

која пробна површина пресметана е бројноста на единките на единица површина од 1 ha, а податоците се изнесени во табели. Понатаму, извршена е компарација со податоците добиени од други истражувања на други локалитети констатирани во слични истражувања. Употребената номенклатурата на шумските заедници е според *Prodromus phytocoenosum Jugoslaviae* (1986), а научните и народните називи на шумската дендрофлора според Џеков (1988) и Ем (1967).

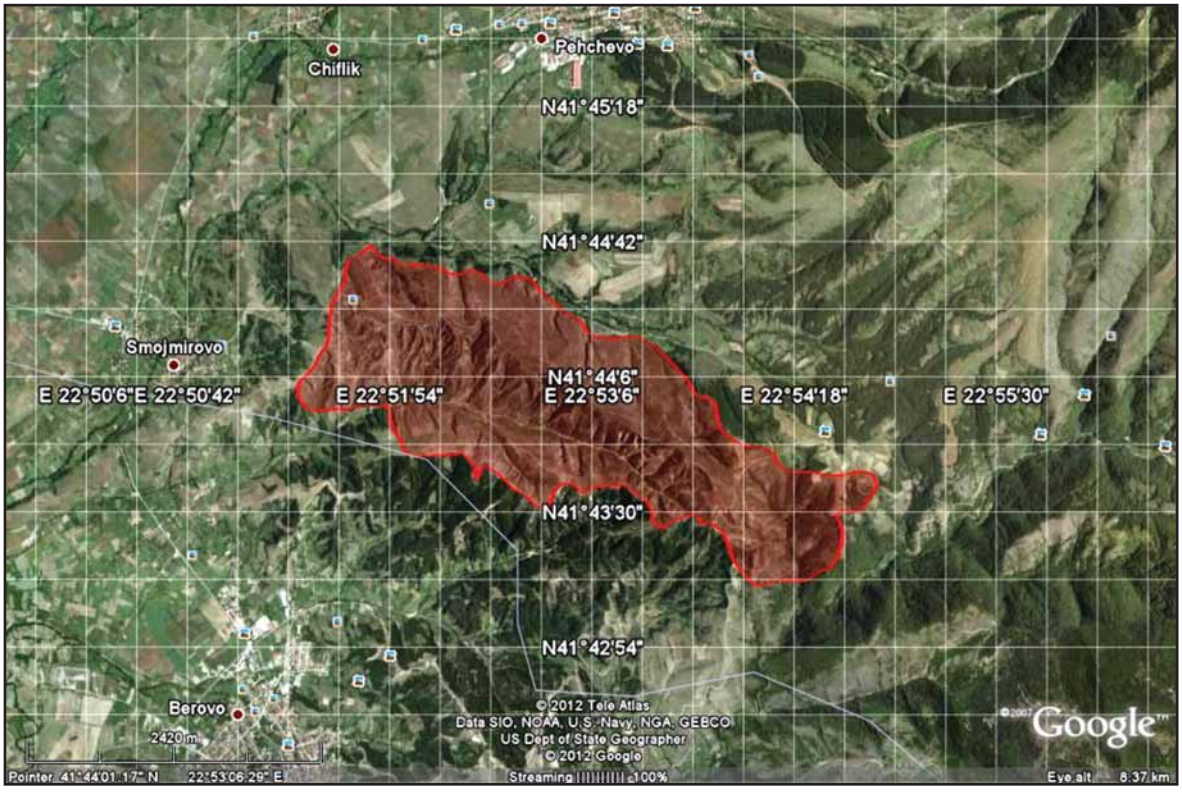
Истражувано подрачје

За подрачје на истражување е избран локалитетот „Паркач“ кој се наоѓа во источниот дел на Република Македонија (Сл. 5). Истражуваното подрачје опфаќа површина од 924 ha и се наоѓа на надморска височина од 950 до 1070 m. Според Филиповски и др. (1996), на ова подрачје преовладува ладната континентална клима со одредено влијание на планинската клима. Средната годишна температура пресметана според кривите на вертикалните градиенти за ова подрачје изнесува од 8,6 до 9,6ºC, или средно околу 9ºC. Просечното количество на врнежи изнесува од 800 до 850 mm, а средната годишна релативна влажност на воздухот 75%. Геолошката подлога е силикатна и на неа е распространета средно длабока почва, свежа, со тенок слој на хумус и литинец од типот еутричен камбисол. Почвениот тип на истражуваното подрачје се карактеризира со висок процент на учество на глина и песок.

Во границите на истражуваното подрачје е застапена шумската асоцијација на даб цер и даб плоскач *Quercetum frainetto-cerris macedonicum* Em H. at Oberd. 1948.

Резултати

Истражуваното подрачје според климатско-вегетациско-почвеното реонирање на Република Македонија припаѓа во ладно континенталното подрачје (Филиповски и др. 1996). И покрај тоа што ова е подрачје кадешто вообичаено доминира климазоналната асоцијација *Orno-Quercetum petraeae* Em 1968 (шумска заедница на дабот горун и црниот јасен), во овој дел на Република Македонија или поточно на овие ограноци на Малешевските Планини тоа е подрачје каде климазонално е застапена асоцијацијата *Quercetum frainetto-cerris macedonicum* Em H. at Oberd. 1948 (шумска заедница на даб цер и даб плоскач). Кон тоа придонеле севкупните природни услови, историски околности, како и биоеколошките особини на видовите. Во такви природни услови на местото на опожарениот шумски екосистем, претежно составен од црн и бел бор со единечни или примеси во мали групи од плоскач и цер,



Сл. 5. Местоположба и граници на истражуваното подрачје
Fig. 5. Location of the study/investigated area

веќе после 5 години од опожарувањето се развива бројна природна обнова од следните шумски видови дрвја: бел бор, плоскач, цер, коза врба, црн бор и јасика. На подрачјето се застапени и поголем број на грмушести и тревести растенија, а поединечно и некои видови од дивата овошна флора, како што се: *Epilobium angustifolium, Rosa canina, Rosa arvensis, Rubus tomentosus, Rubus fruticosus, Ononis spinosa, Crategus monogina, Cytisus leucantus, Hypericum sp., Sorbus torminalis, Pyrus pyraster, Pyrus amigdaliformis, Prunus spinosa* и др. Со ова истражување се опфатени единките од природната обнова од шумските видови дрвја, а добиените податоци се изнесени во шест прегледни табели (Таб. 1, 2, 3, 4, 5, 6), како што следува подолу.

Од изнесените податоци во Табела 1 се забележува дека на источна експозиција се среќаваат по 25000 единки на хектар. Од нив, најзастапена е природната обнова од бел бор со 50%

Таб. 1. Бројност и квалитет на единките од природната обнова на 1 ha на источна експозиција

Tab. 1. Frequency and quality of the offspring of the natural regeneration on 1 ha on East light meter (exposition)

Вид / Квалитет Species / Quality	**добар good**	**%**	**среден medium**	**%**	**лош bad**	**%**	**вкупно total**	**%**
***Quercus frainetto* (плоскач)**	4 667	65	1 622	23	822	12	7 111	**28**
***Quercus cerris* (цер)**	667	72	134	14	133	14	934	**4**
***Salix caprea* (коза врба)**	2 600	66	1 222	31	133	3	3 955	**16**
***Pinus silvestris* (бел бор)**	4 867	39	3 667	29	4 066	32	12 600	**50**
***Pinus nigra* (црн бор)**	267	67	133	33	-	-	400	**2**
Вкупно / Total	**13 068**	**52**	**6 778**	**27**	**5 154**	**21**	**25 000**	**100**

Таб. 2. Бројност и квалитет на единките од природната обнова на 1 ha на западна експозиција

Tab. 2. Frequency and quality of the offspring of the natural regeneration on 1 ha on West exposition

Вид / Квалитет Species / Quality	**добар good**	**%**	**среден medium**	**%**	**лош bad**	**%**	**вкупно total**	**%**
***Quercus frainetto* (плоскач)**	1 200	67	400	22	200	11	1 800	**8**
***Quercus cerris* (цер)**	600	60	200	20	200	20	1 000	**4**
***Salix caprea* (коза врба)**	6 400	49	4 800	36	2 000	15	13 200	**60**
***Pinus silvestris* (бел бор)**	1 600	47	1 230	36	600	17	3 430	**16**
***Pinus nigra* (црн бор)**	400	50	200	25	200	25	800	**4**
***Populus tremula* (јасика)**	1 200	67	400	22	200	11	1 800	**8**
Вкупно / Total	**11 400**	**52**	**7 230**	**33**	**3 400**	**15**	**22030**	**100**

Таб. 3. Бројност и квалитет на единките од природната обнова на 1 ha на северна експозиција

Tab. 3. Frequency and quality of the offspring of the natural regeneration on 1 ha on North exposition

Вид / Квалитет Species / Quality	**добар good**	**%**	**Среден Medium**	**%**	**лош bad**	**%**	**вкупно Total**	**%**
***Quercus frainetto* (плоскач)**	1 100	69	200	12	300	19	1 600	**5**
***Quercus cerris* (цер)**	900	53	500	29	300	18	1 700	**6**
***Salix caprea* (коза врба)**	3 800	59	2 000	31	600	10	6 400	**21**
***Pinus silvestris* (бел бор)**	6 800	33	5 800	28	7 900	39	20 500	**67**
***Pinus nigra* (црн бор)**	100	50	100	50	-	-	200	**1**
Вкупно / Total	**12 700**	**42**	**8 600**	**28**	**9 100**	**30**	**30 400**	**100**

и дабот плоскач со 28% од вкупниот број единки. Значително учество има и козјата врба (*Salix caprea* L.) со 16%. Најголем број од единките на природната обнова на источна експозиција се со добар квалитет (52%), потоа со среден квалитет (27%), а најмал со лош квалитет (21%).

Од изнесените податоци во Табела 2 се забележува дека на западна експозиција се среќаваат по 22030 единки на хектар. Од нив најзастапена е природната обнова од козјата врба со 60%, а потоа белиот бор со 16%. Бројноста на другите видови е помала од 10%. Најголем број од единките на природната обнова се со добар квалитет (52%), потоа со среден квалитет (33%), а најмал со лош квалитет (15%).

Од изнесените податоци во Табела 3 се забележува дека на северна експозиција се среќаваат по 30400 единки на хектар. Од нив најзастапена е природната обнова од белиот бор со 67%, а потоа од козјата врба со 21%. Бројноста на другите видови е под 10%. Најголем број од единките на природната обнова се со добар квалитет (42%). Исклучок се забележува кај природната обнова од бел бор, каде најголем дел од единките се со лош квалитет (39%).

Од изнесените податоци во табела 4 се гледа дека на јужна експозиција се среќаваат по 19600 единки на хектар. Од нив најзастапена е природната обнова од козјата врба со 32%, а потоа дабот плоскач 18%. Со по 14% се застапени дабот цер и јасиката (*Populus tremula* L.), а бројноста на белиот и црниот бор изнесува 12%, односно 10%. Најголем број од единките на природната обнова се со добар квалитет (60%), потоа со среден квалитет (23%), а најмал со лош квалитет (17%).

Од изнесените податоци во табела 5 се гледа дека на рамен терен се среќаваат по 23377 единки на хектар. Од нив најзастапена е природната обнова од белиот бор со 54%, а потоа дабот плоскач 16%, дабот цер 11%, козјата врба со 14% и црниот бор со 5%. Најголем број од единките на природната обнова се со добар квалитет (59%), потоа со среден квалитет (31%), а најмал со лош квалитет (10%).

Покрај наведеното, извршени се и истражувања на развојните стадиуми во кои се наоѓа природната обнова. Истражувањата се изведени според класификацијата на Шафар, согласно која единките од природната обнова се двојат во посебни развојни стадиуми. Имајќи предвид дека се работи за релативно млада природна обнова од 5 години, проучувањата се насочени кон развојните стадиуми подмладок и младик, а тие, пак, се двојат во два потстадиуми: подмладок (неодрас-

Таб. 4. Бројност и квалитет на единките од природната обнова на 1 ha на јужна експозиција

Tab. 4. Frequency and quality of the offspring of the natural regeneration on 1 ha on South exposition

Вид / Квалитет **Species / Quality**	**добар** **good**	**%**	**среден** **medium**	**%**	**лош** **bad**	**%**	**вкупно** **Total**	**%**
Quercus frainetto **(плоскач)**	2 000	59	1 000	29	400	12	3 400	**18**
Quercus cerris **(цер)**	1 600	57	800	29	400	14	2 800	**14**
Salix caprea **(козја врба)**	4 200	68	1 200	19	800	13	6 200	**32**
Pinus silvestris **(бел бор)**	1 000	42	600	25	800	33	2 400	**12**
Pinus nigra **(црн бор)**	1 200	60	400	20	400	20	2 000	**10**
Populus tremula **(јасика)**	1 800	64	600	21	400	15	2 800	**14**
Вкупно / Total	**11 800**	**60**	**4 600**	**23**	**3 200**	**17**	**19 600**	**100**

Таб. 5. Бројност и квалитет на единките од природната обнова на 1 ha на рамен терен

Tab. 5. Frequency and quality of the offspring of the natural regeneration on 1 ha on plateau / flat terrain

Вид / Квалитет **Species / Quality**	**добар** **good**	**%**	**среден** **medium**	**%**	**лош** **bad**	**%**	**вкупно** **Total**	**%**
Quercus frainetto **(плоскач)**	2 148	58	904	25	637	17	3 689	**16**
Quercus cerris **(цер)**	1 274	50	770	30	504	20	2 548	**11**
Salix caprea **(козја врба)**	2 281	69	637	19	400	12	3 318	**14**
Pinus silvestris **(бел бор)**	7 096	56	4 978	39	637	5	12 711	**54**
Pinus nigra **(црн бор)**	1 111	100	-	-	-	-	1 111	**5**
Вкупно / Total	**13 910**	**59**	**7 289**	**31**	**2 178**	**10**	**23 377**	**100**

нат = НП и одраснат = ОП) и младик (неодраснат = НМ и одраснат = ОМ).

Од извршените теренски мерења добиените податоци се изнесени во Табела 6.

Од изнесените податоци во Табела 6 се гледа дека најголем процент од единките од даб плоскач (*Quercus frainetto* L.) се во развојниот стадиум неодраснат младик. Тој процент се движи од 47% на северна експозиција до 83% на источна експозиција. Најмало е учеството на единките во развојниот стадиум одраснат младик, кое се движи од 1% на јужна експозиција и на рамен те-

Таб. 6. Бројност и застапеност на природната обнова според развојни стадиуми

Tab. 6. Frequency and representation of the natural representation regarding growth stadium of the species

Разв. стад./Вид Growth stad./Sp.	***Q. frainetto*** **(плоскач)**		***Q. cerris*** **(цер)**		***S. caprea*** **(коз ја врба)**		***P. silvestris*** **(бел бор)**		***P. nigra*** **(црн бор)**		***P. tremula*** **(јасика)**	
	n	**%**	**N**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Источна експозиција / East exposure (light meter)												
НП a=1-5, h<30 cm	356	5	28	3	237	6	1134	9	40	10	0	0
ОП a=5-10, h<130 cm	640	9	75	8	3441	87	11466	91	360	90	0	0
НМ a=10-15, d<3 cm	5902	83	784	84	277	7	0	0	0	0	0	0
ОМ a=15-20, d<10 cm	213	3	47	5	0	0	0	0	0	0	0	0
Западна експозиција / West exposure (light meter)												
НП a=1-5, h<30 cm	54	3	20	2	528	4	377	11	64	8	18	1
ОП a=5-10, h<130 cm	360	20	160	16	11616	88	3053	89	734	92	1764	98
НМ a=10-15, d<3 cm	1350	75	780	78	1056	8	0	0	0	0	18	1
ОМ a=15-20, d<10 cm	36	2	40	4	0	0	0	0	0	0	0	0
Северна експозиција / North exposure (light meter)												
НП a=1-5, h<30 cm	112	7	102	6	320	5	410	2	4	2	0	0
ОП a=5-10, h<130 cm	656	41	544	32	5248	82	20090	98	196	98	0	0
НМ a=10-15, d<3 cm	752	47	901	53	832	13	0	0	0	0	0	0
ОМ a=15-20, d<10 cm	80	5	153	9	0	0	0	0	0	0	0	0
Јужна експозиција / South exposure (light meter)												
НП a=1-5, h<30 cm	170	5	112	4	124	2	24	1	60	3	28	1
ОП a=5-10, h<130 cm	1088	32	812	29	5580	90	2376	99	1940	97	2492	89
НМ a=10-15, d<3 cm	2108	62	1820	65	496	8	0	0	0	0	280	10
ОМ a=15-20, d<10 cm	34	1	56	2	0	0	0	0	0	0		0
Рамен терен / Plateau, flat terrain (up to 5%)												
НП a=1-5, h<30 cm	74	2	51	2	99	3	127	1	33	3	0	0
ОП a=5-10, h<130 cm	1033	28	611	24	2754	83	12584	99	1078	97	0	0
НМ a=10-15, d<3 cm	2545	69	1835	72	465	14	0	0	0	0	0	0
ОМ a=15-20, d<10 cm	37	1	51	2	0	0	0	0	0	0	0	0

рен до 5% на северна експозиција. Во развојниот стадиум одраснат подмладок се застапени поголем број единки (од 9% на источна до 41% на северна експозиција), за разлика од неодраснатиот подмладок каде процентуалната застапеност на единките е меѓу 2% на рамен терен до 7% на северна експозиција.

Кај природната обнова од даб цер (*Quercus cerris* L.) во развојниот стадиум одраснат младик, единките достигнале меѓу 2% на јужна експозиција и рамен терен до 9% на северна експозиција. Најголем број од природната обнова од овој вид се наоѓа во развојниот стадиум неодраснат младик и тоа од 53% на северна експозиција до 84% на источна експозиција. Само мал дел од природната обнова е заостаната во развојниот стадиум неодраснат подмладок чиј што број се движи од 2% на рамен терен и западна експозиција до 6% на северна експозиција.

Природната обнова од козјата врба (*Salix caprea* L.) сеуште не го достигнала развојниот стадиум одраснат младик. Најголем дел од природната обнова од овој вид се наоѓа во развојниот стадиум одраснат подмладок и тоа од 82% на северна до 90% на јужна експозиција. Развојниот стадиум неодраснат младик го достигнале меѓу 7% од единките на источна експозиција до 14% на рамен терен. Бројот на единки кои заостанале во развојниот стадиум неодраснат подмладок се движи меѓу 2% на јужна и 6% на источна експозиција.

Природната обнова од бел бор (*Pinus silvestris* L.) и црн бор (*Pinus nigra* Arn.) е застапена само во развојните стадиуми неодраснат подмладок и одраснат подмладок и тоа во доминантен број во одраснат подмладок, кој кај белиот бор се движи од 89% на северна експозиција до 99% на рамен терен и јужна експозиција. Кај црниот бор бројот на единки кои се застапени во развојниот стадиум неодраснат подмладок се движи меѓу 2% на северна до 10% на јужна експозиција. Сите други единки се во развојниот стадиум одраснат младик.

Природна обнова од јасика (*Populus tremula* L.) е застапена само на јужна и западна експозиција и таа генерално се наоѓа во развојниот стадиум одраснат подмладок, односно 89% на јужна до 98% на западна. Само 10% од природната обнова од јасика и тоа на јужна експозиција достигнал развоен стадиум неодраснат младик, а 1% од единките се во развојниот стадиум неодраснат подмладок.

Дискусија

Бројноста на единките од природната обнова без разлика за кој дел од теренот се работи е задоволителна. Таа е најмала на јужна експозиција и изнесува 19600 единки/ha, а најголема на северна експозиција и изнесува 30400 единки/ha. Оваа бројност се приближува до бројноста на природната обнова за конкретната возраст (од 5 години), која е карактеристична за стопанските шуми кои се предмет на обновителни процеси. Така при обновување на буковите шуми во централните делови на Стара планина утврдени се 31000 до 63000 единки/ha од бука на 6-годишна возраст (Неделин 1991). На Шипченска планина во букови шуми при возраст на подмладокот од 3-5 години утврдено е дека неговата бројност се движи од 15000 до 78000 единки/ha (Ефремов 1987). Во проучувањата на природната обнова од бел бор на планинскиот масив Нице утврден е најголем број на единки при склопеност од 20%. Притоа се утврдени 28070 единки/ha (Баткоски 1977). Големата бројност на природната обнова е добар показател за целосно обновување на опожарените површини. Сепак, распоредот на застапеност на шумските видови дрвја варира во прилично голема мера во зависност од тоа на која експозиција се распространети. На рамен терен, на северна и источна експозиција преовладува природната обнова од бел бор и таа сочинува 50 до 67% од природната обнова. На овие експозиции забележливо учество до 28% имаат дабот плоскач и козјата врба. На потоплите експозиции, западна и јужна, преовладува природната обнова од лисјарски видови дрвја. Така, на западна експозиција, 60% од единките од природната обнова се од козја врба, 8% од даб плоскач, 4% даб цер и 8% јасика. Учеството на иглолисните видови на оваа експозиција е значително помало и за белиот бор тоа изнесува 16%, а за црниот бор 4%. Ако на ова се додаде дека само 47% од единките од бел бор и 50% од единките од црн бор се со добар квалитет, тоа укажува дека на оваа експозиција развитокот на шумскиот екосистем ќе се одвива во насока на доминација на лисјарските видови: козјата врба, дабовите и јасиката. Слична е состојбата и на јужна експозиција со таа разлика што во овој дел учеството на врбата не е толку доминантно и изнесува 32%, а има зголемено учество на дабовите и тоа на плоскачот 18% и на церот и јасиката по 14%. Таму учеството на иглолисните видови бел бор и црн бор е недоволно и изнесува 12 и 10%. Квалитетната структура на белиот бор е прилично слаба бидејќи само 42% од единките се со добар квалитет, што укажува и на послабата виталност на овие единки. Кај црниот бор таа е нешто подобра и изнесува 60% единки со добар квалитет. Вакватa состојба со природната обнова на оваа експозиција создава услови за создавање на мешан шумски насад составен од лисјарски и иглолисни видови во којшто поголемо учество во смесата во следниот временски период ќе имаат лисјарските видови дрвја.

Сл. 6. Опожарени борови и даб (2007)

Fig. 6. Burned pines and oak (2007)

Сл. 7. Природна обнова од даб (2010)

Fig. 7. Natural regeneration of the oak (2010)

Во поглед на квалитетот и виталноста на природната обнова, забележлив е високиот процент на единки со добар квалитет кој кај дабовите се движи меѓу 50 и 72%. На ова придонесуваат вкупните природни услови бидејќи овој тип на месторастење е многу поволен за развиток на плоскачот и церот. Висок процент на учество на единки со добар квалитет има и кај јасиката 64 до 67%, како и кај козјата врба од 49 до 69%. Меѓутоа, поради послабите биоеколошки карактеристики на овие два вида во однос на другите шумски видови дрвја, може да се очекува дека во следните развојни стадиуми на шумата нивното учество постепено ќе се намалува.

Во однос на развојните стадиуми на шумата, забележливо е дека природната обнова од бел бор и црн бор (од 89% до 99%) е застапена само во првите развојни стадиуми неодраснат подмладок и одраснат подмладок и значително заостанува во однос на другите лисјарски видови. Во понапреден стадиум се јасиката и козјата врба чии единки достигнале и во развојниот стадиум неодраснат младик со процентуална застапеност од 1 до 14%.

Најбрз развиток во петте години после шумскиот пожар имаат дабовите плоскач и цер. Тие во најголем процент се наоѓаат во развојниот стадиум неодраснат младик со застапеност меѓу 47 и 84%. Одреден дел од природната обнова со застапеност меѓу 1 и 9% веќе е преминат во развојниот стадиум одраснат младик. Во соодносот помеѓу двата вида од даб, малку понапреден во развитокот е дабот цер.

Сл. 8. Природно обновување (2012)

Fig. 8. Natural regeneration (2012)

Најбрзо после пожарот во првите две години се појавила природната обнова од даб плоскач и даб цер, која е од изданково потекло (Сл. 7). Ваквата природна обнова, поради резервите од хранливи материи во кореновите системи во првите години, многу брзо се развива и затоа само за 5 години некои единки достигнале во развојниот стадиум одраснат младик.

За одбележување е отсуството на модрата смрека (*Juniperus communis* L.), пионерски вид што обично првенствено ги населува отворените/примарните месторастења (Ацевски и Симовски, 2012), како и малото учество на црниот бор.

Треба да се има предвид дека изнесената фактичка состојба со природното обновување го отсликува петгодишниот развиток на шумската вегетација после целосно опожарен шумски екосистем. Оваа состојба во иднина ќе се менува поради конкурентската борба меѓу единките и видовите. Во тој процес на природна селекција треба да се очекува преовладување на единките од генеративно потекло над оние од изданково, бидејќи тие во следниот период побрзо ќе прирастуваат во височина. Бројноста на единките на сите експозиции ќе се намалува, а првенствено со селекција ќе бидат зафатени оние со лош квалитет и слаба виталност. Бидејќи за целосно ревитализирање на шумскиот екосистем ќе биде потребен подолг временски период, јасно се наметнува потребата од понатамошни истражувања и мониторинг над природните сукцесивни процеси. Перманентното следење на овие процеси ќе биде значаен придонес кон проучувањето на природната сукцесија која што се случува на ова подрачје и на слични опожарени шумски екосистеми.

Заклучок

Главната улога во процесот на природно обновување на опожарениот шумски екосистем ја имаат следните видови дрвја: дабот плоскач (*Quercus frainetto* L.), дабот цер (*Quercus cerris* L.), козјата врба (*Salix caprea* L.), белиот бор (*Pinus silvestris* L.), црниот бор (*Pinus nigra* Arn.) и јасиката (*Populus tremula* L.).

Бројноста и квалитетната структура на природната обнова укажуваат на тоа дека опожарениот шумски екосистем успешно ќе се обнови по природен пат.

Различната застапеност на одредени видови во различни делови од локалитетот во зависност од експозицијата на теренот укажуваат дека обновувањето нема да биде рамномерно во сите делови. На потоплите експозиции во следниот период со значително учество ќе бидат лисјарските видови, а на другите делови ќе доминира белиот бор.

Дабовите се во повисоки развојни стадиуми поради нивното изданково потекло, кое се одликува со силна способност за побрз растеж во првите години. Поради тоа, тие се во повисоки развојни стадиуми на шумата во однос на другите видови, а особено во однос на црниот и белиот бор (Сл. 8). Сепак, во следните развојни стадиуми може да се очекува приближување поради тоа што видовите од генеративно потекло, се разбира доколку се развиваат во поволни услови, после одреден период ќе ги достигнат и надминат единките и видовите кои се од изданково потекло.

Опожариениот шумски екосистем на локалитетот „Паркач“ целосно ќе се обнови, но со значително учество на лисјарски видови дрвја и за подолг временски период.

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Summary

The forest ecosystems are one of the most important biodiversity foundations, but they are often on impact and influence by various factors. The wildfires, in particular forest fires are one of the most common factors and can cause enormous consequences and devastating impact on forest ecosystems. In addition, forest fires can burn large forest mass and make the forest ecosystem an erasure. But, the forest vegetation has a very important ability- the dendrofloral capacity for natural regeneration and for a period of time to re-establish and implicitly rehabilitate.

Certain species that have an ability for quickly inhabit and thrive on a burnt area are very significant for the natural regeneration of the forest ecosystem. Therefore, in the investigated area at the locality of Parkach the main role of the rehabilitation process has been determined by the following species: Hungarian oak (*Quercus frainetto* L.), Turkey oak (*Quercus cerris* L.), goat willow (*Salix caprea* L.), Scots pine (*Pinus silvestris* L.), black pine (*Pinus nigra* Arn.), and aspen (*Populus tremula* L.). The frequency and the quality structure of these woody species indicate the natural regeneration and rehabilitation of the forest ecosystem. However, the development of the rehabilitation would not be simultaneous and equal on the total area, i.e. broadleaf will cover warmer sites- southern and western light meters, and the other sites- Scots pine. The oaks due to their vegetative origin are in higher development stadiums. Therefore, *Quercus frainetto* L. and *Quercus cerris* L. have increased growth in the first years compared to the *Pinus silvestris* L. and *Pinus nigra* Arn. (because of the seed/generative origin). These pines will up-growth the oaks subsequently, and gain greater heights afterwards.

It is important to note that the forest regenerates slowly, but assuredly. Eventually, the complete rehabilitation of the forest ecosystem by natural regeneration needs a long period of time.

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ЕКОЛОГИЈА И ДИСТРИБУЦИЈА НА ГАБИТЕ ОД ТИПОТ *ASCOMYCOTA* НА ПЛАНИНСКИОТ МАСИВ ДОБРА ВОДА

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Извод

Мурати, Е. и Караделев, М. (2013). Екологија и дистрибуција на габите од типот *Ascomycota* на планинскиот масив Добра Вода. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 28, Скопје.

Во трудот се опфатени резултати од еко-таксономските истражувања на габите од типот Ascomycota. Истите се вршени во период од 2002 до 2009 година, а најинтензивно од 2002 до 2003 и од 2006 до 2008 година, на различни локалитети на планинскиот масив Добра Вода. За овој дел на Република Македонија не постојат многу податоци за диверзитетот на аскомицетите. Во студијата беа истражувани териколните и лигниколните аскомицети кои се развиваат на различни шумски и ливадски заедници и различни супстрати.Утврдени беа вкупно 33 вида, од кои 19 се териколни и 14 вида селигниколни.Најзастапени редови се Pezizales со 17 вида, Xylariales (5) и Helotiales (4), а најзастапени фамилии се: Pyronemataceae со 5 вида, Morchellaceae со 4 вида, Pezizaceaeco 3 вида, Xylariaceae со 3 вида итн. Како најчести видови аскомицети на планината Добра Вода можеме да ги истакнеме следните: *Bisporella citrina, Diatrype disciformis, D.stigma, Hypoxylon fuscum, Morchella conica, Nectria cinnabarina, Rhytisma acerinum* и*Xylaria hypoxylon*. Од вкупниот број на видови, 22 вида се сапроби, додека 11 вида се микоризни или паразитски видови.

Клучни зборови: аскомицети, габи, дистрибуција, екологија, Добра Вода, Македонија.

Abstract

Murati, E. and Karadelev, M. (2013). Ecology and distribution of ascomycota fungi in Dobravoda mountain massive. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

This paper includes results from eco-taxonomic studies of fungi such as Ascomycota. The study was conducted during the period from 2002 to2009, most intensively from 2002 to 2003 and from 2006 to 2008, on various localities of the mountain massive Dobra Voda. There has not been much data on the diversity of Ascomycetes for this part of Macedonia. Terricolous and lignicolous ascomycetes that develop in different forest and meadow associations on different substrates were studied. A total of 33species were established, 19 of which tericolous and 14 lignicolous. The most common orders were: Pezizales with 17 species, Xylariales (5) and Helotiales (4).The most represented families were as follows: Pyronemataceae with 5 species, Morchellaceae with 4 species, Pezizaceae and Xylariaceae with 3 species each respectively etc.The most common Ascomycetes species in Dobra Voda Mountain are the following: *Bisporella citrina, Diatrype disciformis, D.stigma, Hypoxylon fuscum, Morchella conica, Nectria cinnabarina, Rhytisma acerinum, Xylaria hypoxylon* etc.Of the total number of species, 22 species are saprobionts, while 11 species are mycorrhyzal or parasitic species.

Keywords: Ascomycetes, fungi, distribution, ecology, Dobra Voda, Macedonia

Вовед

Република Македонија е миколошки релативно добро истражена. Во последно време се вршат континуирани систематски истражувања во одредени региони од земјата и тоа најчесто во Бистра, Пелистер, Јакупица, Галичица, Кожуф, Шар Планина, Јужно Повардарие итн. Првите истражувања во територијата на Р. Македонија ги направил Ранојевиќ (1909), потоа следуваат

Sydow (1921), Lindtner (1950, 1957), Litschauer (1939). Значаен придонес за макромицетите на Р.Македонија дава Тортиќ (1975, 1977, 1979) која врши систематски истражувања на габите во одделни региони во земјата (Пелистер, Јакупица). Во поново време миколошки истражувања во различни делови на Република Македонија интензивно врши Караделев (2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012). Врз база на досегашните истражувања во Република Македонија е утврдено присуство на над 2000 вида на макромицети. Од нив на типот Ascomycota му припаѓаат околу 300 видови додека на Basidiomycota над 1700 видови. Податоци за досегашни миколошки истражувања на планината Добра Вода даваат Караделев, Сулејмани и Мурати (2008) и Караделев и Мурати (2008). Овие се први подетални истражувања и податоци за аскомицетите на планинскиот масив Добра Вода. Истражувањата се вршени во дабовата заедница Quercetum frainetto-cerris macedonicum, буковата заедница Calamintho grandiflorae-fagetum, во азонална вегетација, покрај реките и потоците. Во овој труд се дадени подетални податоци и резултати за дистрибуцијата и екологијата на аскомицетите на планинскиот масив Добра Вода. Овие податоци се резултат на истражувањата вршени во периодот од 2002 до 2009 год.

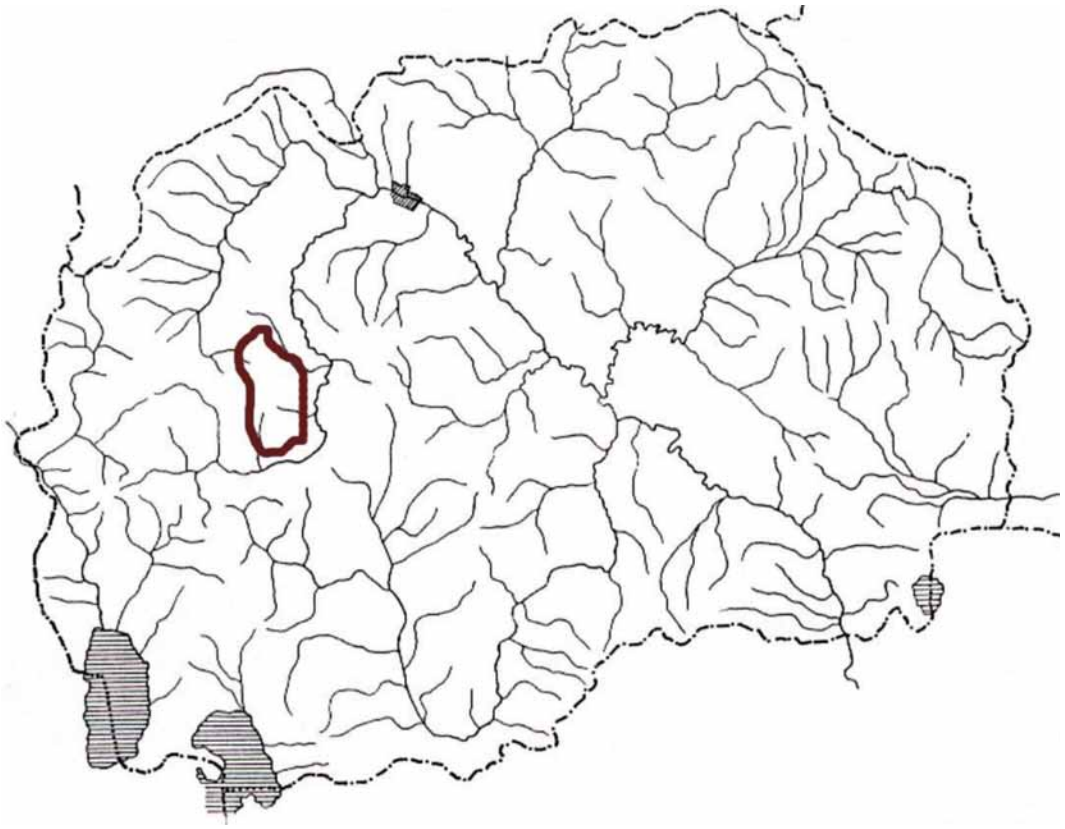
Материјали и методи на работа

Миколошкиот материјал е собиран на различни локалитети во истражуваното подрачје. За секој вид се колектирани по неколку по неколку примероци, неопходни за подетална анализа. Идентификацијата на собраниот материјал се вршеше во Миколошката лабораторија при институтот за Биологија, на ПМФ-Скопје. За детерминација и систематизација на видовите се користени најновите клучеви и монографии на познати европски и светски автори за аскомицетите како што се: Ahti et al. (2000), Boertmann et al. (1992), Breitenbach & Kranzlin (1981), Corfixen et al. (1997), Eriksson et al. (1975-1985), Alessio (1985), Mosser (1983), Horak (2005,1986), Eriksson, (Hjortstam)& Ryvarden (1975-1985) и други. Кај некои видови се направени измени според номенклатура на Index Fungorum 2012 и Mycobank. Од секој вид, еден дел е исушен, презервиран, потоа е етикетиран со главните податоци (локалитет, надморска височина, датум на собирање, итн) и зачуван во базата на податоци (MACFUNGI). За секој регистриран вид (таксон) во рамките на поглавјето ,, Резултати и дискусија,, се наведени следните податоци:

- Име на видот на латински со повисоките систематски категории (род, фамилија, ред, тип)
- Субстрат каде е најден (почва, живо дрво, пенушка, гранки, лисја)
- Шумската заедница (букова, дабова, азонална вегетација)
- Животна форма (паразит, сапроб или микоризен вид)
- Податоци за наоѓалиштето на видот (надморска височина)
- Датум на наоѓање
- Фреквенција и честота на појавување
- Информации за лицето што го собрал и/или детерминирал видот
- Дали е нов вид за Р. Македонија.

Опис на истражуваното подрачје

Планинскиот масив Добра Вода, со најголемиот врв Добра Вода (2062м) се протега во северниот дел на Кичевската Котлина (Сл. 1) и заедно со планината Буковиќ претставува гранична рамка кон Полошката Котлина. Тој претсавува јасен хидрографски јазел помеѓу сливот на реката Лакавица на север и Треска на југ и исток, а кон југозапад стрмно се спушта кон дното на Кичевската Котлина (Андоновски, 1984). Источно од Добра Вода се надоврзуваат Скала (1826), Белези Планина (1754) и Туинска Планина (Туинско Кале, 1808м), кои претставуваат еден континуиран планински венец со генерален правец на протегање север-северозапад и југ-југоисток. Во подрачјето на планинскиот масив Добра Вода доминираат дабови и букови шумски заедници, низ кои се протегаат и други заедници, главно од азонален тип на дистрибуција. Регистрираните видови се истражувани исклучиво на територијата на Добра Вода, претежно во пролетните месеци во годината. Истражувањата се вршени во заедници на азонална вегетација, на опожарени места, во дабови заедници и борови насади.Многу интензивни и доста чести истражувања се вршени во овие локалитети: Шумјак, кој се наоѓа помеѓу селата Доленци, Поповјани и Туин на 750-850м; Радилица, кое се наоѓа помеѓу атарите на селата Јагол и Папрадишта; Рамниште (850-950 м) кое се наоѓа помеѓу селата Доленци и Папрадишта; Горица, во близина на селото Поповјани. Исклучително значаен локалитет е местото наречено Поповјански Лаг во атарите на с.Поповјани (азонална вегетација со *Populus, Salix, Alnus* итн). Во буковата заедница *Calamintho grandiflorae-Fagetum* позначајни локалитети се околините на селата Ќафа и Папрадишта. Сите видови се регистрирани на територијата на Добра Вода со исклучок само на еден вид (*Anthracobia subatra*) кој е собран во близина на селото Премка, кое се наоѓа во падините на планината Челоица.



Сл. 1. Географска положба на планинскиот масив Добра Вода

Резултати на истражувањето и дискусија

Опис на карактеристики на видови макромицети од типот *Ascomycota* за фунгијата на Република Македонија, регистрирани од 2002-2009 година, на територијата на планинскиот масив Добра Вода.

Тип : ASCOMYCOTA
Ред:***Erysiphales*** Gwynne-Vaughan
Фамилија : ***Erysiphaceae*** Tul. & C. Tul.

1. ***Microsphaera alphitoides*** Griffon & Maubl.

- с.Јагол Доленци, 900-950 m, *Quercetum frainetto-cerris*, на *Quercus* sp.,23.10. 2007.

Ред: ***Helotiales*** Nannf. ex Korf & Lizon

Фамилија:***Bulgariaceae*** Fr.

2. *Bulgaria inquinans* (Pers.) Fr.

- С Поповјани, Шумјак 800-850 ас. *Quercetum frainetto-cerris*, на *Quercus* sp., 24.10.2008.

Фамилија: ***Helotiaceae*** Rehm

3. ***Ascocoryne sarcoides*** (Jacq.) J.W. Groves & D.E. Wilson

- С. Поповјани, Горица, 800м, на *Quercetum frainetto-cerris*, на *Quercus* sp., 23.10.2007,МАК 07/8149.

4. ***Bisporella citrina*** (Batsch) Korf & S.E. Carp.

- с. Поповјани Шумјак, 800-850 м., ас. *Quercetum frainetto-cerris*, на *Quercus* sp., 2007.

5. Sclerotinia pseudotuberosa (Rehm) Rehm

- Горица, во близина на селото Поповјани, 800 m, ас.*Quercetum frainetto-cerris*, 23.10.2007.
- Радилица, над селото Јагол, 900 m, дабова шума, *Quercetum frainetto-cerris*, 23.10.2007.

Ред:*Pezizales* J Schröt.
Фамилија: ***Discinaceae*** Benedix

6. **Discina parma* J. Breitenb. & Maas Geest.

- с. Поповјани , азонална вегетација со *Populus* spp., 750-800 m, на *Populus tremulae,* 23.04.2008.

Фамилија: ***Helvellaceae*** Fr.

7. **Helvella acetabulum* (L.) Quél.

- С. Поповјани, Горица, 800м, *Quercetum frainetto-cerris*, на почва 23.04.2008 год.

8. *Helvella lacunosa* Fr.

- С. Поповјани, Шумјак, 800-850 м., *Quercetum frainetto-cerris*, на почва, 2002.

Фамилија: ***Morchellaceae*** Rchb.

9. ***Mitrophora semilibera*** (DC.) Lév.

- Поповјански Лаг, с. Поповјани и Жубрино, 750 m, азонална вегетација со *Populus sp.*, крај река, 23.04.2008.

10. ***Morchella conica*** *Pers.*

- Поповјански Лаг, с. Поповјани и Жубрино, 750 m, азонална вегетација со *Populus sp.*, крај река, 20.04.2008.

11. ***Morchella esculenta*** (L.) Pers.

- С. Јагол, 850-900 м., во азонална вегетација со *Populus* sp., *Quercetum frainneto-cerris*, 20.04.2002.
- С. Поповјани, Поповјански Лаг, азонална вегетација со *Populus* spp , 750-800 м., 10.04.2008.
- С. Поповјани, Горица 800-850 м., *Quercetum frainetto-cerris,* под *Quercus* sp., 23.04.2008.

12. ***Verpa bohemica*** (Krombh.) J. Schröt.

- С. Јагол Доленци, 800м., азонална вегетација под *Salix* sp., 20.04.2008.
- С.Поповјани, Поповјански Лаг, 750-800м., под *Populus* sp. и *Salix*sp. 30.04.2008.

Фамилија: ***Pezizaceae***

13. ****Peziza celtica*** (Boud.) M.M. Moser

- С. Поповјани, Шумјак, 800-850 м., ас. *Quercetum frainetto-cerris*,на почва 23.04.2008.

14. ****Peziza domiciliana*** Cooke

- С. Јагол, на влажна почва со знаци на опожареност, 750-800 м., (*Quercetum frainetto-cerris*), 20.10.2007.

15. ***Peziza vesiculosa*** Bull.

- С. Поповјани 750-800 м., на влажна почва, ас. *Quercetum frainetto-cerris*, 20.10.2008.

Фамилија: ***Pyronemataceae*** *Corda*

16. ****Anthracobia macrocystis*** (Cooke) Boud**.**

- Шумјак, над селото Поповјани, ас. *Quercetum frainetto-cerris*, 850-900м., 23.10.2007.

17. ****Anthracobia maurilabra*** (Cooke) Boud.

- Горица, западно од село Поповјани, ас. *Quercetum frainetto-cerris,* 850м.,на опожарено место, 08.11.2008 година.

18. ****Anthracobia subatra*** *(Rehm) M.M. Moser*

- с. Премка планински масив Челоица 750 м, опожарена почва, боров насад.

19. ***Humaria hemisphaerica*** (Hoffm.) Fuckel

- с. Туин, 800 м., на почва, Шумјак, ас. *Quercetum frainetto-cerris*, 01.11.2007

20. ***Otidea concinna*** (Pers.) Sacc.

- С.Јагол Доленци, 750-800 м., ас. *Quercetum frainetto-cerris*, на влажна почва, 20.10.2007.

21. ***Otidea onotica*** (Pers.) Fuckel

- С.Поповјани, Шумјак, ас. *Quercetum frainetto-cerris,* 23.10.2007.

Фамилија: ***Hyaloscyphaceae***

22. ***Hymenoscyphus calyculus*** ***(***Sowerby) W.Phillips

- с. Папрадиште, 1350-1500 m, ас. *Calamintho grandiflorae-Fagetum*, 01.11.2007

23. ****Hymenoscyphus separabilis*** (P. Karst.) Dennis

- с.Поповјани 800-850м., 23.10.2007.
- с.Јагол 850-900м., ас. *Quercetum frainneto-cerris,* 23.10.2007.

24. ***Sarcoscypha coccinea*** (Scop.) Lambotte

- с. Жубрино, 750 m, во мешана шума, дел од дабова шума, 23.01.2009.

Ред: ***Rhytismatales*** M.E. Barr ex Minter

Фамилија: ***Rhytismataceae*** Chevall.

25. ***Rhytisma acerinum (Pers.) Fr.***

- с. Јагол Доленци, до училиштето, 750-800 м., на лисја од *Acer* sp. 23.10.2007.

Ред: ***Sordariales*** Chadef. ex D. Hawksw. & O.E. Erikss.

Фамилија: ***Nitschkiaceae*** (Fitzp.) Nannf.

26. ***Bertia moriformis*** (Tode) De Not.

- с.Ќафа, 1350м., ас. *Calamintho grandiflorae-Fagetum*, на *Fagus,* 24.10,2007 год.

Ред: ***Xylariales*** Nannf.

Фамилија: ***Diatrypaceae*** Nitschke

27. ***Diatrype disciformis*** (Hoffm.) Fr.

- С. Јагол, 750 м., ас. *Quercetum frainetto-cerris,* на гранче од *Quercus* sp.*,*18.01.2007 год.
- с. Јагол Доленци, Шумјак, 800-900 м, награнки од разни дрвја, 24. 10. 2007.
- С.Туин 850-900 м., ас. *Quercetum frainetto-cerris*, на гранчеод даб. 18.01.2007.
- с. Ќафа, 1350м., ас. *Calamintho grandiflorae-Fagetum*, 24.10.2007,
- с.Папрадиште,1350-1500 м., ас. *Calamintho grandiflorae-Fagetum*, 01.11.2007.

28. ***Diatrype stigma*** Sacc.

- С. Ќафа, 1350м., ас. *Calamintho grandiflorae-Fagetum*, на Fagus, 24.10.2007.

Фамилија: ***Xylariaceae*** Tul. & C. Tul.

29. ***Hypoxylon fuscum*** (Pers.) Fr.

- с.Ќафа, 1350 м., ас. *Calamintho grandi-*

florae-Fagetum, на*Fagus*, 24.10.2007.

- с. Јагол Доленци, 800 м., ас. *Quercetum frainetto-cerris*, на гранки од *Quercus* sp., 27.09.2007 година.

30. *Hypoxylon fragiforme* (Pers.) J. Kickx

- с. Јагол Доленци 800м., ас. *Quercetum frainetto-cerris*, на гранки од *Quercus* sp., 20.12.2006 година.

31. *Xylaria hypoxylon* (L) Grev,

- с.Јагол Доленци, 850 м., ас. *Quercetum frainetto-cerris*, на даб, 27.10. 2006
- с. Поповјани, 850-900 м., ас. *Quercetum frainetto-cerris*, на изумрено дрво од даб. 23.10.2007 година.
- с.Папрадиште, 1350-1450 м, ас. *Calamintho grandiflorae-Fagetum*, на Fagus sp.

Ред**: *Hypocreales*** Lindau

Фамилија**: *Hypocreaceae*** De Not.

32. *Trichoderma viride* Tulasne & Tulasne 1860

Фамилија**: *Nectriaceae*** Tul. & C. Tul.

33. *Nectria cinnabarina* (Tode) Fr.

- с. Јагол Доленци, 800 m, на паднати гранчиња од разни листопадни дрвја.

Нови видови за фунгијата на Р. Македонија се следните 8 вида:

1*Anthracobia macrocystis (Cooke) Boud.

2***Anthracobia maurilabra*** (Cooke) Boud.,

3*Anthracobia subatra (Rehm) M.M. Moser

4*Discina parmaJ. Breitenb. & Maas Geest.

5*Helvella acetabulum (L.) Quél.

6***Hymenoscyphus separabilis*** (P. Karst.) Dennis

7*Peziza celtica (Boud.) M.M. Moser

8*Peziza domiciliana Cooke

Заклучоци

На територијата на планинскиот масив Добра Вода во период од 2002-2009 година вршени се истражувања на видовиот состав на габите од типот Ascomycota. Истражувањата се вршени во следните шумски заедници: *Quercetum frainetto-cerris, Calamintho grandiflorae-Fagetum,* азонална вегетација, боров насад итн., при што е утврдено следното:

Идентификувани се 33 вида аскомицети од кои 19 се лигниколни, додека 14 се териколни видови. Од нив, 22 вида се сапроби, додека 11 вида се јавуваат како микоризни или паразитски видови. Најзастапени редови се Pezizales со 19 вида, Xylariales со 5 и Helotiales со 4 вида, додека најзастапени фамилии се: *Pyronemataceae* со 6 вида, *Hyaloscyphaceae*со 5 вида, *Morchellaceae* со 4 вида, *Pezizaceae* со 3 вида и *Xylariaceae* со 3 вида. Нови видови за фунгијата на Македонија се осум (8) вида: *Discina parma*, *Helvella acetabulum, Peziza celtica, Peziza domiciliana, Anthracobia macrocystis, Anthracobia maurilabra, Anthracobia subatra, Hymenoscyphus separabilis.*

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Summary

On the territory on Dobra Voda Mountain massive, 33 species of ascomycota were registered, 19 lignicolus and 14 tericolous. 22 species of the total number of species are saprobionts, while 11 species are as mycorrhizal or parasitic species. The following communities were studied: Quercetum frainetto-cerris, Calamintho grandiflorae-Fagetum, Azonal vegetation, Pinus plantings, etc.The majority of the registered fungi species belong to the folloving orders: *Pezizales (19),* Xylariales (5) and Helotiales (4).The most common families are as follows: Pyronemataceae with 6 species, *Hyaloscyphaceae* with 5 species, *Morchellaceae* with 4 species, *Pezizaceae* with 3 species, *Xylariaceae* with 3 species etc. The most frequent ascomycetes species in the Dobra Voda mountain are the following: *Bisporella citrina, Diatrype disciformis, D.stigma, Hypoxylon fuscum, Morchella conica, Nectria cinnabarina, Rhytisma acerinum, Xylaria hypoxylon* etc.

New fungi for Republic of Macedonia are the following species (8): *Discina parma*, *Helvella acetabulum, Peziza celtica, Peziza domiciliana, Anthracobia macrocystis, Anthracobia maurilabra, Anthracobia subatra, Hymenoscyphus separabilis.*

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ECOLOGICAL AND MORPHOLOGICAL CHARACTERISTICS OF RARE AND ENDANGERED PLANT *Ramonda serbica* FROM DIFFERENT LOCALITIES OF THE REPUBLIC OF KOSOVO

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Abstract

Gashi, B., Millaku, F., Abdullai, K., Krasniqi, E., Kongjika, E. (2013). Ecological and morphological characteristics of rare and endangered plant *Ramonda serbica* from different localities of the Republic of Kosovo. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

The rare and endangered specie *Ramonda serbica* is a Balkan endemorelict plant, included in the European list of rare plants, in danger of extinction. The aim of this study is to present the current natural condition and to elaborate the risk assessment for extinction of some *R. serbica* localities from Republic of Kosovo. We started the mapping and exploration of habitats for six localities of *R. serbica* in Sharri Mountains (three are new) and five in Albanian Alps. Their current distribution is restricted to the northern, north-east and north-west on rocky slopes of gorges and canyons, mainly on foothills (530m a.s.l. – Gorge of river Prizreni), sometimes reaching the subalpine belts (1651m a.s.l. – Guri i Dellocit). The area of the localities varies widely - from several m^2 to more than 4 km^2. Almost all morphological characteristics, plant density, phenological traits, as well as the presence of the anabiosis stage was significantly different at $P<0.05$ between the localities. Based on our obtained results of expeditions, the most endangered localities of *R. serbica* for extinction are: Canyon of Rugova, Gorge of Zhlebi, Radac and Gorge of River Sushica, followed by Gorge of river Prizreni and Gorge of Rusenica.

Key words: *Ramonda serbica*, endangered, ecology, morphology, *in vitro* conservation.

Introduction

The *Gesneriaceae* are a middle-sized family of angiosperms, comprising over 150 genera and more than 3200 species of mainly tropical and subtropical distribution (Kubitzki and Kadereit 2004). In Europe this family is represented by three genera (*Ramonda*, *Haberlea* and *Jankaea*) and five species (*Ramonda serbica, Ramonda nathaliae Ramonda myconi*, *Haberlea rhodopensis* and *Jankaea heldreichii*). Four of these species occur in the Balkan Peninsula, and the only representative in the Iberian Peninsula is *R. myconi*. *Ramonda serbica* is represented in: Albania, Kosovo, Montenegro, Serbia, Macedonia, Bulgaria and Greece. Their current distribution is restricted to the northern rocky slopes of gorges and canyons, mainly on foothills, reaching sometimes the alpine belts (Meyer, 1970). It inhabits mostly shaded, northern, chiefly limestone slopes in mountain zones with relatively high humidity. *R. serbica* is endemic and relict species of the Balkan Peninsula and listed in the European Register of rare, endangered and endemic plants under the Rare Species category.

Previous investigations have shown that *Ramonda* plants during desiccation stage have changed the: cell membrane integrity (Quartacci et al., 2002), antioxidative capacity (Sgherri et al., 2004; Jovanovic et al., 2011), photosynthetic activity (Augusti et al., 2001), CO_2 fixation and chlorophyll a fluorescence (Degl'Innocenti et al., 2008) and osmotic adjustment (Zivkovic et al., 2005). Other authors confirmed some cytogenetical and physiological aspects of *Ramonda* plants from different locality (populations): genome size variation and polyploidy (Siljak-Yakovlev et al., 2008), seed germination (Gashi et al., 2012) and *in vitro* cultivation from

seeds of *Ramonda* plants (Kongjika et al., 2002; Dontcheva et al., 2009; Gashi et al., 2011).

Nevertheless, up to now there is only a few data from other authors for ecological, morphological and current natural conditions of *R. serbica* in our country. Right now the study belonging to *R. serbica* species on different locations is still missing.

For the first time in the Republic of Kosovo our researcher group is incited to investigations of rare, endangered and endemic plants for Kosova's Red Book (Red list of Flora of Kosovo).

The aim of this study is to present the current natural condition and comparison of some ecological and morphological characteristics of *R. serbica* from different localities in the Republic of Kosovo.

Materials and methods

These researches are conducted during the expeditions by our group in two consecutive years 2011 and 2012, three times (in spring, summer and autumn) for each year. Researches are carried out at different localities of *R. serbica* from Sharri Mountains (6 localities) and Albanian Alps (5 localities) (Table 1). During the expeditions (over 50 expeditions for two years), certain morphological, phenological and ecological characteristics were monitored for nine localities and their seed collections. These localities were chosen as representative because each of them is unique in some geographical and biological aspects.

GPS mapping and exploration of *R. serbica* localities in combination with monitoring of some characteristics of morphology and phenology were the following (Daskalova at al. 2011):

ANR – Average number of rosettes per m^2; **NJP** – Number of young plants per m^2 (Fig. 1a); **NVA** – Number of vegetative adults per m^2 (Fig. 1b); **NGA** – Number of generative adults (vegetative+sexual reproduction) per m^2 (Fig. 1c); **NAP** – Number of ageing plants (with necrosis and/or irreversible dissections) per m^2 (Fig. 1d); **TF** – Time of flowering; **TS** – Time of seed productions; **NPP** – Number of peduncle per plant; **NFP** – Number of flowers per peduncle; **% T** – Percentages of flowers with four petals; **% P** – Percentages of flowers with five petals; **% H** – Percentages of flowers with six petals; **NL** – Number of leaves per plant; **LA** – Leaf area in cm^2 per plant; **TLA** – Total leaf area in cm^2 per plant.

The average of these parameters (plant density and phenology) was calculated for five square spots (subpopulations) 1×1 m were chosen for each locality, in which the plant rosettes were counted and the average number was recorded.

The average of morphological parameters for each locality was recorded after measuring and averaging of 20 plants *R. serbica* comparative in size and age structure (vegetative and generative).

Ecology factors were also recorded for some of the representative localities, including:

- Abiotic factors (drought, light exposure, rock type, etc.)
- Biotic factors (associated plant species)
- Anthropogenic factors (pollution, urbanization, etc.)

Selected characteristics were used for elaborat-

Fig. 1. Age (stage) categories of *R. serbica*: **a)** Yang plants (up to 6 leaves); **b)** Vegetative adults (without flowers); **c)** Generative adults (vegetative+sexual reproduction); **d)** ageing plants (with necrosis and/or irreversible dissections).

Tab. 1. Geographic origin of *R.serbica* localities in Republic of Kosovo.

Code of localities	Locality of populations	Directions	Altitude (m)	Geological substrate	UTM coordinates
1	**Gorge of Zhlebi**	N and NE	1250	Limestone	X=0440095 Y=4735341
2	**Radac**	N	545	Limestone and dolomite	X=0443216 Y=4731643
3	**Gorge river of Sushica**	N	676	Limestone	X=0441054 Y=4727481
4	**Canyon of Rugova**	N	800	Limestone	X=0434691 Y=4723960
5	**Gorge of Koprivnik**	N and NE	750	Limestone	X=0439892 Y=4719967
6	**Gorge of river Prizreni**	N	530	Limestone	X=0482119 Y=4671129
7	**Gorge of Rusenica**	N	1340	Limestone	X=0489481 Y=4679712
8	**Gorge of Matosi**	N	910	Limestone	X=0492515 Y=4680316
9	**Shkëmbi i përgjakur**	N	1170	Limestone	X=0494025 Y=4679758
10	**Guri i Dellocit**	N and NW	1651	Limestone	X=0495690 Y=4680067
11	**Guri i Dellocit 2**	N and NW	1524	Limestone	X=0494630 Y=4679159

N – North; **NE** - North-East; **NW** – North-West

ing the risk assessment for extinction of each *R. serbica* localities in the Republic of Kosovo.

Data analysis: The experiment was performed in a randomized design with five replicates. Differences among parameters and between the localities were tested using SPSS 17 statistical program. Statistical variance analysis of all the data was performed using one-way ANOVA and compared with Duncan's Multiple Range Tests at the 5% level of significance.

Results and Discussions

Based on the gained results out of expeditions conducted in two consecutive years of exploring habitats of Ramondas, this plant is in risk of extinction in our country, too. Having this fact, we have instantly started applying methods for their micropropagation and *in vitro* conservation, by this we have tried to give our contribution to their *ex situ* preservation at germplasm of this specie.

Plant density and phenology: Measuring was conducted at 9 localities which were more representative out of 11 researched ones. For these parameters measuring was conducted in 5 subpopulations (the distance between the subpopulations was 20m) with 1x1m for each locality.

Based on results presented in Table 2, it is noticed that for all parameters of plant density there were significant differences for P 0.05 between localities. Concerning the average number of rosettes (ANR) per m^2 the highest was in Shkembi i përgjakur and Gorge of river Sushica (50.75 and 40.25, respectively), whereas the lowest was in Radac locality (17.85). In this respect, the lowest number of young plants (NYP) and the lowest number of vegetative adults (NVA), per m^2, the lowest was at Canyon of Rugova and Radaci locality (0.70 and 1.05, respectively). For the number of generative adults (NGA) per m^2, the highest was in the localities of Gorge of Matosi and Gorge of river Prizreni (14.00 for each). Regarding the number of ageing plants (NAP) per m^2, the highest was in Shkëmbi i përgjakur (20.30) compared with other localities. This high diversity between localities is explained through the fact that this plant is encountered in a very small group and with highly fragmented habitat and it is influenced by other factors, such as: temperature, air humidity, directions, altitude, forestry, etc. Our results for these parameters are in accordance with the results by Daskalova et al. (2011), which showed that the plant of *Haberlea rhodopensis* Friv. (Geseneriaceae) growths in different locality in Bulgaria have some changes in age structure (plant density and phenology). As it was previously shown, locality with small number of rosettes per m^2 and smaller regeneration were Radaci, Canyon of Rugova, Gorge of Zhlebi and Gorge of river Sushica locality, therefore the risk of extinction is very high.

Tab. 2. Mean of spatial parameters, plant density and phenology differences per 1 m^2 of habitats of some more representative *R. serbica* localities.

Code of locality	Area (m^2)	ANR	NJP	NVA	NGA	NAP	TF	TS
1	280 ±20	**21.00** ^{E} ±0.61	**3.50** ^{C} ±0.11	**7.00** ^{D} ±0.20	**3.85** ^{F} ±0.11	**6.65** ^{B} ±0.19	June 3rd-4th decade	July 3rd-4th decade
2	240 ±10	**17.85** ^{F} ±0.52	**1.05** ^{D} ±0.03	**4.20** ^{F} ±0.12	**7.00** ^{D} ±0.20	**5.60** ^{C} ±0.16	June 1st-2nd decade	July 3rd-4th decade
3	4000 ±200	**20.65** ^{E} ±0.59	**4.20** ^{B} ±0.12	**6.30** ^{DE} ±0.18	**10.15** ^{B} ±0.29	**1.40** ^{E} ±0.03	June 3rd-4th decade	July 3rd-4th decade
4	500 ±25	**19.95** ^{EF} ±0.57	**0.70** ^{D} ±0.02	**3.50** ^{F} ±0.10	**10.15** ^{B} ±0.29	**5.60** ^{C} ±0.16	June 3rd-4th decade	July 3rd-4th decade
5	2200 ±180	**40.25** ^{B} ±1.16	**7.70** ^{A} ±0.22	**18.20** ^{A} ±0.52	**8.05** ^{C} ±0.24	**6.30** ^{BC} ±0.18	June 2nd-3rd decade	July 3rd-4th decade
6	180 ±10	**27.30** ^{C} ±0.78	**3.15** ^{C} ±0.92	**9.45** ^{C} ±0.27	**14.00** ^{A} ±0.40	**0.70** ^{E} ±0.02	June 3rd-4th decade	July 3rd-4th decade
7	850 ±30	**23.80** ^{D} ±0.68	**3.50** ^{C} ±0.11	**5.95** ^{E} ±0.17	**7.70** ^{CD} ±0.22	**6.65** ^{B} ±0.19	June 1st-2nd decade	July 4th decade
8	160 ±10	**29.75** ^{C} ±0.86	**3.50** ^{C} ±0.11	**10.15** ^{C} ±0.29	**14.00** ^{A} ±0.40	**2.10** ^{D} ±0.06	June 2nd-3rd decade	July 4th decade
9	240 ±20	**50.75** ^{A} ±1.46	**7.70** ^{A} ±0.22	**16.80** ^{B} ±0.48	**5.95** ^{E} ±0.17	**20.30** ^{A} ±0.58	June 2nd-3rd decade	July 4th decade
	F	*162.37*	*353.69*	*310.35*	*155.95*	*634.52*		
	P<0.05	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*		

ANR – Average number of rosettes per m^2; **NJP** – Number of young plants per m^2; **NVA** – Number of vegetative adults per m^2; **NGA** – Number of generative adults (vegetative + sexual reproduction) per m^2; **NAP** – Number of ageing plants (with necrosis and/or irreversible dissections) per m^2; **TF** – Time of flowering; **TS** – Time of seed productions. Columns with different letters differ significantly at $p < 0.05$ by one-way ANOVA with Duncan's multiple range tests.

In general, time of flowering was from the first decade up to the fourth decade of June, depending on vicinity of water sources, forests, air humidity, altitude of these localities and directions (Table 1 and 2). The localities with north-eastern and north-western directions had precocious time of flowering compared to localities with eastern direction. Similar results, during the time of flowering observed for the impact in forests, water sources, air humidity and altitude were also shown by other authors at *Haberlea rhodopensis* Friv. (Daskalova et al., 2011) and *Ramonda serbica* (Pteroviq et al., 1975). Southern populations of *A. lyrata* were flowered earlier than northern ones in all environmental conditions (Riihimaki and Savolainen, 2004).

Morphological characteristics of flowers and leaves: Significant differences were observed at morphological parameters for the flowers of *R. serbica* between different localities (Table 3). For the number of peduncle per plant (NPP) and number of flowers per peduncle (NFP), the highest was in the locality of Radac (6.20 and 1.77), whereas the lowest in the locality of Gorge of river Prizreni (2.70 and 1.00). On the all researched localities of *R. serbica* the most dominant were the pentmetric flowers (% P) from 62.96 % (Gorge of river Prizreni) up to 90.28 % (Shkëmbi i përgjakur). On the other hand, the tetrametric flowers (% T) were in lower percentage from 9.72 % (Shkëmbi i përgjakur) up to 25.93 % (Gorge of river Prizreni). In the increase of the percentage of pentmetric flowers there will be a decrease of tetrametric flowers and vice versa. Lower percentage was for hexametric flowers (% H) from 1.24 % up to 11.11 %. At localities of Gorge of river Sushica, Gorge of Matosi and Shkëmbi i përgjakur, which were the localities with less shed and high air humidity, no hexametric lowers were found.

Concerning the morphological parameters of leaves from Table 3, it is noticed that the highest number of leaves per plant (NL) was at the locality of Shkembi i pergjakur, whereas the lowest was at the locality of Gorge of Rusenica and Zhlebi (11.31 and 11.53). For this parameter there were significant differences in P 0.05 between localities. The highest leaf area in cm^2 (LA) were in the Radaci and Gorge of river Sushica (12.52 and 12.61 cm^2) localities. For this parameter there were no significant differences between localities. Similar results were observed for total leaf area (TLA) as well, but also slight significant differences between localities. The obtained results of morphological characteristics are in accordance with previous researches. Daskalova et al. (2011) showed the significant differences in morphological characteristics of *Haberlea rhodopensis* Friv. from different locality. In addition, Millaku et al. (2010) confirmed differences in some morphological parameters of leaves and flowers of *Primula veris* growing in different ecological conditions and localities in Kosovo.

Tab. 3. Mean of some morphological differences per plant of some more representative *R. serbica* localities.

Code of locality	NPP	NFP	% T	% P	% H	NL	LA	TLA
1	**3.00** ^{DE} ±0.35	**1.10** ^{C} ±0.06	**16.50** ^{D} ±0.46	**80.50** ^{B} ±2.33	**3.00** ^{C} ±0.09	**11.53** ^{C} ±0.85	**8.16** ^{B} ±0.68	**108.39** ^{C} ±10.88
2	**6.20** ^{A} ±0.72	**1.77** ^{A} ±0.10	**27.95** ^{A} ±0.46	**70.81** ^{D} ±1.42	**1.24** ^{E} ±0.35	**16.58** ^{B} ±0.13	**12.52** ^{A} ±1.48	**212.56** ^{AB} ±9.43
3	**4.10** ^{CD} ±0.47	**1.51** ^{B} ±0.08	**19.58** ^{C} ±0.81	**78.34** ^{BC} ±2.26	**2.08** ^{D} ±0.36	**19.56** ^{AB} ±0.80	**12.61** ^{A} ±2.55	**250.17** ^{A} ±13.36
4	**2.00** ^{E} ±0.23	**1.00** ^{C} ±0.06	**25.00** ^{B} ±0.72	**75.00** $^{B-D}$ ±2.16	/	**12.61** ^{C} ±0.38	**10.41** ^{AB} ±1.01	**130.16** ^{C} ±12.68
5	**2.10** ^{E} ±0.24	**1.10** ^{C} ±0.06	**17.39** ^{D} ±0.50	**78.26** ^{BC} ±2.25	**4.35** ^{A} ±0.13	**13.53** ^{C} ±0.70	**10.03** ^{AB} ±1.29	**140.53** ^{BC} ±13.21
6	**2.70** ^{E} ±0.31	**1.00** ^{C} ±0.05	**28.00** ^{A} ±0.81	**68.00** ^{D} ±1.96	**4.00** ^{B} ±0.11	**13.33** ^{C} ±0.69	**10.06** ^{AB} ±0.45	**137.74** ^{BC} ±13.61
7	**3.00** ^{DE} ±0.35	**1.10** ^{C} ±0.06	**16.13** ^{D} ±0.47	**80.65** ^{B} ±2.33	**3.23** ^{C} ±0.09	**11.31** ^{C} ±0.67	**9.06** ^{AB} ±0.62	**105.15** ^{C} ±12.73
8	**2.70** ^{E} ±0.72	**1.03** ^{C} ±0.06	**28.57** ^{A} ±0.82	**71.43** ^{CD} ±2.06	/	**12.77** ^{C} ±1.47	**10.08** ^{AB} ±0.24	**133.76** ^{BC} ±14.16
9	**4.70** ^{B} ±0.54	**1.53** ^{B} ±0.09	**9.72** ^{E} ±0.28	**90.28** ^{A} ±2.61	/	**20.50** ^{A} ±0.50	**11.28** ^{AB} ±0.86	**231.16** ^{A} ±19.01
F	*10.620*	*15.822*	*112.75*	*9.048*	*538.15*	*11.572*	*1.463*	*4.918*
P<0.05	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.238*	*0.002*

NPP – Number of peduncle per plant; **NFP** – Number of flowers per peduncle; **% T** – Percentages of flowers with four petals; **% P** – Percentages of flowers with five petals; **% H** – Percentages of flowers with six petals; **NL** – Number of leaves; **LA** – Leaf area in cm^2; **TLA** – Total leaf area in cm^2; Columns with different letters differ significantly at $p < 0.05$ by one-way ANOVA with Duncan's multiple range tests.

Distribution, ecological conditions and associated plant species: Out of all localities, three were found for the first time in Kosovo by us, and those are in Sharri Mountains (Shkëmbi i përgjakur, Guri i Dellocit dhe Guri i Dellocit 2) (Table 1). Almost in all the researched localities at *R. serbica* it is grown in gorges (Table 1), in rocks and in the crakes of limestone's except for the localities of Radac and rocks of dolomite. Mainly on foothills (530m a.s.l. – Gorge of Prizren), sometimes reaching the subalpine belts (1651m a.s.l. – Guri i Dellocit). Directions for the most of localities was northern and north-eastern, but there were cases with north-western directions (Guri i Dellocit dhe Guri i Dellocit 2), too. Directions in which the *R. serbica* plants were in weaker state and at rare spreading. The area of occupancy at *R. serbica* in different localities ranges from 160-4500 m^2 (Table 2). The total area of occupancy of the species on our country is more than 100 km^2.

Out of conducted researches throughout the expeditions we have stated that the most dominant plant community in the localities was *Musco-Ramondaetum serbicae*, whereas in some subpopulations *Ceterato-Ramondaetum serbicae* was also dominant plant community. For the all researched representative localities we have explored the associated plant species, where on Table 3 it is noticed that the species dominating at all localities were: *Musco* sp. and *Asplenium ruta-muraria.* In this case, the localities which had higher quantity of *Musco sp.* the rigeneration of that population/subpopulation was higher. Associated plant species that occurred at more than four localities: *Ceterach officinarum, Popipodium vulgare, Asplenium trichomanes, Arabis caucasica, Mycelis muralis, Geranium robertianum, Geranium lucidum , Saxifraga paniculata, Saxifraga rotundifolia, Hedera helix, Lilum martagon, Doronicum columnae, Hieracium waldsteinii, Asplenium scolopendrium, Hieracium sp., Fraxinus ornus, Erysiumum helveticum, Cystopteris sp., Calamintha grandiflora, Valeriana montana, Geranium macrorrhizum, Lamium garganicum, Lamium galeobdolon, Achillea ageratifolia, Silene vulgaris, Silene saxifraga, Polygonum odoratum, Arabis constricta*, *Oxalis acetosella*, *Fritillaria gracilis*, *Calamintha acinos*, *Coronilla emeroides*, *Campanula versicolor,* etc.

Associeted plants species that only occurred at one locality:

Gorge of Zhlebi (1): *Sedum acre, Leucanthemum vulgare, Rubus ideus, Cryptogramma crispa, Viola bifolia, Campanula grandiflora, Geranium sylvatica, Veronica urticifolia, Thalictrum minus*; Gorge of river Sushica (3): *Hieracium bifidum, Hieracium murorum*;

Canyon of Rugova (4): *Hesperis dinarica, Sedum telephium*;

Gorge of Koprivniku (5): *Crepis albanica, Lamium album, Campanula crassipes, Amphoricarpus neumayeri, Gnaphalium roeseri*;

Gorge of river Prizreni (6): *Leonatodon hispidus, Hieracium racemosum, Arabis verna, Cyclamen hederifolia*;

Gorge of Rusenica (7): *Micromeria cristata, Daphne oleoides*; *Ostrya carpinifolia, Sempervivum hirtum, Achillea holosericea, Cerastium decalvans, Thesium dollineri, Scabiosa crenata, Carumm graeca, Minuartia verna, Alyssum saxatile, Leontodon hirsutus, Cryptogamma crispa*;

Gorge of Matosi (8): *Mercurialis perennis, Polygonatum multifida, Lonicera xylosteum, Micromeria cristata*;

Shkëmbi i përgjakur (9): *Galium lucidum, Sempervivum tectorum, Sempervivum heuffelii, Moehringia muscosa, Cardamine glauca, Corydalis ochroleuca, Hieracium villosum, Saxifraga sempervivum,* ***Mercurialis perennis***, *Prenanthes purpurea.*

Endemic plants that occurred in different localities: *Hieracium waldsteinii, Crepis albanica, Lamium garganicum, Achillea ageratifolia, Micromeria cristata, Hesperis dinarica, Amphoricarpus neumayeri, Gnaphalium roeseri, Daphne oleoides, Sempervivum heuffelii, Saxifraga sempervivum*.

Anthropogenic factors that impact on the growth and development of *R. serbica* plants were different on almost all localities. In this case, the locality of Gorge of river Prizren and Gorge of Zhlebi, except that it is found at the edges of roads (urbanism), it is on the higher pollution but also it endangered by human factor that can be used for cultivation. The locality of Gorge of Rusenica and Gorge of river Sushica is endangered by anthropogenic factor resulting from digging of rocks and dust pollution. The locality of Radac and Canyon of Rugova are a touristic zones and thay can be endangered by anthropogenic factor resulting from high attendance in this zone.

Conclusions

Based on the obtained results during the expeditions and *in vitro* conservation, conclusion is that:

- The most endangered localities of *R.serbica* for extinction due to the small number of rosettes per m^2 and number of young plants per m^2 as well as biotic, abiotic and anthropogenic factors are: Canyon of Rugova, Gorge of Zhlebi, Radac and Gorge of river Sushica, followed by Gorge of river Prizreni and Gorge of Rusenica.
- The less endangered localities of *R.serbica* for extinction for all investigated parameters and factors are: Gorge of Koprivniku, Shkëmbi i përgjakur and Gorge of Matosi.
- The localities with high number of rosettes per m^2 and associated plants with *Musco* sp. are very important and have great impact on the higher number of young plants per m^2.
- Almost at all localities where the number of rosettes per m^2 is high these cases reduced the percentage of flowers per plant but also sun lighting environment has high effect.
- Generally, for all localities where the percentages of flowers with four petals is high, the percentages of flowers with five and six petals is reduced.

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ECOLOGY AND DISTRIBUTION ON THE GENUS *Macrolepiota* (Basidiomycota, Fungi) IN MACEDONIA

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Abstract

Karadelev, M., Jovanovska, I., Mitic-Kopanja, D. & Koteska, L. (2013). Ecology and dıstrıbutıon on the genus Macrolepiota (Basidiomycota, Fungi) in Macedonia. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 218, Skopje.

Based on previous research on the distribution of the species of the genus *Macrolepiota* in the Republic of Macedonia, there is data for 7 species and one variety of the genus. However, systematic research of this kind has never been conducted before. In order to obtain more complete data on the distribution of the genus *Macrolepiota* in Macedonia, all available data from the Macedonian national collection (MCF) and the MAC FUNGI database were used. Additionally, notes from various researchers' collected data of fungi from the territory of the Republic of Macedonia were included in this study. Thus, we established 7 species and one variety, of which one species *Macrolepiota heimii* is new for Macedonia. In this study we obtained a clearer picture of the ecology and distribution of the genus *Macrolepiota.* Based on the fact that the number of registered representatives of the genus *Macrolepiota* in Europe is 17, it could be expected that the number of species will increase with the further observations. During further research this number is expected to increase.

Key words: *Macrolepiota*, fungi, distribution, ecology, Macedonia

Апстракт

Караделев, М., Јовановска, И., Митиќ-Копања, Д. и Котеска, Л. (2013). Екологија и дистрибуција на родот *Macrolepiota* (Basidiomycota, Fungi) во Македонија. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 28, Скопје.

Според досегашните истражувања на дистибуцијата на видовите од родот *Macrolepiota* во Република Македонија постојат 7 вида и еден вариетет, но систематски истражувања на овој род досега не се направени. Со цел да се добијат покомплетни податоци за дистрибуцијата на родот *Macrolepiota* во Република Македонија користени се сите достапни податоци од Македонската национална збирка (MCF), базата на податоци (MAC FUNGI), како и белешки од разни истражувачи кои собирале податоци за габите на територијата на Република Македонија. На тој начин се констатирани 7 вида и еден вариетет, од кои видот *Macrolepiota heimii* е нов за Македонија. Со овој труд е добиена појасна слика за екологијата и дистрибуцијата на родот *Macrolepiota*. Со оглед на фактот дека бројот на регистрирани претставници од родот *Macrolepiota* во Европа е 17, се очекува со понатамошните истражувања овој број да се зголеми.

Клучни зборови: *Macrolepiota*, габи, дистрибуција, екологија, Македонија

Introduction

In Macedonia systematic research on the genus *Macrolepiota* Singer (1948) has not been conducted up till now, there are few mycological papers concerned with individual species of the genus. Publications making reference to individual species of *Macrolepiota* genus are as follows: *Macrolepiota excoriata* (Karadelev, Rusevska 2004); *Macrolepiota mastoidea* (M.K. & K.R. 2004); *Macrolepiota procera* (M.K. & K.R. 2004; Karadelev 1999b); *Macrolepiota procera* (Karadelev 2000a); *Macrolepiota gracilenta, Macrolepiota mastoidea, Macrolepiota procera,* (Karadelev 2000d); *Macrolepiota procera* (Karadelev & Rusevska 2000); *Macrolepiota procera, Macrolepiota mastoidea, Macrolepiota rhacodes* (Karadelev 2001a); *Macrolpeiota procera* (Karadelev and coworkers 2002b); *Macrolepiota konradii, Macrolepiota procera, Macroleipta rhacodes* (Karadelev et al. 2003a); *Macrolepiota mastoidea, Macrolepiota procera, Macroleipta rhacodes* (Karadelev & Rusevska 2004); *Macrolpeiota rhacodes* (Karadelev et al. 2004a; Karadelev et. al 2008d).

Material and methods

The observed material was collected during the period of 1987 till now, in different regions in Macedonia. Species were collected on marginal areas of the deciduous forest, mixed forests, coniferous forest, meadows, pastures, cultivated fields. Determination of the species was made at the Mycological Laboratory, Institute of Biology, Faculty of Natural Science in Skopje, Republic of Macedonia. The species identification was made macroscopically and microscopically by using reagents (5% KOH, H_2O, Melzer's reagent). Some of the species were determinate while in fresh condition, and the others were to undergo further laboratory analyses. Part form the samples have been preserved in the Macedonian Collection of Fungi (MCF), while all the indispensable data about the species are entered in the MACFUNGI database. The following keys and monographs were used as resources for determination of the collected fungi: Moser (1983), Breitenbach & Kränzlin (2000), Hansen & Knudsen (1992), Däncke (2001), Horak (2005). For each fungal species data of geographical distribution, altitude, forest association, substrate, data source and previous publications and maps for some species are provided.

Marks and abbreviations:

exs. - Collections in which the dried material (exsiccatum) is deposited

Ref. - References (sources of records and information)

vill. - Village

Mt. - Mountain

* - New species for the Republic of Macedonia

Results

Of the total of 30 species in the world of *Macrolepiota* genus, the following eight species have been recorded in Republic of Macedonia:

1. *Macrolepiota excoriata* (Schaeff.: Fr.) Waster

Ref.: Karadelev, Rusevska 2004;
Collections: MCF.

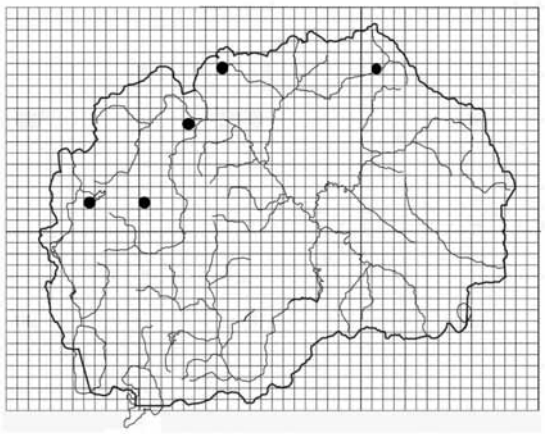

Fig. 1. Distribution of *Macrolepiota excoriata* in Macedonia
Сл. 1. Дистрибуција на *Macrolepiota excoriata* во Македонија

Dobra Voda Mt.: Jagol Jagol Dolenci vill., Naim Frasheri primary school, 800 m, azonal vegetation, 23.10.2007, exs. MCF 07/8168; **Kitka Mt.:** Kitka mountain house, 1100 m, meadow, 21.09.2003, exs. MCF 03/3328; **Osogovski Mt.:** Krupishte vill. 320 m, meadow, plantings of *Populus nigra*, 21.10.2007, exs. MCF 07/8197; **Skopska Crna Gora Mt.:** vill. Ljubanci, Zgurovci, 800 m, meadow, 02.10.2005, exs. MCF 05/5445**.**

2. Macrolepiota gracilenta (Krombh.) Wasser
Ref.: Karadelev 2000d,
Collections: MCF.

Kozhuf Mt.: vill. Konjari, 1000 m, Festuco heterophyllae-Fagetum, 13.10.2000, exs. MCF 00/4620; **Bistra Mt.:** Mavrovo, Bunec, Experimantal plot, 1350 - 1400 m, medow, 25.09.1998, exs. 21; MCF 98/1841.

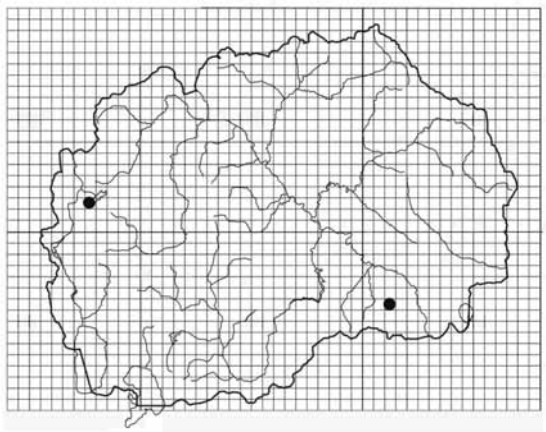

Fig. 2. Distribution of *Macrolepiota gracilenta* in Macedonia

Сл. 2. Дистрибуција на *Macrolepiota gracilenta* во Македонија

3. *Macrolepiota heimii (Locq.) Bon
Ref.:
Collections: MCF.

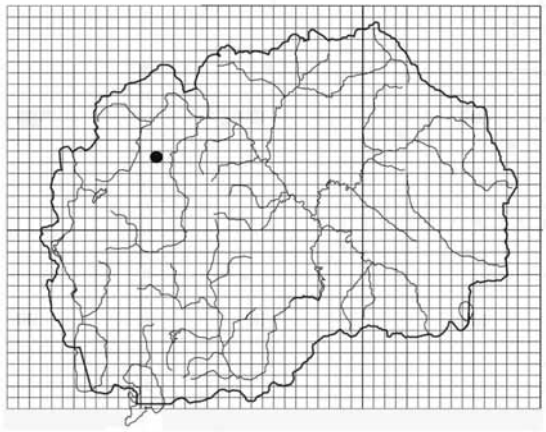

Fig. 3. Distribution of *Macrolepiota heimi*in Macedonia

Сл. 3. Дистрибуција на *Macrolepiota heimi* во Македонија

Suva Gora Mt.: Trebovle vill. (Porechje), medow, *Quercus* forest with *Pinus* plantings, 11.10.2011, exs. MCF 11/13257.

4. Macrolepiota konradii (Huijsman ex P.D. Orton) M.M. Moser

Ref.: Karadelev et al. 2003a,

Collections: MCF.

Galichica Mt.: Konjsko vill., grass, 17.10.2008, exs. MCF 08/10461; Leskoec vill, 1300 m, Quercetum frainetto-cerris, 13.10.2002, exc. MCF 11/13258; **Skopje:** Katlanovo, 150 m, Querco-Carpinetum orientalis, 16.10.2002, exs. MCF 02/2783; **Pelister Mt.:** Caparska Preseka, 1300 m, medow, 30.09.2002, exs. MCF 02/3573; **Jakupica Mt.:** vill. Bogomila, *Quercus* forest (with *Fagus* and *Pinus*), 26.09.2010, exc. MCF 10/12090.

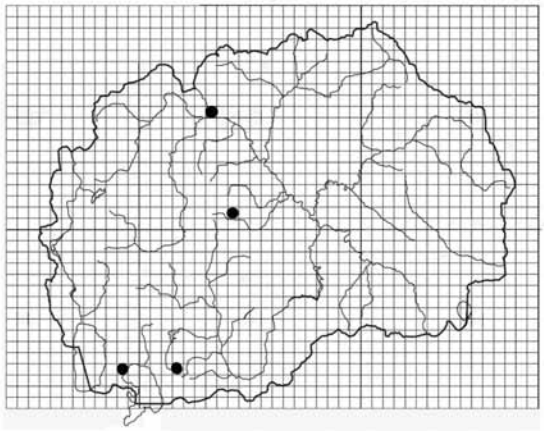

Fig. 4. Distribution of *Macrolepiota konradii* in Macedonia

Сл. 4. Дистрибуција на *Macrolepiota konradii* во Македонија

5. Macrolepiota mastoidea (Fr.: Fr.) Singer

Ref.: Karadelev 2000d , Karadelev 2001a, Karadelev, Rusevska 2004, Karadelev et al. 2008d

Collections: MCF.

Bistra Mt.: Ehloec vill. (above), 700 m, oak forest, oak forest *Quercus cerris*, 14.10.2006; Elen skok, 600 m, deciduous forest, deciduous forest *(Quercus*, *Carpinus*), 15.10.2006; Bunec, 1300 m, beech forest, 24.10.2000; Bunec, 1280-1300 m, on experimental plot, Calamintho grandiflorae-Fagetum, 26.09. 1998, exs. 21; M.K. & K.R. 2004; Sretkovo vill., 1000 m, *Fagus* forest with *Corylus* trees, 17.6.2007; **Bogdanci:** Stojakovo vill., meadow, april.1994; **Dobra Voda Mt.:** between Tuin vill. and Popovjane vill., 800-900 m, oak forest, 6.11.2002, exs. MCF 02/2858; between Jagol Dolenci and Dobra Voda Mt., oak forest, 22.10.2006; **Galichica Mt.:** Stenje vill., Quercettum frainetto-cerris, 22.10.2005; **Jakupica Mt.:** Gorno Vranovce vill., Festuco heterophyllae-Fagetum, exs. MCF 98/1807; **Jasen reserve:** Nova Bresnica vill. (below), Querco-Carpinetum orientalis, 14.10.2010, exs. MCF10/12561; **Kitka Mt.:** forest house Kitka 1300 m, meadow, 19.10.1998, exs. MCF 98/2222; **Krushevo (vicinity):** 1300 m, meadow, 15.10.2006; **Kumanovo (vicinity):** Staro Nagorichane vill., mixed forest, (*Populus, Betula, Alnus, Salix*), exs. MCF 05/8957; **Kozhuf Mt.:** Konsko vill. (above), Zajchev Rid, *Quercetum* with *Pinus* sp., 15.11.2009, exs. MCF 09/11294; **Mavrovo NP:** Zhirovnica vill. (above) Brezna, Festuco heterophyllae-Fagetum (with *Betula*) 03.10.2010, exs. MCF 10/12765; Zhirovnica vill. (above) Brezna, Festuco heterophyl-

lae-Fagetum (with *Betula*) 03.10.2010 exs. MCF 10/12216; Zhirovica vill. (above), Brezna, Festuco heterophyllae-Fagetum (with *Betula*) 03.10.2010; Rosoki vill., (above) Mlache, *Quercus cerris* forest, 10.10.2010, exs. MCF 10/12262; Kisevica vill. 974 m, mixed deciduous forest (*Alnus, Corylus, Acer pseudoplatanus*), 18.09.2010, exs. MCF 10/12023; Rostushe vill. (above), 1072 m, *Pinus nigra* plantings, 19.09.2010; **Near Skopje**: Matka, Osoj, 300 m, medow, 25.10.2006; **Vodno Mt.:** Krushopek vill. 800 m, meadow, 11.10.2005, MCF 05/5278; vill. Krushopek 800 m, meadow with *Juniperus*, 16.10.2005, exs. MCF 05/5299; **Osogovski Planini Mt.:** Ponikva, Calmintho grandiflorae-Fagetum, 1500-1600 m, 20.9.2001, exs. MCF 01/813; vill. Pripor (between Kocani and Gratce vill.), 723 m, *Quercus* and *Carpinus* forest, 14.11.2008; **Pelister Mt.: around vill. Kopanki**, 1500-1700 m, Digitali viridiflorae-Pinetum peuces with Fagus, 19.10.2005; vill. Rotino**,** 1000 m, oak forest, 26.10.2004, exs. MCF 04/4952; **The confluence of Pchinja river and Vardar river:** Pchinja river, azonal vegetation, 16.12.2009, exs. MCF 09/11499; **Shar Planina Mt.:** between Selce vill. and Banjiche, 800-600 m margins of deciduous forest, 11.10.2006; Kobilica, Kuchibeg (Vejce vill.), 2100-2500 m, 1.10.2006, high mountain pastures, exs. MCF 06/10912; Kobilica, Kobilichka Shuma (Brodec vill.),1200-1400 m, 1.10.2006, *Fagus* forest, exs. MCF 06/10913; **Skopska Crna Gora Mt.**: Brodec vill. (above), *Fagus* forest, 1.11.1999; Ljubanci vill., above St. Nikola monastery, 800-900 m, oak forest (*Quercus frainetto, Q. petraea, Castanea, Carpinus)*, 11.10.2008, exs. MCF 08/10396; Ljubanci vill., around St. Nikola monastery, 800 m, Querco-Carpinetum orientalis, 9.10.2005, exs. MCF 05/2465; **Tetovo:** below Kale 450-500 m, edge of deciduous forest, 11.10.2006; **Valandovo:** around St. Gjorgija monastery, Coccifero-Carpinetum orientalis, 16.12.2006; **Veles:** Izvor vill., Umin Dol, 300 m, Querco-Carpinetum orientalis, 5.11.2007, exs. MCF 07/8352.

6. Macrolepiota procera (Scop.: Fr.) Singer

Ref.: Karadelev 1999b, Karadelev, Rusevska 2000, Karadelev 2000a, Karadelev 2000d, Perić et al. 2001, Karadelev et al. 2002b, Karadelev et al. 2003a, Karadelev, Rusevska 2004, Karadelev et al. 2008d

Collections: MCF.

Bogdanci: Bolovan, 200 m, Querco - Carpinetum orientalis, 1.6.2003; Bolovan, Paljurci 150 m, Juglando- Platanetum orientalis, 11.1992; Kozarnik, 200 m, *Pinus* plantations, (*Pinus nigra*, *P. pinea, P. halepensis*), 24.10.2006, very frequent; North hill, 150 m, meadow, 17.10.2010; Pobregovo, *Robinia pseudoacacia* plantings, 20.10.1989; **Belasica Mt.:** Bansko, the water coverage, 4.11.2010; **Bigla Mt.:** Cer (15 km north-west from Krushevo); **Bistra Mt.:** Mavrovo, Fago-Abietetum meridionale, 29.10.2009; Mavrovo, Bunec, beech forest; **Demir Hisar:** Čagor, near the river, 645m, 1.10.2009, exs. MCF 09/11310 **Dobra Voda Mt.:** Jagol Dolenci vill. oak forest, 14.10.2006; 12.10.2008, Quercetum frainetto-cerris, exs. MAK 08/10915; Strajane vill. (near Srbinovo), 950 m, 25.10.2008, Quercetum frainetto-cerris, exs. MAK 08/10914; Popovjane vill., Gorica, meadow in Quercetum frainetto-cerris, 23.10.2007; **Dojran:** Crnichini vill., 200 m, 30.10.1987; **Galichica Mt.:** Mala Galichica, high mountain pasture, 15.07.2010 exs. MCF10/13409 Stenje vill., Quercettum frainetto-cerris, 22.10.2005, MMS; Trpejca vill., 800 m, oak forest; **Jakupica Mt.:** Cheples, 12.8.1995; Chestak, near vill. Oreshche, 800-900 m, Quercetum frainetto-cerris, 15.7.1999, exs. MCF 99/2022; Gorno Vranovce vill., 8.11.1998; **Karabalija:** Bolovan, 150 m, Juglando - Platanetum orientalis, 27.9.2003, exs. MCF 03/3444; **Kavadarci:** Vitachevo, near the lake, *Pinus* and *Quercus* forest, 17.10.1998; Vitachevo, *Pinus* plantings, 28.9.1998; **Kichevo:** Staorec vill., meadow, 8.10.2006; **Kozhuf Mt.:** Konjsko vill., meadow, 5.10.1996; Visoka Chuka, 1000 m, Festruco heterophyllae-Fagetum, July1998; **Kozjak:** Nagorichani vill., by the r. Pchinja, azonal vegetation, September 2005; **Kumanovo:** Zhegljane vill., *Pinus* plantings, 31.10.2007; **Mariovo:** road to Vitolishte vill., meadow, 11.10.2005, exs. MCF 05/5433; Shtavica vill. 500m, 7.10.2009; **Mavrovo NP:** Bitushe vill.(above), fountain, *Fagetum* forest, 19.09.2010; Bitushe vill, (watch tower) *Fagetum* forest, 19.09.2010; Crveni krasti, 1359 m, mixed forest *Fagus, Quercus* 2.10.2010; Vrben vill., *Abies* forest, 22.09.2010, exs. MCF 10/12405; Zhirovica vill. (above), Brezna, 1143 m, Festuco heterophyllae-Fagetum (with *Betula*), 3.10.2010; **Ograzden Mt.:** Chanaklija, 425 m, forest with *Pinus*; Ezhov Rid, 1100-1200 m, 10.09.1995 forest from *Fagus* and *Pinus*; **Osogovski Planini Mt.:** Konopnica vill. 1100 m, meadow, 14.7.2003; **Probishtip (vicinity):** 2007; **Serta Mt.:** Lipa vill. 500 m, oak forest, 11.10.2002, exs. MCF 02/6588; **Shar Planina Mt.:** between Popova Shapka and Jelak, meadow with *Juniperus*, 16.10.2000; Kobilica, Gornovica (Vejce vill.), 1600-2000 m, high-mountaine pasture, 1.10.2006; Mala Smreka, 1800 m, high montain pastures, 8.9.2006; Vratnica vill. oak forest under *Castanea*, autumn period; **Skopje:** Vodno, above St. Pantelejmon monastery, mixed plantings *(Castanea, Quercus*) 27.09.2009; Vodno 2.11.1992; **Skopje vicinity:** Vodno, between St. Pantelejmon and Sredno Vodno, *Quercus*, *Pinus*, *Acer*, *Castanea*, *Juniperus*, 12.10.1998; Vodno, top 1000 m, mixed anthropogenic forest, 4.09.2009; **Skopska Crna Gora Mt:** Brodec vill. (above), pasture; Chucher-Sandevo vill. (above), 600 m, degradated oak forest (Querco-Car-

pinetum orientalis), 6.10.1998; Ljubanci vill., above St. Nikola monastery, 800-900 m, meadow in oak forest with *Castanea* plantings, 15.10.2006; Ljubanci vill., above St. Nikola monastery, 800-900 m, oak forest with *Castanea* plantings, 15.10.2006; Ljubanci vill., above St. Nikola monastery, 773 m, oak forest (*Quercus frainetto, Q. petraea, Castanea, Carpinus*), 11.10.2008; Ramno, arable land with potatoes, 19.09.2009; Ramno, meadow, 19.09.2009; Rashtak vill., oak, 1.10.1998; Rashtak vill., 700 m, oak forest, 22.10.2006; **Suva Gora Mt.:** Trebovle vill. (Porechje), 11.10.2011; Trebovle vill. (Porechje), *Quercus* forest with *Pinus* plantings, 11.10.2011, exs. MCF 11/13396; **Tetovo:** Kale (below), 450-500 m, vine yard in deciduous forest, 11.10.2006; **Veles:** between Pomenovo vill. and Omorani vill., 400-500 m, meadow, 24.10.1992; between Pomenovo vill. and Omorani vill., 400-500 m, meadow; Izvor vill., Umin Dol, 300 m, 7.11.1992; **Jakupica Mt.:** Bogomila vill., *Quercus* forest (with *Fagus*), 3.10.2010, exs. MCF 10/12099; **Ograzhden Mt.:** Ezhov Rid, 1100-1200 m, *Fagus* and *Pinus* fores, 10.09.2005.

7. ***Macrolepiota rhacodes*** (Vitt.) Singer

Ref.: Karadelev 2001a, Karadelev, Rusevska 2004, Karadelev et al. 2004a
Collections: MCF.

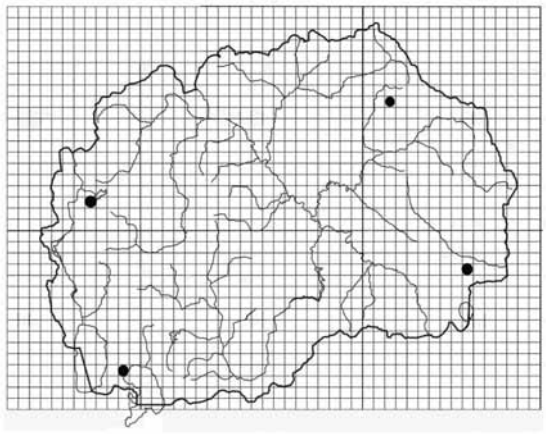

Fig. 5. Distribution of *Macrolepiota rhacodes* in Macedonia

Сл. 5. Дистрибуција на *Macrolepiota rhacodes* во Македонија

Belasica Mt.: Smolarski waterfall, 490 m, 3.11.2010; **Bistra Mt.:** Mavrovo, Bunec, beech forest, 2011; **Galichica Mt.:** stall, 5.11.2008, exs. MCF 08/10820; **Osogovski Planini Mt.:** Durachka Reka vill., edge of *Fagus* forest, 16.10.2007, exs. MCF 07/8130.

8. ***Macrolepiota rhacodes*** **var.** ***hortensis*** (Pilát) Wasser

Ref.:
Collections: MCF.

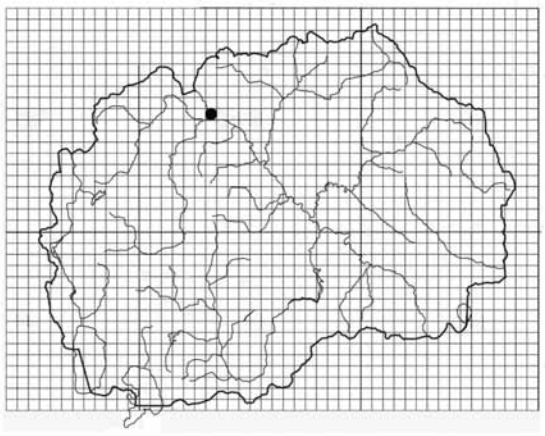

Fig. 6. Distribution of *Macrolepiota rhacodes* var. *hortensis* in Macedonia

Сл. 6. Дистрибуција на *Macrolepiota rhacodes* var. *hortensis* во Македонија

Skopje: Gazi Baba, Faculty of Natural Science and Mathematics, 250 m, park, 10.10.2006, exs. MCF 06/6025.

Disscusion

Macrolepiota excoriata (Schaeff.: Fr.) Waster, grows alone or in groups, on soil, in mixed forest with fruiting in spring till autumn. *Macrolepiota excoriata* is characterized by pale scales that appear star - shaped and basidia provided of fibulae baseline (Vellinga 2001: 70). In the Republic of Macedonia it is known to grow at the following localities: Bistra Mt. (meadow with *Juniperus*; Karadelev & Rusevska 2004), Dobra Voda Mt. and Kitka Mt. in meadows, Osogovo Mt. (meadow in *Populus nigra* plantings). According to this data, it is frequent species. All the above mentioned localities are new for this species except for Bistra Mt. This species is edible (Figure1).

Macrolepiota gracilenta (Krombh.) Wasser, grows on edge of woods, meadows and clearings and fruiting from summer till autumn. In the Republic of Macedonia two localities have been recorded: Bistra Mt. (Karadelev 2000d) and Kozhuf Mt. It is found in the associations of Festuco heterophyllae-Fagetum. According to this data, it is rare species. Kozhuf Mt. is a new locality for the mycobiota of the Republic of Macedonia. This species is edible. (Figure 2).

****Macrolepiota heimii*** (Locq.) Bon., Solitary to grouped, in meadows, in herbaceous places in gardens and parks (Breitenbach & Kränzlin 1995). In Macedonia it has been observed at one locality, Suva Gora Mt. It is found in *Quercus* forest with *Pi-*

nus plantings and meadows. According to these data, it is rare species, which is published in this paper for the first time. *Macrolepiota heimii* fruiting from summer to autumn and is poisonous. (Figure 3).

Macrolepiota konradii (Huijsman ex P.D. Orton) M.M. Moser, grows alone or in groups from summer till autumn, on marginal areas of deciduous forests, mixed forests, meadows and pastures. In Macedonia it is known from the following localities: Galichica Mt. (Quercetum frainetto-cerris), near Skopje (Querco-Carpinetum orientalis), Pelister Mt. (Karadelev et al. 2003a), Jakupica Mt. (*Quercus* forest with *Fagus* and *Pinus*) between 320 and 1300 m altitude. It is very frequent in Europe and Macedonia. This species is edible. (Figure 4).

Macrolepiota mastoidea (Fr.: Fr.) Singer., This species bears fruit in grassy areas, grasslands, sometimes in clear woods. Grows in small groups or isolated. Fruiting in late summer. According to Karadelev 2000d , Karadelev 2001a, Karadelev & Rusevska 2004, Karadelev et al. 2008d, this species have been observed on 39 localities, 13 of which are new: Galichica Mt., Jasen reserve, Kozhuf Mt., Mavrovo NP (villages: Kisevica, Rosoki, Rostushe, Zhirovica, Brezna), Osogovski Planini Mt., Shar Planina Mt., vicinity of Skopje, the confluence of the rivers Pchinja and Vardar. It grows in the following association: Calamintho grandiflorae-Fagetum, Quercettum frainetto-cerris, Festuco heterophyllae-Fagetum, Querco-Carpinetum orientalis, *Pinus nigra* plantings, Digitali viridiflorae-Pinetum peuces with *Fagus*, Coccifero-Carpinetum orientalis, between 200 and 2500 m altitude. According to the current data it is very common and widespread species in Macedonia. It is very common in Europe as well. This species is edible.

Macrolepiota procera (Scop.: Fr.) Singer., Grows in areas like other species from the same genus in deciduous and coniferous forest, sometimes can be found in degrade forest too, in open areas, meadow, high pastures. Fruiting in spring till late autumn. According to Karadelev 1999b, Karadelev & Rusevska 2000, Karadelev 2000a, Karadelev 2000d, Perić et al. 2001, Karadelev et al. 2002b, Karadelev et al. 2003a, Karadelev & Rusevska 2004, Karadelev et al. 2008d, is found between 150 m and 2100 m altitude. This species has been registered in more than 70 localities in following associations: Fago-Abietetum meridionale, Calamintho grandiflorae-Fagetum, Querco- Carpinetum orientalis, Juglando- Platanetum orientalis, *Pinus* plantings (*Pinus nigra, P. pinea, P. halepensis*), Quercetum frainetto-cerris, Festuco heterophyllae-Fagetum (with *Betula*) and Digitali viridiflorae-Pinetum peuces. According to the current data it is very common and widespread species in Macedonia. It is very common in Europe as well but in our country is on the red list, because of overexploitation.

Macrolepiota rhacodes (Vitt.) Singer and *Macrolepiota rhacodes* var. *hortensis* are growing alone or in groups, in gardens, cultivated areas, pastures and forests of deciduous and coniferous forest. It is fruiting from summer to autumn. In Macedonia it is found in five localities such as Bistra Mt., Galichica Mt., Osogovo Mt., Belasica Mt. and Skopje (*M. rhacodes.* var *hortensis*). Three of them were published: Galichica Mt., Osogovski Mt. and Skopje (Karadelev 2001a, Karadelev and Rusevska 2004, Karadelev et al. 2004a). The mountains Belasica and Bistra are new localities for this species. It is found in beech forest, between 200-900 m altitude. *Macrolepiota rhacodes* var. *hortensis* is poisonous species and very rare in Macedonia. (Figures 5 and 6).

Conclusion

Of about 30 species of the genus *Macrolepiota* known in the world, in Macedonia the following seven species and one variety are known: *Macrolepiota excoriata, Macrolepiota gracilenta, Macrolepiota heimii*, *Macrolepiota konradii*, *Macrolepiota mastoidea*, *Macrolepiota procera*, *Macrolepiota rhacodes*, *Macrolepiota rhacodes* var. *hortensi*s. All these species have European distribution according to Breitenbach, J. & Kränzlin, F. (1995). *Macrolepiota heimii* is new species for the Republic of Macedonia. It is known that all *Macrolepiota* species are saprobes. There are two poisonous species in Macedonia: *M. heimii* and *M. rachodes* var. *hortensis (*Breitenbach, J. & Kränzlin, F. 1995). *Macrolepiota Procera* is red listed because of overexploitation. Some localities where these fungi were found are presented on Figures 1, 2, 3, 4, 5 and 6. The species which are known from one or two localities need further investigations to provide a more comprehensive review on the ecology and distribution of this systematic category in the Republic of Macedonia.

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LICHENS AND LICHENICOLOUS FUNGI AROUND LAKE GÖKPINAR (GÜRÜN-SİVAS-TURKEY)

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Abstract

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A contribution to the lichen and lichenicolous fungi biodiversity of Turkey is presented. In this study, fifty four lichens and lichenicolous fungi are reported from 6 localities around the Lake Gökpınar (Gürün) within the boundaries of the Sivas Province. There is no published data on lichenized and lichenicolous fungi of Gürün. For this reason, all of the reported taxa in this study are new records for the area; 37 of these taxa are new records for the Sivas Province. All species grow on gypseous rocks. *Acarospora cervina, Caloplaca variabilis, Diplotomma epipolium, Placocarpus schaereri, Protoparmeliopsis muralis* are common on calcareous rocks. Gürün district is very important in terms of (plant) endemism. In addition, the type locality of the lichenicolous fungus *Lichenostigma anatolicum* Halici & Kocakaya on *Acarospora* sp. and the lichenized fungus *Sarcogyne magnispora* K. Knudsen & Halici are from this area.

Keywords: biodiversity, endemism, Gürün, lichens, lichenicolous fungi.

Introduction

Although studies on Turkey lichens were initiated about thirty years ago, they have been intensified in the last 5-6 years: Halıcı (2009); Kocakaya (2009); Candan (2008). Studies on lichenicolous fungi have only commenced recently (Halıcı 2008), therefore, there is a rather large gap in the above mentioned studies.

Recent studies concerned a wide range of biodiversity in Turkey but there have only been a few lichen records from Sivas Province (John 2000, 2006).

The aim of the current study is providing contribution to lichen biodiversity of Sivas Province and Turkey.

Materials and methods

Lichen samples were collected from 6 localities around Lake Gökpınar, on 09.08.2008 and 10.08.2008. The samples were identified according to the following identification books: Purvis (1992); Wirth (1995); Timdal (1991). Field equipment was taken for collecting samples with their substrates (hammers, chisels, knives etc). Onion-skin papers were taken for wrapping of samples. Notebook and pencils were taken for writing information related to the field and the collected samples. OLYMPUS SZ60 stereo microscope, OLYMPUS CHK light microscope, ocular micrometer, and chemical reagents such as potassium hydroxide, calcium hypochlorite, phenylenediamine, Lugol‘s solution were used for determination in the laboratory.

List of Localities:

1. Turkey, Sivas (58), Gürün, Gökpınar, 38° 39.328’ N 37° 18.255’ E, 1,486 m, 09.08.2008.
2. Turkey, Sivas (58), Gürün, Gökpınar, 38° 39.251’ N 37° 18.108’ E, 1,550 m, 09.08.2008.
3. Turkey, Sivas (58), Gürün, Gökpınar, 38° 39.304’ N 37° 18.149’ E, 1,506 m, 09.08.2008.

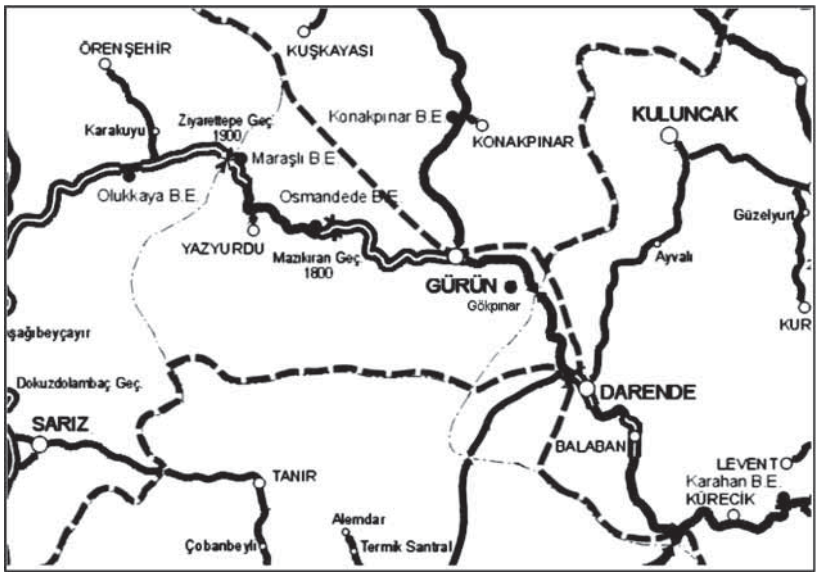

Fig. 1. Map of the study area

4. Turkey, Sivas (58), Gürün, Gökpınar, 38° 39.337' N 37° 18.070' E, 1,500 m, 09.08.2008.
5. Turkey, Sivas (58), Gürün, Gökpınar, 38° 39.111' N 37° 18.070' E, 1,562 m, 10.08.2008.
6. Turkey, Sivas (58), Gürün, Gökpınar, 38° 39.071' N 37° 18.309' E, 1,620 m, 10.08.2008.

Investigated area

Climate

Gürün, which was our studied area, does not have a weather station, unfortunately. So, Pınarbaşı (town of Kayseri) climatic data have been used, a town which is located west of the studied area and has almost the same climatic conditions. According to this data, the average annual precipitation is 405 mm, the average annual temperature is 7.7°C, the average minimum temperature of the coldest month is -9°C, and the average maximum temperature of the warmest month reaches 27.5°C. Steppe vegetation is dominant in the region.

Geomorphological Conditions

The studied area is located within the Eastern Taurus Zone. The geological development of this region has been in process from the early Devonian to present day. Pınarbaşı ophiolites settled on carbonate units (East Limestone) before Maastrichtian. As a result of the jamming effect of the contraction in the region starting from the early Paleocene NS and NW-SE compression and EW, NE-SW direction as a result of stress folds, reverse faults, strike and dip-slip faults have been developed. There are foldings especially in the Gürün formation. Munzur limestones have developed as autochthonous units (Kaçaroğlu, 2006).

Results

The identified species are given in alphabetical order. The number of each of the localities has been written next to the species name. The species that are new to the province of Sivas are marked with "*".

Acarospora cervina A. Massal. 1, 2, 3, 5

**Acarospora scabra* (Pers.) Th. Fr. 1

**Arthonia molendoi* (Heufl. ex Frauenf.) R. Sant. 1

**Aspicilia calcarea* (L.) Mudd. 1

Aspicilia contorta subsp. *hoffmanniana* S. Ekman & Fröberg 1, 2, 3, 4, 5

Aspicilia desertorum (Kremp.) Mereschk. 1, 3

**Aspicilia farinosa* (Flörke) Motyka 3

**Caloplaca agardhiana* (A. Massal.) Clauzade & Cl. Roux 1, 4

**Caloplaca alociza* (A. Massal.) Mig. 3

**Caloplaca chalybaea* (Fr.) Müll. Arg 1

**Caloplaca dolomiticola* (Hue) Zahlbr. 1

**Caloplaca flavovirescens* (Wulfen) Dalla Torre & Sarnth. 2, 5

Caloplaca holocarpa (Hoffm.) A.E. Wade 3

Caloplaca lactea (A. Massal.) Zahlbr. 4

**Caloplaca tiroliensis* Zahlbr. 6

Caloplaca variabilis (Pers.) Müll. Arg. 1, 2, 3, 4, 5

**Caloplaca xantholyta* (Nyl.) Jatta 4

Candelariella vitellina (Hoffm.) Müll. Arg. 2, 3, 5

**Cercidospora epicarphinea* (Nyl.) Grube & Hafellner, lichenicolous fungi on *Caloplaca agardhiana*, 1

**Collema flaccidum* (Ach.) Ach. 6

**Dermatocarpon miniatum* (L.) W. Mann 4

**Diplotomma epipolium* (Ach.) Arnold 1, 2, 6

Diplotomma pulverulentum (Anzi) D. Hawksw.

lichenicolous lichen on *Physconia grisea*, 3

Fulgensia fulgens (Sw.) Elenkin 6

**Fulgensia schistidii* (Anzi) Poelt 3

**Lecania nylanderiana* A. Massal. 1

**Lecanora agardhiana* Ach. 3

**Lecanora dispersa* (Pers.) Röhl. 2, 3, 5

**Lecanora flotowiana* Spreng. 1

Lecanora usbekica Poelt 5

Lecidella carpathica Körb. 3

**Lecidella patavina* (A. Massal.) Knoph & Leuckert 3

Lecidella stigmatea (Ach.) Hertel & Leuckert 1, 2, 5, 6

**Lichenostigma anatolicum* Halici & Kocakaya, lichenicolous fungi on *Acarospora sp*., 6

**Lobothallia alphoplaca* (Wahlenb.) Hafellner 4

**Lobothallia radiosa* (Hoffm.) Hafellner 1, 3

**Muellerella lichenicola* (Sommerf.) D. Hawksw., lichenicolous fungi on *C. holocarpa*, 3

**Muellerella pygmaea* (Körb.) D. Hawksw., lichenicolous fungi on *Aspicilia contorta* subsp. *hoffmanniana*, 1

**Physcia dubia* (Hoffm.) Lettau 3

**Physconia grisea* (Lam.) Poelt 3

**Physconia muscigena* (Ach.) Poelt 5

**Placocarpus schaereri* (Fr.) Breuss 2, 3, 4, 5

Protoparmeliopsis muralis (Schreb.) M. Choisy 1, 2, 3, 4, 5, 6

Rinodina bischoffii (Hepp) A. Massal. 1

Rinodina calcarea (Arnold) Arnold 2, 3, 5

Rinodina immersa (Körb.) Arnold 1, 2, 3

**Rinodina lecanorina* (A. Massal.) A. Massal. 2, 4

**Sarcogyne magnispora* K. Knudsen & Halici 2

**Staurothele areolata* (Ach.) Lettau 6

**Toninia candida* (Weber) Th. Fr. 1

**Toninia rosulata* (Anzi) H. Olivier 4

**Verrucaria nigrescens* Pers. 2, 3, 4

Xanthoria elegans (Link) Th. Fr. 3

**Zwackhiomyces sphinctrinoides* (Zwackh) Grube & Hafellner, lichenicolous fungi on *C. variabilis*, 4

Discussion

In this study, 54 taxa belonging to 27 genera were identified around the Lake Gökpinar (Gürün-Sivas). All of the taxa are new records for the area. In addition, 37 taxa are new records for Sivas Province. Limestone-preferred species like *Acarospora cervina, Caloplaca variabilis, Diplotomma epipolium, Placocarpus schaereri* and *Protoparmeliopsis muralis* were found as quite abundant on calcareous rocks. *Diplotomma pulverulentum* was found as lichenicolous lichen on *Physconia grisea. Placocarpus schaereri* was identified, especially in the young stages, as a parasite on *Protoparmeliopsis muralis.* This information is identical with the available literature data.

Following lichenicolous fungi have also been found in the studied area: *Cercidospora epicarphinea* on *Caloplaca agardhiana*, *Muellerella lichenicola* on *Caloplaca holocarpa*, *Muellerella pygmaea* on *Aspicilia contorta* subsp. *hoffmanniana* and *Zwackhiomyces sphinctrinoides* on *C. agardhiana*. Almost all taxa were found on calcareous rocks. The number of recorded species was insignificant due to a lack of habitats diversity around the study area.

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DISTRIBUTION AND CONSERVATION STATUS OF THE BALKAN LYNX (*Lynx lynx balcanicus* Bureš, 1941)

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Abstract

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Population size and distribution of a target species are among the most important features in conservation biology. By knowing these parameters, an effective management for conservation can be applied in the range countries of its distribution. This is particularly relevant for the smallest and long-term isolated autochthonous populations of the Eurasian lynx in Europe. In 1941, zoologist Ivan Bureš was the first to acknowledge the subspecies status of the Balkan lynx - *Lynx lynx balcanicus* Bureš (1941). However, this subspecies has never been recognized by a wider scientific public, even though morphometric and genetic analysis support the subspecies status. The topic of the critical status of the Balkan lynx has become even more alarming with a recent dramatic decline in population size and the probability of extinction in the near future.

The main objectives of this paper are to present the distribution range, population size and conservation status of the Balkan lynx. We have used three data sets in order to achieve the above mentioned goals: literature data, questionnaires from a baseline survey performed in the study area (western Macedonia and eastern Albania) and camera-trapping results. The conservation status of the Balkan lynx was assessed using the Species Information Service of the IUCN. The distribution range was calculated taking into account the IUCN standards, thus focusing on the Area of Occupancy (AOO) and Extent of Occurrence (EOO). The population size was calculated using the Area of Occupancy and the mean density of the Balkan lynx inside the Mavrovo NP extrapolated from the data acquired during the systematic camera-trapping session in 2010. The results show a decline in population size in comparison with the results of the baseline survey. The pessimistic scenario for the population size of the Balkan lynx is pointing to only 20 to 44 mature individuals, while the most optimistic one, to 220 individuals. These individuals are distributed mainly in the western part of Macedonia and eastern Albania. No firm evidence could be obtained for the presence of the Balkan lynx in the North of the study area (Kosovo and Montenegro). The Area of Occupancy for the Balkan lynx is probably between 4,000-20,000 km^2. According to the IUCN Red List criteria, the conservation status of this taxon is Critically Endangered (CR (C2a(i,ii)D). We suggest taking urgent measures in order to save the Balkan lynx from extinction.

Key words: Balkan lynx, *Lynx lynx balcanicus*, distribution range, population size, status, historical review, IUCN Red List assessment.

Introduction

A small and long-term isolated population of the Eurasian lynx has survived in the south-western Balkans till present. The Balkan lynx was for the first time described as a separate subspecies in 1941 by the Bulgarian zoologist Ivan Bureš (*Lynx lynx balcanicus* Bureš, 1941). Almost 40 years later, the Serbian mammologist Gjoge Mirić did much more fundamental description of this subspecies but also gave a different scientific name (*Lynx lynx martinoi* Mirić, 1978). Even though this taxonomic status was never officially recognised by the wider scientific public, today's taxonomists and ecologists believe that Bureš's *balcanicus* should be considered as a legal name of the Balkan lynx (Krystufek, in press; Melovski 2012).

The issue of the Balkan lynx attracted many other scientists and conservationists in Europe because of its critical status in the 20th century. Being in the verge of extinction before and during the Second World War, the authorities in that time's Yugoslavia decided to grant this animal a legal status of protection. Very soon, the population started to recover and by 1974, the lynx population in the southwestern Balkan Peninsula counted around 280 individuals (Mirić 1981). However, these estimates were done taking into consideration very basic knowledge on lynx' ecological knowledge in general. Mirić estimated that these individuals in average shared 30 km^2 of a home range size, which in nowadays radio-telemetry studies is considerable underestimation (Sunde et al. 2000; Linnell et al. 2001; Breitenmoser-Würsten et al. 2007; Okrama et al. 2007).

The period in the 1990's and early 2000 was a nuisance for the wildlife of the Balkans. The split of Yugoslavia, the civil unrest in Albania and the ethnic conflicts in Serbia, Kosovo and Macedonia were part of the factors that brought back the Balkan lynx on its verge. Poor law enforcement and the appalling development politics of these countries in transition placed the nature conservation in the last priorities.

Having the above mentioned in mind, a group of external experts from Switzerland and Germany with local NGO's from Macedonia and Albania started the implementation of the ever first project for the conservation of the Balkan lynx. The Balkan Lynx Recovery Programme is an applied conservation project that began in 2006 and aiming in building capacities on a local level for a long-lasting monitoring and conservation of the Balkan lynx, assessing the conservation status of the Balkan lynx, rising the awareness in nature protection in the region while involving with rural communities and working towards the establishment of the new protected areas.

In this paper we are focusing on: 1. assessing the distribution and conservation status of the Balkan lynx population through surveying the present status of the population (distribution and population size) based on the local ecological knowledge and 2. listing the conservation status of the Balkan lynx according to the IUCN Red List criteria. The main data sets used in this paper are the questionnaire performed in Macedonia and Albania in order to determine the presence of the Balkan lynx, as well as the camera-trapping results to find out the potential population size. Finally, the gathered data were used so that we can evaluate the official status of the Balkan lynx according to the standards of the IUCN Red List of threatened species.

Methods

Study area

The study area within Albania and Macedonia was selected taking into account the already known biology and ecology of the Eurasian lynx. Unsuitable areas for lynx such as plains, big-river valleys, ravines, non-forested and low-elevation hillsides were excluded from the survey. In Macedonia, mountains west of river Vardar were taken as most relevant (Fig. 1). In Albania, all the mountains in the northern and eastern part of the country, bordering with Montenegro, Kosovo, Macedonia and Greece belong into the survey area. The study area was designated using a 10x10 km grid map (100 km^2) of the countries (Fig. 1). For better interpretation of the results (analyses and comparison), the study area (eastern Albania and western Macedonia) was divided into several topographical and/or political regions (separated by mountains, big rivers and state borders). In order to include the whole potential range of the Balkan lynx, we have consulted the relatively recent papers on its distribution for Montenegro and Kosovo.

Present status and distribution of the Balkan lynx based on the LEK

LEK stands for Local Ecological Knowledge. Local peoples' knowledge on abundance and distribution of species is gained through individuals' observation in their lifetime. It is a commonly used method for qualitative estimates of presence and abundance of species, as well as quantitative assessment on population trend (Anadon et al. 2009). Across the entire potential distribution area in both countries we used a questionnaire (Baseline Survey) to compile local peoples' knowledge. The questionnaire included 13 wildlife species and 50 questions divided into six categories. The first group of questions was related to the presence, abundance and trend of the targeted species over a period of the past 5 years from when the questionnaire was made. The

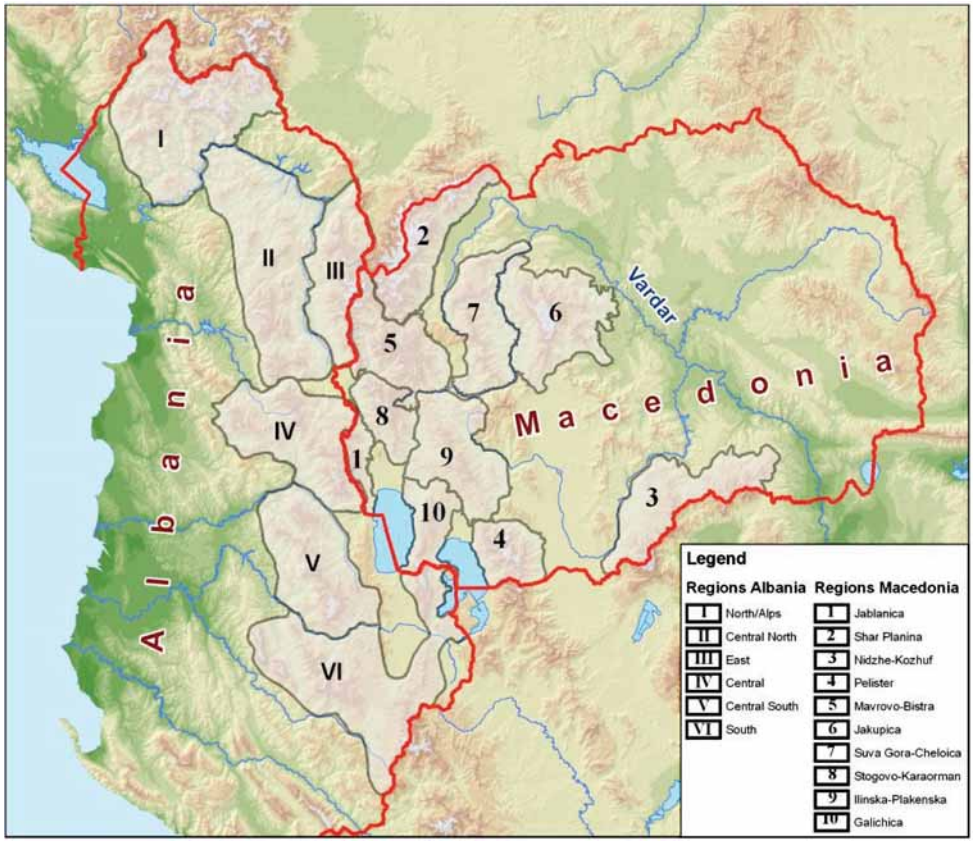

Fig. 1. The study area divided in regions.

second group is related to the conflicts between people and large carnivores and the human attitudes towards them. Socio-economic aspects of the villages are addressed in the third group of questions, while some detail information on livestock breeding and damage compensation system are asked in the fourth group of questions. The fifth and the sixth group of questions deal with general information on the person interviewed and the village in which he/she lives. For the purpose of this paper, we've considered only the first group of questions. Particularly, distribution pattern and trends are outlined only for the lynx, as well as its main prey species (roe deer, chamois and brown hare). The sample design focussed on people relevant for the study: hunters, game wardens, foresters, livestock breeders, beekeepers, farmers, veterinarians, naturalists but also owners of cafeteria or markets as well as a random sample of informants which did not fall in one of the mentioned profiles. The interviewing technique was face-to-face and the questionnaire was completed at the time of interviewing in order to avoid misinterpretation of data. During the survey, verified lynx findings such as: stuffed animals, lynx pelts, museum specimens, photographs of lynx were considered as a Category 1 data or "Hard facts". Records of livestock killed, wild prey remains, tracks and scats reported and confirmed by trained people, we considered as Category 2 data, whereas the positive interviews during the questionnaire for lynx sightings, as well as accidental and unverified lynx-observation reports fall into the Category 3 (Molinari-Jobin et al. 2003). Furthermore, camera-trapping photos of a lynx are considered Category 1 data.

We assessed the presence of predator and prey species according to the number of positive answers per grid cell. Each grid cell within the Baseline Survey questionnaire with more than 50 % positive answers indicates good evidence for presence. Less than 50 % indicates scarce presence. Evidence for scarce presence was added to the previous results as a potential area of the lynx, outside the most probable area of distribution. No positive answers indicate that the species is not present. We estimated the **Minimum Grid Range** (MGR_{min}) of the Balkan lynx by counting the number of grid cells with more than 50% positive answers per 100 km². The **Maximum Grid Range** (MGR_{max}) is the number of grid cells with at least one positive answer per 100 km². The polygon for Balkan lynx distribution according to the findings from the Baseline Survey is shaped considering the natural and anthropogenic boundaries in the landscape (plains, big rivers, towns, high mountain pastures etc.). We used the Corine Landcover (www.eea.europa.eu/publications/COR0-landcover) system and followed the forest areas or patches in-

side or closely outside the cells. In cases with some grid cells when the natural or anthropogenic border was not clearly defined, or could not be established, the forested areas according to the Corine Land-cover was most important feature to follow. In order to represent the whole potential range of the Balkan lynx, its distribution range was extended into the three neighbouring countries in the north (Kosovo, Montenegro and Serbia (south-western part)), referring to the most recent research (Grubač 2000, 2002) and expert opinion (Paunović et al. 2001). Grubač's research is based on interviews with local people and these data are considered Category 3. In this way, we have outlined the present Balkan lynx distribution with an area calculation for both: **Area of Occupancy** (AOO) and **Extent of Occurrence** (EOO). While the AOO is a very detailed range of likely and possible distribution pattern of the Balkan lynx, the EOO is the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of the Balkan lynx, excluding cases of vagrancy. The EOO can be measured using the Minimum Convex Polygon (MCP) – the smallest polygon in which no internal angels exceeds 180° and which contains all the sites of occurrence (IUCN, 2008). The EOO are also sites which haven't been searched for (or at least not in a near past), but contain known appropriate habitat for lynx presence. We have come up with two different values for AOO and EOO depending on the data taken for their calculation. The **Minimum Area of Occupancy** (AOO_{min}) was obtained taking only the Category 1 and 2 data for Macedonia and Albania later than year 2000 as an adjusted polygon. The **Maximum Area of Occupancy** (AOO_{max}) was calculated taken the Category 1, 2 and 3 data for Macedonia and Albania later than the year 2000; C3 data for Montenegro and Kosovo were taken from the recent literature and the MGR_{max} as an adjusted polygon. Considering the two different values obtained for the AOO, the MCP for EOO was also calculated with two different values. The **Minimum Extent of Occurrence** (EOO_{min}) is the MCP including all AOO_{min} polygons, while the **Maximum Extent of Occurrence** (EOO_{max}) is the MCP including all AOO_{max} polygons. The area calculations for both, AOO and EOO are computed in the GIS ArcMap software.

Estimation of the population density and size

We took two different data-sets in order to calculate the size and density of the Balkan lynx population: camera-trapping in a reference area and Baseline Survey data on Balkan lynx distribution. The population density was directly calculated taking the results from the two systematic camera-trapping sessions in one reference area (Mavrovo NP, Macedonia) in 2008 and 2010. Mean value of the two session is presented and then used with the intention of calculating the population size. This was done by extrapolating the population density (number of lynx individuals per 100km^2 in the reference area, over the whole distribution range of the Balkan lynx. We used the simple equation:

$$\frac{X * Y}{100},$$

where X is the **minimum** or **maximum** value of the Area of Occupancy (AOO_{min} or AOO_{max}, respectively; see above) and Y is the population density taken from the camera-trapping findings. According to IUCN (2008), AOO is a useful proxy for the population size, because there is generally a positive correlation between AOO and population size.

The camera-trapping results were also used for calibration of the distribution pattern of the Baseline Survey data, by confirming the presence of the Balkan lynx in, until recently, doubtful areas and for a better calculation of the Area of Occupancy and Extent of Occurrence during the IUCN Red List assessment. Camera-trapping data are 'hard-facts' data of their own.

The results obtained from the above-mentioned methods were used to give explanation to the two possible scenarios:

- Pessimistic scenario: Taking the standard deviation of the population density into account; the lowest, highest and the mean value of the population density gained from the camera-trapping in the reference, core area will be extrapolated into the **minimum value** of the Area of Occupancy (AOO_{min}) of the Balkan lynx. These results reveal the frame of the population number for its minimum range of distribution.
- Optimistic scenario: Taking the standard deviation of the population density into account; the lowest, highest and the mean value of the population density gained from the camera-trapping in the reference, core area will be extrapolated into the **maximum value** of the Area of Occupancy (AOO_{max}) of the Balkan lynx. These results reveal the frame of the population number for its maximum range of distribution.

Assessment of the conservation status

The IUCN Red List assessment was carried out using the Species Information Service toolkit (online available at: https://sis.iucnsis.org). The toolkit helps the assessor as accurately as possible to assess

the red list category of a species. The results for the assessment of the conservation status are discussed in three main directions: population status (area and size of the population), population development (size and trend) and threats to the population.

We assessed the population trend of the Balkan lynx by asking each interviewee during the Baseline Survey questionnaire for the population dynamics during the last 5 years per grid cell. When more than 75 % of interviewees answered that the population is increasing, decreasing or stable in any one grid cell, then this was interpreted as a strong evidence for the population trend. When 50 – 75 % of interviewees had same judgment for the trend in any one grid cell, this was interpreted as a weak evidence for population trend. If less than 50 % of interviewees gave the same response regarding trend for any one grid cell, the trend was considered non-assessable.

Threats obtained from the Baseline Survey are also part of the IUCN assessment. Baseline Survey questions are taking into consideration the persecution of the lynx – as a direct threat and the presence/absence and negative trend of its main prey, as an indirect one. The following species were considered as main prey of the Balkan lynx: roe deer (*Capreolus capreolus*), chamois (*Rupicapra rupicapra*) and the brown hare (*Lepus europaeus*), due to literature reviews (Jobin et al. 2000; Molinari-Jobin et al. 2007) and a radio-telemetry study in Macedonia. Cases of poached lynx individuals were classified in three periods: before 1990, between 1990 and 2000 and after 2000 (see subchapter "Present status and distribution of the Balkan lynx based on the LEK" in this chapter).

Results

Present status and distribution of the Balkan lynx based on the LEK

Tab. 1. Number of completed questionnaires per profile of the interviewees and per country during the Baseline Survey.

	Profile	Macedonia	Albania
1	hunter	195	48
2	livestock breeder	86	22
3	farmer	43	53
4	naturalist	24	/
5	forester	22	26
6	shop owner	16	24
7	game warden	13	/
8	veterinarian	8	9
9	beekeeper	5	/
10	other	141	138
	TOTAL	**553**	**320**

During the intensive questionnaire survey throughout western Macedonia and eastern Albania we visited 258 villages where we interviewed a total of 873 people (Tab. 1)**.**

In Macedonia only, most of the interviewees were hunters (195) and random informants (145), while the veterinarians (8) and the beekeepers (5) were the categories containing the fewest people in sample size. Balkan lynx presence (Fig. 2) was reported for the following regions: Shar Planina (region 2 in Fig. 1), Mavrovo-Bistra (5) and Stogovo-Karaorman Mts. (9). In addition, certain indications for lynx presence appear in the areas of Jablanica Mt. (its northern part) (1), Suva Gora-Cheloica (7) and Jakupica Mt. (6). These data are confirmed by new findings from the camera-trapping for lynx presence in those areas (see the paragraph below in this chapter). In a total of 25 out of 73 grid cells, locals have indicated that lynx is present with more than 50% (good presence); in 36 grid cells the percentage is less than 50% (scarce presence); and in 12 grid cells, no interviewees answered positively for the presence of lynx (Fig. 2). In Albania, random informants (138) were mostly present at the interviews and are followed by farmers (53) and hunters (48), while veterinarians (9) were the category with the fewest people in the sample size. The areas with the most reported lynx presence were Eastern Albanian Alps (Prokletije Mountains) as well as Shebenik-Jablanica and Martanesh region. Region-wise, Balkan lynx is present in the Central (region IV in Fig. 1), Central-North (II) and North-Alps (I) regions (Fig. 2). Several grid cells with more than 50 % positive answers appeared in the Southern (VI), Central-South (V) and East (III) regions. There are 12 out of 63 grid cells with a good lynx presence. In total, in 26 grid cells there is a scarce lynx presence and in the remaining 25 grid cells, there was no positive answer for lynx presence (Fig. 2).

Moreover, the distribution of the Balkan lynx was calibrated using the Category 1 and 2 findings and the Chance observation (Category 3). During the Baseline Survey the proof for lynx existence in the study areas was gathered in the form of chance photos of living or dead individuals and verified stuffed lynx or lynx pelts. The Balkan lynx team managed to collect a total of 22 'hard facts' (Category 1 data) from Macedonia and Albania of this kind and 19 findings which are considered Category 2 data (lynx tracks, scats or prey animals). Camera-trapping photos are also category 1 data. During our studies, we manage to photograph 88 photos of lynx at 26 camera-trapping sites. These sites represent 26 locations where a 'hard-fact' is encountered and are part of the AOO_{min} calculation. Beside the C 1 and 2 data, and the systematic questionnaire performed in the countries, 252 spontaneous lynx sightings (C3 data) reported by people were gathered and are used to shape the AOO_{max} polygons.

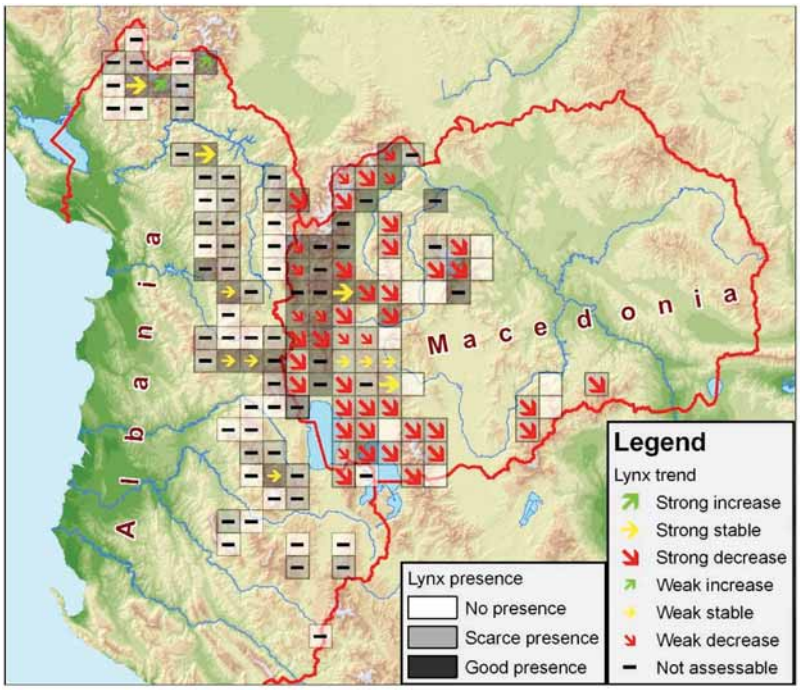

Fig. 2. Balkan lynx presence and trend in Albania and Macedonia.

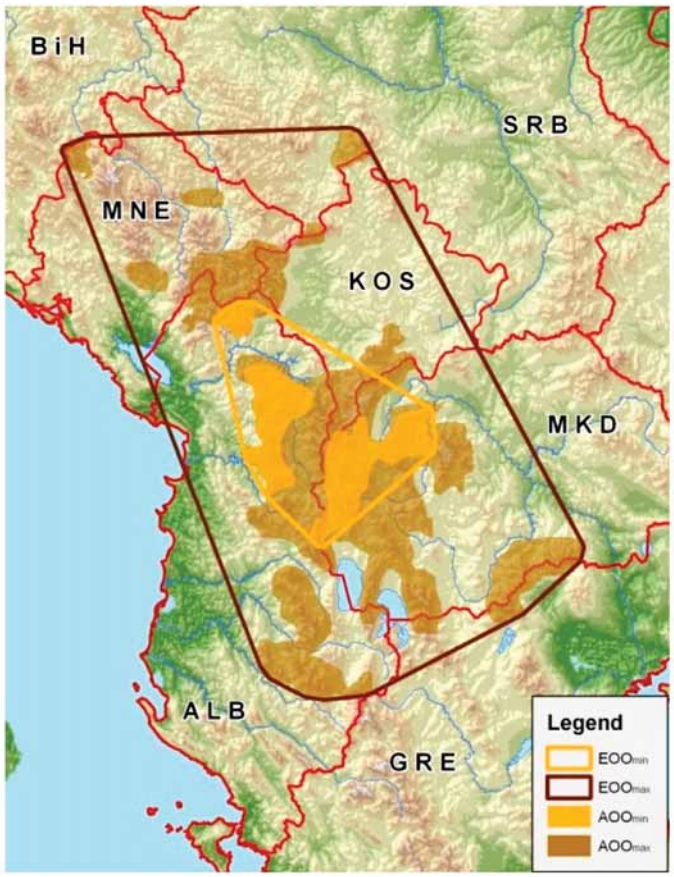

Fig. 3. Balkan lynx presence in its current distribution area. The AOO_{min} (orange polygons) taken from the C1 + C2 data from Macedonia and Albania and AOO_{max} taken from C 1, 2 and 3 data for Macedonia and Albania later than year 2000; C3 data for Montenegro and Kosovo taken from the recent literature and the MGR_{max} as an adjusted polygon. EOO_{min} is presented with orange polygon line, while EOO_{max} has brown polygon line.

In total, the Minimum Grid Range (MGR_{min}) of the Balkan lynx inside the investigated area is 3700 km^2, or 37 grid cells (see chapter above). However, several (8) of the cells with good presence were isolated, hence did not have any neighbouring cell in the same category. Taking the Maximum Grid Range (MGR_{max}), we counted 99 grid cells which equal 9900 km^2. But also for the scarce presence, several cells were isolated, so their status was not confirmed by observations in neighbouring cells (Fig. 2).

Taking into account the Baseline Survey data, the Hard-facts findings and 'Chance observations' for Macedonia and Albania, as well as the most recent records on Balkan lynx presence in Kosovo and Montenegro (Grubač, 2000 and 2002; Paunović et al. 2001), the calculated Minimum Area of Occupancy (AOO_{min}) where the Balkan lynx is **likely** to be present is 4007 km^2, while the Maximum Area of Occupancy (AOO_{max}) is 19886 km^2. These results represent the actual Area of Occupancy used during the Red List Assessment. The **possible** area of its distribution is calculated within the Minimum Extent of Occurrence (EOO_{min}) - 10124 km^2 and the Maximum Extent of Occurrence (EOO_{max}) - 58435 km^2 (Fig. 3)

Estimation of the population density and size

Estimation of the population size of the Balkan lynx was completed with the help from the results of the systematic camera-trapping session compiled in Mavrovo National Park in 2010. As the investigated area of the session was extended towards the south (Stogovo-Karaorman and Jablanica region), I only used the results for the Mavrovo NP territory, and compared them with the previous findings. Population density was calculated at **0.80 ± 0.31 individuals** per 100 km^2 (Stojanov et al. 2010). Taking into account the standard deviation from the 2010 session (± 0.31 individuals per 100 km^2), the minimum population density is 0.49, while the maximum is 1.11 individuals per 100 km^2.

Pessimistic scenario: I have taken the $\mathbf{AOO_{min}}$ and:

The lowest value of the population size:

$$\frac{4007 * 0.49}{100} = 20 \text{ individuals.}$$

The mean value of the population size:

$$\frac{4007 * 0.80}{100} = 32 \text{ individuals.}$$

The highest value of the population size:

$$\frac{4007 * 1.11}{100} = 44 \text{ individuals.}$$

Optimistic scenario: I have taken the $\mathbf{AOO_{max}}$ and:

The lowest value of the population size:

$$\frac{19886 * 0.49}{100} = 97 \text{ individuals.}$$

The mean value of the population size:

$$\frac{19886 * 0.80}{100} = 159 \text{ individuals.}$$

The highest value of the population size:

$$\frac{19886 * 1.11}{100} = 220 \text{ individuals.}$$

Assessment of the conservation status

The results from the Baseline Survey, camera-trapping findings, threats, as well as the expert opinion on presence, distribution, population number and trend (von Arx et al. 2004) were used to perform a regional Red List assessment according to the IUCN guidelines.

According to the Baseline Survey, the population trend of the Balkan lynx is strongly decreasing. In Macedonia, no evidence from the Baseline Survey is pointing out an increase of the population trend in any regard (strong or weak). Only 2 grid cells are representing strong evidence for stable trend and 3 are with weak evidence for stable trend respectively. In 42 grid cells, people reported a general decline of the Balkan lynx. Strong evidence for a decline is reported in 32 grid cells while weak evidence in 10. In the rest of the 26 grid cells, the population trend could not be assessed (Fig. 2). 11 of those cells represent cells with a good lynx presence (where more than 50% of the people answered positively on lynx presence) which indicates inconsistency in peoples' opinion. In Albania the population trend could be assessed in only 9 grid cells, all of which indicate good lynx presence (see the distribution part above). In one cell there is a strong evidence for population decrease, six grid cells are with a stable assessment, among which two agree strongly and four weakly. In two grid cells there is a weak evidence for increase in the population trend. Both of these grid cells come from the North-Alps region (Fig. 2).

Threats relevant for the survival of the Balkan lynx are shown in table 2.

The order of these threats follows the importance of certain threats according to the literature. The first four threats in the table 2 are mentioned in every article in the target country reports in von Arx et al. (2004). Poaching of the Balkan lynx as a direct and unsustainable hunting of its prey as an indirect threat is certainly posing a great risk for the population. In addition, trapping and poisoning are factors for the direct persecution of the lynx (Grubač, 2000; 2002). Habitat degradation is an obvious problem in Albania. The large areas of forest that were destroyed in the 1990s have not yet had time to regenerate.

Tab. 2. Threats to the Balkan lynx population.

	Threats	Macedonia	Albania	South Serbia & Kosovo	Montenegro
1.	Poaching	← ↔	← ↔	← ↔	← ↔
2.	Prey/food base reduction	↔	↔	↔	↔
3.	Habitat degradation	↔	↔ →	↔	↔
4.	Fragmentation	↔ →	↔ →	↔ →	↔ →
5.	Trapping/snaring	←		←	↔
6.	Restricted range	↔ →	↔ →	↔ →	↔ →
7.	Limited dispersal		↔ →	↔ →	↔ →
8.	Low densities		↔	↔	↔
9.	Population fluctuation			← ↔ →	← ↔ →
10.	Agriculture		↔		
11.	Tourism/recreation	↔ →	↔ →	↔ →	↔ →
12.	Vehicle and train collision	↔ →	↔ →	↔ →	↔ →
13.	Competition	?	?	?	?
14.	War/civil unrest	←	←	←	

← arrow indicates threats relevant for the past; ↔ stands for a present threats; → shows threats that might inflict the Balkan population in the future. The combination of arrows represents combination of periods for a certain threat: future, past or present. Bold arrows are the most important threat factors for the survival of the Balkan population in a given country. The question marks states a lack of knowledge for a given threat in a given country. Whether the competition from other carnivores living in the area – wolf and fox for instance are a real threat to the Balkan lynx, is yet to be discovered. Without any ground knowledge, we can only assume that the particular threat affects the Balkan lynx population. Derived from von Arx et al. (2004).

Most of the beech and fir forests consist of young trees, while the treeless hills and ravines are affected by heavy erosion. The population of the Balkan lynx is also strongly fragmented, which, according to von Arx et al. (2004), is distributed over an area of ca. 5000 km^2 and split into eight patches. The River Drim forms a border between the Dinarides (North-Alps region and the mountains in Montenegro) and Scardo-Pindic mountain range (the rest of the investigated regions), separating the lynx subpopulations. Considering the findings of this research, it will be challenging to connect the possible individuals from the north (Montenegro, north Albania) with the core population in Mavrovo area. Nidze-Kozhuf region is also considered a fragmented part of the main core area, divided by populated plains with farmland. Intrinsic factors such as restricted range, limited dispersal and low density are an obvious threat to the survival of the Balkan lynx given the small distribution range and the reduced population size.

According to the analysis mentioned above, the status of the Balkan lynx is **Critically Endangered - CR (C2a(i,ii)D)**. The acronyms in the brackets stand for more detailed explanation of the cause that the taxon is being listed in one of the threatened categories, i.e. the criteria used to determine its threatened category affiliation. In our case, the main cause that the Balkan lynx is considered critically endangered is the **C** – 'small population size and decline', or more specifically **C2** – 'a continuing decline' in **a(i)** – 'number of mature individuals in each subpopulation' is less than 50 and/or **a(ii)** – '90 to 100% of the individuals are in one subpopulation'. Finally, **D** represents a 'very small and restricted population'.

Discussion and conclusions

For the first time a systematic field-based collection of information on the Balkan lynx and its potential prey species has been carried out, covering an area from central, northern and eastern Albania to western and central Macedonia (Ivanov et al. 2008). The Baseline Survey has revealed many important data on the distribution, trend and abundance of the Balkan lynx, with considerable data coming directly from the local people living in its distribution range. The abundance, trend and presence of its main prey, and the conflicts between the people and the large carnivores, helped us to see what the main obstacles, strengths and opportunities to the survival of the Balkan lynx population are. So far, the Baseline Survey study has been completed in Macedonia and Albania. Further studies are now needed in Montenegro and Kosovo to fill the gaps in baseline data and to utilise the existing knowledge. Expert opinion and sporadic interviews accomplished so far in these countries are neither up-to-date nor are sufficient to confirm the presence of the Balkan lynx today and there is a need to start more scientific-based methods like the camera-trapping and radio-telemetry. Furthermore, the basic information on the lynx and its prey are a considerable contribution for the development of the Regional Conservation Strategy (Breitenmoser et al. 2008).

The results from the Baseline Survey on the presence of the Balkan lynx in Macedonia confirmed conclusions/assumptions from earlier expert assessments. Indeed, the situation of the Balkan lynx is even worse than the last expert estimate of 80 to 105 individuals distributed on approximately 6700 km^2 (von Arx et al. 2004). The results in this paper are suggesting a realistic estimate of 20 to 44 individuals taking the minimal extent of the Area of Occupancy and a population density of 0.8 adult individuals per 100 km^2. As much as one may think of the pessimistic scenario being too pessimistic, the population density taken directly from the Mavrovo NP as core area for the Balkan lynx distribution puts forward even more pessimism in the calculations. Mavrovo NP within the Mavrovo-Bistra region (region 5 in Fig. 1) can be considered as core area of the Balkan lynx population with highest reported presence. Favourable conditions that this protected area is offering in terms of relatively large areas of suitable habitats, abundant prey base and ground protection, allowed the lynx to survive during the past three centuries of harsh persecution. The other national parks in Macedonia and Albania (Pelister, Galichica, Albanian Alps) did not indicate a constant presence of the Balkan lynx. Even if there might be a certain number of individuals there, a good connection must be established to the Mavrovo area in order to ensure exchange of individuals and spread of the population. The Ilinska-Plakenska Mts. (region 9 in Fig. 1) are serving as a very important bio-corridor connecting the three existing national parks in Macedonia (Schwaderer et al. 2008). Shar Planina region (2) is another possible direction of north – north-east dispersal of the Balkan lynx towards Kosovo. Eastwards, the mountains connected to the Suva Gora-Cheloica (7) and Jakupica (6) regions are also possible area for the Balkan lynx existence in Macedonia. In Albania on the other hand, the results revealed a very fragmented distribution of lynx. More research is needed (e.g. camera-trapping studies) to find out whether there are still reproducing individuals present, rather than simply dispersing individuals.

An alarming negative trend of the Balkan lynx population was encountered with the Baseline Survey in Macedonia. In most of the grid cells in Albania the trend could not be assessed. In some cells, people's opinion differed greatly, and in others, they did not have any opinion, which may indicate the extinction of the species in these parts. These results may reflect the real situation considering the rapid increase of lynx poaching reported in the past 15 years (Ivanov et al. 2008). Illegal hunting of the ungulates in both countries is another factor limiting the lynx dispersal outside the core area. Nevertheless, prey presence according to the Baseline Survey is still very optimistic, which was not confirmed by the field signs of prey species compiled during the subsequent field work in the frame of the BLRP. Therefore, further field investigation is needed to confirm the real situation of potential lynx prey.

The collected hard facts are a proof that the Balkan lynx still exists in the survey area and that it is successfully reproducing. However, there was widespread evidence of illegal killing of lynx in both countries; though while conducting the interviews few people (53 out of 873 (6%)) reported direct or indirect knowledge of killed lynx. This can be interpreted either as a true statement, or as fear of prosecution because of the legal protection given to the Balkan lynx. Additionally, some of the statements for killed lynx could refer to a single/the same case more than one time. Poaching together with habitat degradation, depletion of prey base and fragmentation of the habitat are the most prominent threats to the survival of the Balkan lynx. Mitigating the main threats is a must in the coming years. Poaching is perhaps still a valid reason for the disappearance of the lynx from the other territories in the Balkans (Mirić 1981). A lot has to be done in education and law-enforcement in order to deal with this threat.

The Baseline Survey was a milestone activity from where other monitoring methods like the camera-trapping and radio-telemetry, took off. It indicated that Mavrovo NP may host the only source population with evidence of breeding. All other confirmed lynx presence sites were within dispersal distance of sub-adult lynx. The camera-trapping results provided direct evidence to support estimates of the population size and density in Mavrovo NP, and the radio-telemetry study is revealing the land-tenure system, the social organization, prey spectrum and other important aspects for a long-term conservation project. Estimating the population size of the Balkan lynx is one of the more important parameters for its further conservation work. By knowing these parameters, detailed and solid actions concentrated on the specific problems can be outlined. The research project called "Status, ecology and land-tenure system of the critically endangered Balkan lynx in Macedonia and Albania" has already resulted in the first three radio-tagged Balkan lynx individuals. More individuals are needed for assessing other important ecological features. Without this ecological knowledge, no conservation programme can safeguard the survival of any endangered taxon.

In terms of taxonomy, the question whether the Balkan lynx is a separate subspecies is finally not decisive. Evolutionary Significant Unit (ESU) is perhaps one way to describe this population - a population that is considered distinct for purposes of conservation (http://en.wikipedia.org). In order for a taxon to be operationally useful unit for evolutionary and ecological studies, it needs to be recognizable and identifiable as distinct entity (Riddle

& Hafner 1999). Riddle & Hafner (1999) also argue that ecologists should use the term of ESU as a basic unit for analysis when evidence cannot support the geographical and evolutionary information by formally recognized species.

This paper demonstrates that the Balkan lynx is an autochthonous metapopulation that must be considered as Critically Endangered according to the IUCN Red List Criteria, and it therefore deserves conservation attention with high priority. Considering the IUCN Red List criteria, the next step will be to look into down-listing the Balkan lynx to a lesser category. According to IUCN (2008), a taxon may be moved from a higher to a lower threat-category if none of the criteria of the higher category has been met for five years or more. It is thus clear that in the near future efforts for negating the main threats (see the threats in the Results chapter) should be the foremost focus. Urgent measures for its protection will become even more important as no large carnivore population in Europe was so far extinct under the operation of the Bern Convention (Breitenmoser-Würsten & Breitenmoser, 2001).

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THE SUSTAINABILITY OF HUNTING IN ALBANIA

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Abstract

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The history of hunting in Albania is earliest, but if you compare with the foreign countries it has another chronological line. In 1912 hunting was made discipline according to western models, where the main role was the organization of hunting associations and establishment law for the hunting. In 1944 followed the model of eastern countries, where hunting activity was based on two pillars, Department Forest Service and Association of Hunters. In 1947-1950 created „The General Association of Hunters and Fishermen Sport" localized in Tirana. Today The Albania Hunters Federation has 37 branches in the districts, which more than 17 thousand hunters, is a member of FACE and CIC. In11.3.2010 approved the law "For Hunting", which the primary objective is the approximation with European Union legislation and in Albania today they have 108 hunting zone. Aim of the study was to identify the hunting sustainability, is collected the information from baseline survey of the sustainable hunting and management of wildlife. A questionnaire was developed to gather information for the baseline survey of the sustainable hunting and management of wildlife, also to gather information for the baseline survey of the Balkan Lynx Recovery Programmers. The purpose of the questionnaire is to collect information about the types of wild animals hunted in the territory in Albania about the seasons, times and date shooting in some different territories, information about the procedure to take hunting and weapon license, details of the breeding of wild animals and establishment of penalties. The studies are realized from October 2010 to November 2011, with a total of 32 zones like Tiranë, Vlore, Sarandë, Elbasan, Korçe, Ersekë, Burrel, Pogradec, Librazhd etc. During this period 86 people are interviewed include those who have a basic knowledge on nature and wildlife like hunters, police, biologist, from Department of Forest Service and from Hunters Association. The purpose is to describe a review of the current hunting, management legislation of the wild animal, a reality by making a balance between national and international hunters. This study is to determination and comparison of current systems with reality, to identify the evaluation of systems for the long term sustainability and maintenance, in the context to create healthy populations for protection aphids and carnivores. The importance is that fauna has influence on ecological values of biodiversity, protects the species from extinction, conservation and human impact on the environment.

Keywords: Hunter, sustainability, wildlife, hunting zones, monitoring of wild fauna, hunting weapons.

Introduction

Although Albania has a small territory it has a large number of mammalian species. During the twentieth century in the country, there was missing only one type of mammal, Cervus elaphus L. Albania also has important populations of large mammals such as bear (*Ursus arctos*), wolf (*Canis lupus*), lynx (Lynx lynx), jackal (*Canis aureus*), chamois (*Rupicapra rupicapra*), capreolus (*Capreolus capreolus*), wild boars (*Sus scrofa*) etc. It is clear to see that in Albania, hunting is often done in an uncontrolled and illegal way. Problem of sustainability of hunting in Albania is one of the issues that has reached a critical point, it is time that implementation of law must be rigorous. Very few studies have been conducted about the sustainability of hunting. This study is based on questionnaire that was done to gather information for the baseline survey of the sustainable hunting and management of wildlife, also to gather information for the baseline survey of the Balkan Lynx Recovery Programmer. The questionnaire is divided in 5 parts: 1. The killing of the species- to collect information about the types

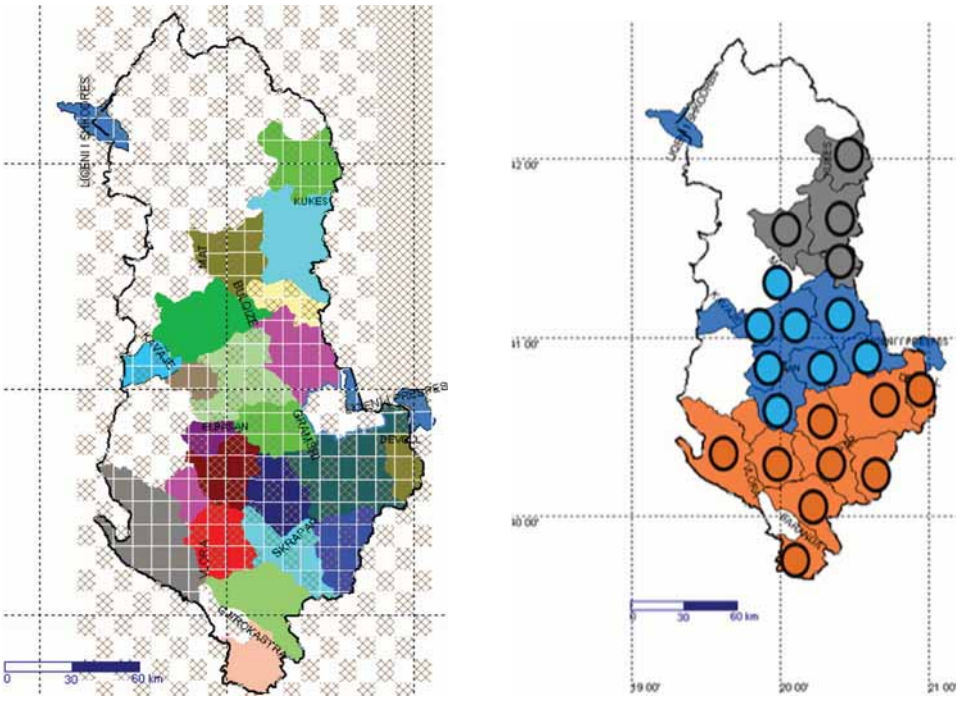

Fig. 1. Grid cell maps of the survey area

of wild animals hunted in the territory in Albania, as well as animals kept in the reserves of different farms; 2. Hunting seasons- collect information about the seasons, times and date shooting in some different territories; 3. About the procedure of obtaining the hunting- collect information about the procedure to take hunting and weapon license; 4. Details of the breeding of wild animals and establishment of penalties; 5. Informant details; 6. Village details and impressions. As well are collected data from the Department of Forest Service (for registration of wild fauna and monitoring tactics) also have been taken into consideration the Hunter Associations, in different countries for membership in the association.

Materials and methods

Survey areas were selected using the existing data on lynx and other animals location and distribution, considering the problems of hunting that are for the wild animals in the territory of Albania Fig. 1.

The map of the territory of Albania was overlaid with a 10x10 km grid (100 km^2) and 51 cells were pointed out as survey units, 30 of the cells being *"priority"* and considered areas with more problematic. For every cell 32 cities (Tab 1) was selected for the same survey questionnaires (1 cell/ 100 km^2). Besides the grid cell unit the study area was also divided in 3 regions for better detailed data analyses and comparison.These regions are:

Tab. 1. Conducting questionnaires during the Baseline Survey and study regions

Nr	Place	Number of interviewers	Nr	place	Number of interviewers
1	Berat	2	17	Leskovik	4
2	Bulqizë	2	18	Librazhd	4
3	Burrel	3	19	Mallakastër	1
4	Carçovë	2	20	Peqin	3
5	Devoll	3	21	Përmet	4
6	Dibër	2	22	Peshtan	1
7	Elbasan	6	23	Pogradec	4
8	Ersekë	4	24	Radat	1
9	Frashër	1	25	Rehovë	1
10	Gjirokastër	3	26	Sarandë	3
11	Gramsh	2	27	Skrapar	3
12	Kavajë	2	28	Steblevë	1
13	Klos	2	29	Tepelenë	3
14	Korçë	5	30	Tiranë	6
15	Kuçovë	2	31	Vlorë	3
16	Kukës	3	32	Xibër	1

1. North region- Kukës, Dibër, Mat and Bulqizë; 2. Central region- Tiranë, Librazhd, Pogradec, Elbasan, Peqin, Gramsh, Berat and Kuçovë; 3. South region- Korçë, Vlorë, Gjirokastër, Përmet, Sarandë, Tepelenë, Ersekë, Devoll, Skrapar, Leskovik,

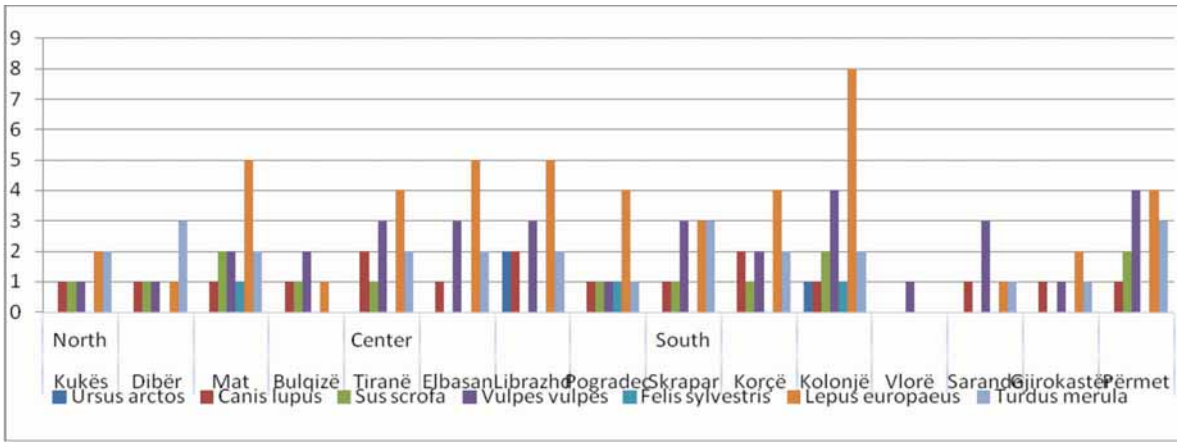

Fig. 2. The different animals hunted in three study areas

Mallakastër, Radat, Rehovë, Peshtan, Çarçovë and Frashër.

The questionnaire was addressed to specific target groups. These include people with a decent knowledge about nature and wildlife like hunters, shepherds, farmers, foresters, police, wildlife management etc. For every village one representative from the above groups should be interviewed and at least 2 hunters, Mayor hunter Association and Directorate of Forest Service. Interviews were made face to face, by filling the questionnaire at the moment, in order to get the most precise data. Species concerned in the questionnaire include: roe deer (*Capreolus capreolus*), chamois (*Rupicapra rupicapra*), wild boar (*Sus scrofa*), hare (*Lepus europaeus*), fox (*Vulpes vulpes*), jackal (*Canis aureus*), wolf (*Canis lupus*), wild cat (*Felis silvestris*), lynx (*Lynx lynx*) and brown bear (*Ursus arctos*).

The questionnaires have been sorted, coded and digitalized into an excel-sheet form. This file has been checked several times for errors and a data cleaning procedure was implemented through cross-checks. All data is stored in an electronic archive. Standard questionnaires are adapted for hunting and field work is based on a methodology that is applicable in practice, this questionnaire have been review and agreed by our partners Switzerland in the program of "Balkan Lynx program". Data analyses was made using the programs MS Excel 2010, maps were produced with ArcGis Explorer and GPS TrackMaker.

Results and Discussions

-Types of animals hunted

For all it is clear that in Albania, hunting is conducted often in a way uncontrolled and illegal. The animals that are more hunted are rabbit, partridge, fox and wild boar Fig 2.

These animals are completely disappeared:

Grouse field Vlorë, Korçë; Pheasant Vlorë, Elbasan, Korçë; Roe deer; Vlorë, Kukës, Dibër, Librazhd, Gjirokstër; Wild boar Kukës, Vlorë Chamois Dibër, Përmet, Ersekë; Rabbit Vlorë. Are at risk of disappearing: Mountain grouse, rabbit and areas in risk are Kukës, Dibër, Tepelenë, Gjirokastër, Mat, Bulqizë , Korçë and Librazhd.

- The implementation for hunting seasons and hunting timetables

Hunting is allowed to begin an hour before sunrise to sunset it. This implementation of the hunters is at minimum (0%). The number of hunting days is three days a week, Friday, Saturday and Sunday. From the questionnaire has come that this law does not apply, but it is performed on every day of the week irrespective of this particular law is specifically stated in rural areas, because of not having control in these areas by the forest service

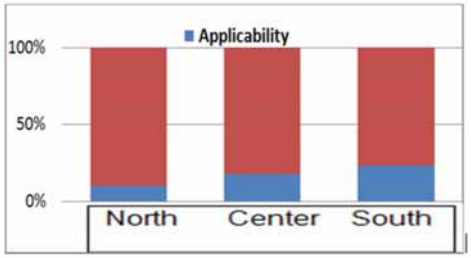

Fig. 3. The applicability of hunting seasons in three regions

- The payment for conduct of hunting

From questionnaires realized in different cities, results that these are in the level 0% none of the hunters interviewed have not taken any penalty. This is also confirmed by Department of Forest Service's who say that is difficult to identify the individuals

that have killed one animal, because is difficult to find the track of her and cannot accuse anybody because lacking proofs.

-Hunting trophies

On Fig 4 is presented the hunting trophies where the most higher percentage occupies the leather of different animals, exotic places, homes etc.

-Hunting weapons

The Director of Hunting Association was asked for the number of hunting he say that in our district are 1165 peoples that have arms from these 260 have paid gun license and only 65 have paid hunting license. In Përmet have 750 hunters, only 98 of them are regular. In Pogradec are 847 hunters from these 138 having paid gun license and only 85 have paid hunting license. In the territory of Albania counted about 150 000 weapons. Only 50% of them are registered in enforcement authorities. Only 13 000 weapons (Fig 5) or less than 10% belong to the members of Hunting Associations. The analysis of the location shows that the 87 people interviewed 67% of them are native (autochthon) and 33% have moved from surrounding villages and only one of these is a foreigner (Bulgaria) in Stebleva.

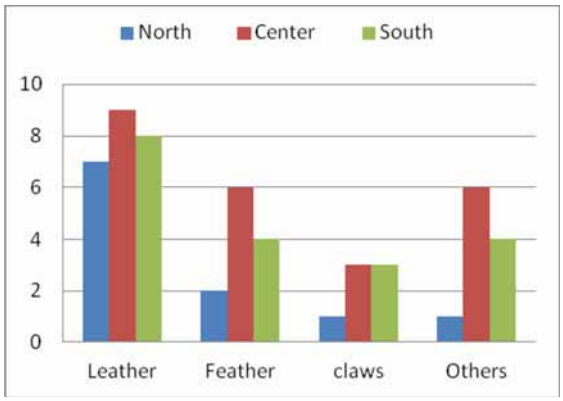

Fig. 4. Hunting trophies

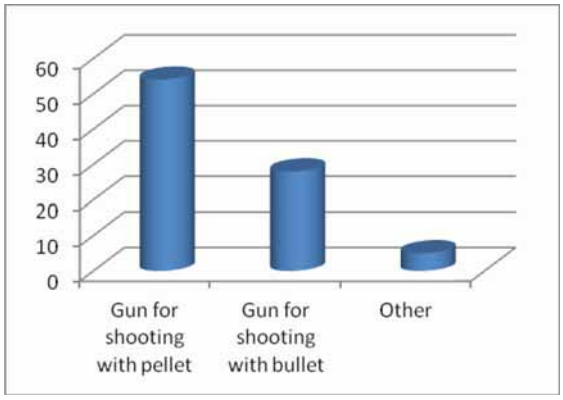

Fig. 5. Number of weapons used for hunting

-Respecting for hunter manual

54 of the interviewers did not recognize hunters manual and 9 peoples who know are the persons that work in Hunters Associations (Fig 6).

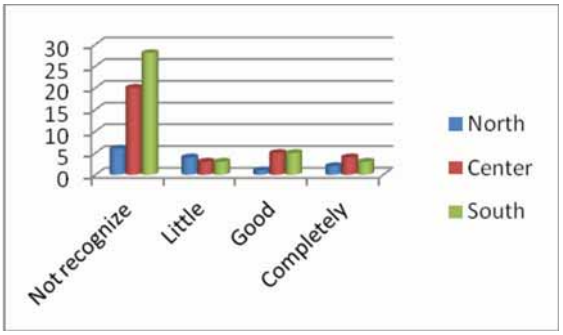

Fig. 6. Respecting for hunter manual

-Informant details

The following questions comprise the final part of the questionnaire and include information related to the interviewed person. People were asked about occupation (Fig 7) their name, sex, age, etc.

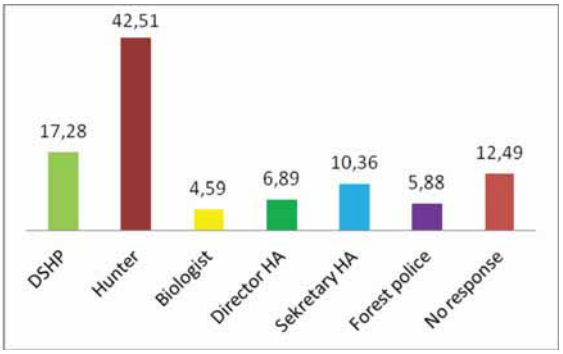

Fig. 7. Percentages of interviewees' occupation

-Percentage of seasonal and permanent residents interviewed

The analyze of the location shows that the 87 people interviewed 67% of them are permanent and 33% are seasonal.

-Presence in the commission to take hunting license

The legislation guides the hunters, that to o get the hunting license should do the written exam and in the commission to get the hunter license must be Director of Forest Service, the Forest Police, a representative of Hunter Association and a professor of zoology (Fig 8).

By interviewed comes out that this rule does

not apply and the exam of hunting is not realized, but after he received the gun license and has paid to become member of the association he can take the hunting license.

-Hunting zones

Hunting zones are surface that are determined by the Forestry Service Directorate of each district. But until today in Albania there is no free hunting area to practice the hunting. An overview of hunting zone that supposed to be realized in the future, she includes: 1.Description of area (territorial restrictions), 2 Forms of terrain (height above sea level), 3 Hydrographs, 4 Description of automobile roads, 5 Residential areas, 6 The surface, 7 Property, 8 Climate, 9 Biodiversity, 10 Forest and pasture vegetation, 11 Wild Fauna and 12 The distance from city.

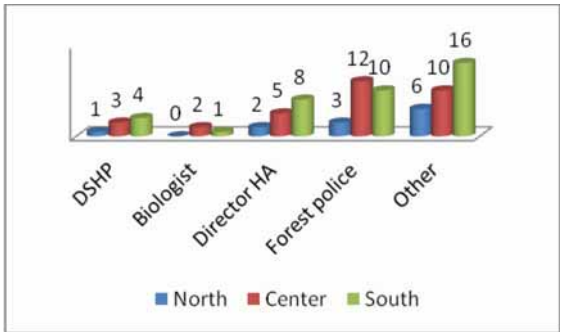

Fig. 8. Presence to take the hunting license

- Mapping of hunting zone and their division in some different places

On Fig 9 is presented the hunting zone in Mat that includes 15 areas for hunting.

Elbasan has declared 9 free zone in ha for hunting (Fig 10) and Vlora are declared 22 areas allowed for hunting (Fig 11).

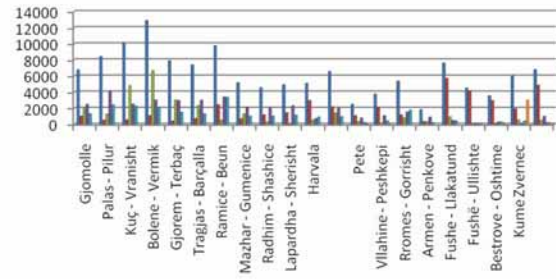

Fig. 10. 9 free zone for hunting in Elbasan and their categorization

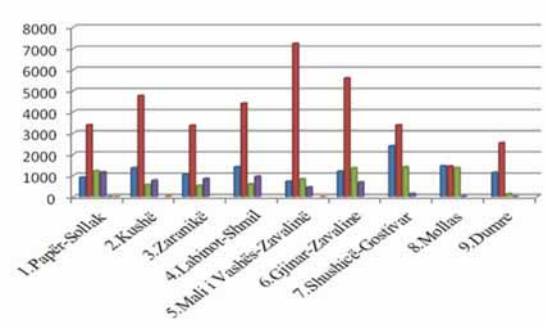

Fig. 11. 22 areas allowed for hunting in Vlora and their categorization

- The monitoring of wild fauna

Inventory of wild fauna (Fig 12) is necessary to identify the quantity and types that have the territory, for the preservation stability of fauna. Before being declared an area for subject to hunting, need to know the number of species and if hunting represents in this area any problem of breaking the balance of biodiversity.

Fauna at risk

During the 12th century in the country is missing only one type of mammal (Fig 13), *Cervus ela-*

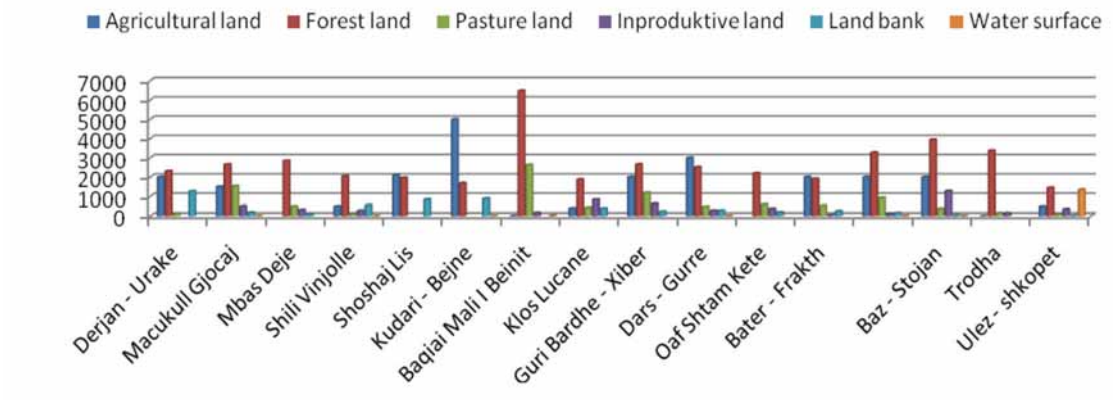

Fig. 9. 15 zones (in ha) for hunting in Mat and their categorization

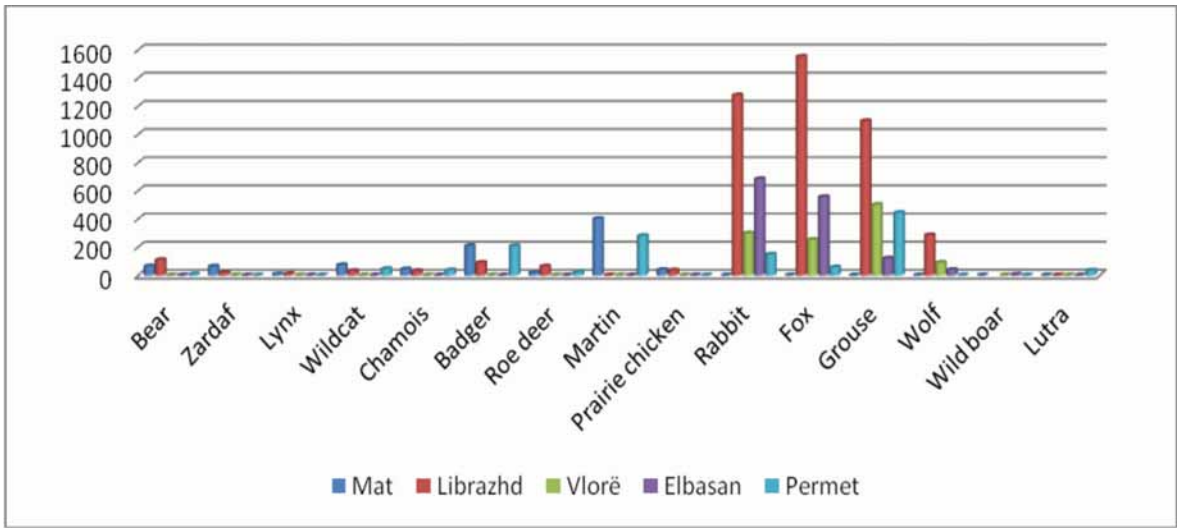

Fig. 12. Inventory of species in 2011(the data are collected from DSHP)

phus L. Albania also has important populations of large animals like *Ursus arctos, Canis lupus, Lynx lynx, Canis aureus, Rupicapra rupicapra, Capreolus capreolus, Sus scrofa* etc. Among the causes that threaten wild fauna in the country are illegal hunting (without any criteria, without season, hunting at night); habitat destruction (deforestation, overgrazing, fires); use the means of mass destruction (by means not allowed, without licensed gun, flashlights, mimetic devices); functioning not correctly of Forest Police (establishing of penalties, monitoring expeditions); complete fragmentation of habitats (agricultural and livestock activities, demographic developments); the impoverishment of habitats (overexploitation of forest resources and pasture); applicability of law at the minimum.

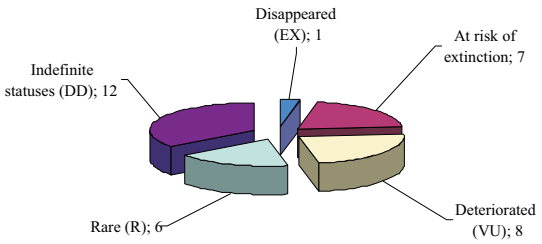

Fig. 13. Status of animals in Albania

Conclusions

From the conclusion of the questionnaire, results that animals more fished are rabbit, partridge, fox and wild boar. From cell division in the study area of hunting results that 22 of them, rabbit hunting situation (*Lepus europaeus*) is in a high level of risk. In addition animals allowed to hunt, are killed also other animals such as bear (*Ursus arctos*) in Kolonjë (Gërmenj), wild boar (*Sus scrofa*) in Përmet, Kolonjë and Korça,while in Vlora he results missing. The Animals that are in serious risk of extinction consist of, the mountain partridge, the wild rabbit. The areas in risk are: Kukës, Tepelenë, Gjirokastra, Mat, Bulqizë, Korça and Librazhd. People go against the law, they do not apply the right number of days hunting (3 days per week) It is realized in every day of the week regardless of the law. The law is especially more disobeyed in rural areas, because of not having control in these areas by the forest service.

We have a high number of hunting where the highest percentage occupies mummified animals. The number of hunting weapons is high in Mat 1165 people have been equipped with weapons, of these 260 have paid the card and only 65 have paid hunting permission. In Përmet the number of hunters is 750, of these only 98 are regular. In Pogradec are 847 hunters, 447 pairs in total, of these only 138 are equipped with weapon permission and only 85 are equipped with a regular hunting license. In Vlora only 300 of them are equipped with a hunting permission. Hunting is not committed inside the territory allowed for hunting, it exceeds it. Even the hunters that have hunting permits use illegal tools like automatic weapons, snares etc. In the three regions, as well as today in the present, it does not apply the procedure of receipt a hunting license, no test performed for obtaining a hunting permit. Adhering to the „Manual of hunter“ is in low levels, 54 of the interviewers did not know the hunter‘s manual, and the nine people that knew that were secretaries of hunter associations. By analysis of the location shows that the 87 people interviewed 67% of them are permanent and 33% are seasonal and only one of these is a foreigner (Bulgaria) in Stebleva. But we have specifically stated

that the town of Gjirokastra, Korça and Kolonja, in hunting season arrive especially foreign from Italy and less Greek (this according to the DFS of these cities and associations hunter). We have a decrease in the number of species revealed subject to hunting. Result of without any criteria hunting of hunter's, malfunction as should the Forestry Service Directorate-s to impose effective penalties as well as the role of small hunting associations. Monitoring of wild fauna is realized without any basic criterion and as a consequence we still do not have one correct inventory of wild animals in the territory of Albania. On 28000 square km there was no hunting preserve until today. There is a high number of areas declared object of hunting, 11 in Librazhd, 9 in Pogradec, 9 in Elbasan and 15 in Mat. In all Balkan Peninsula in the last 50 years, Albania is one of the countries with higher rate loss of biological diversity. Even though there is a low rate of hunting, although various amendments were made, the situation is getting worse. To be precise as well as exact, the protection of wild fauna needs to be done to save the sport of hunting. A number of factors have influenced the deterioration, to the danger of extinction of a major number of mammal populations. According to the two existing pieces of data, it shows that 34 out of 70 species known until today are at risk in varying degrees. Factors influencing the extinction of wild fauna are; Destruction of habitat, use of tools of mass destruction, the forest police do not function in a correct manner, complete fragmentation of habitats the impoverishment of habitats and applicability of the law on minimum levels.

Recommendations

Creation of a system for the collection of information and monitoring of wild fauna. Hunting associations should play an important role in informing the hunter for wild animals. Hunters should be informed on the importance of wild animals in the sustainability of biodiversity of species. Penalty collection from the forest service should be at maximum. The tariffs of hunting killing of the species as subject to hunting are high, hunters must inform the area manager for prey that is killed, because reporting of hunting counts in the inventory of species and makes an access to management development. Basis for planning effective management of wild animals should be the first priority. It should be published as soon as the hunting areas are allowed by the Ministry of Environment, before the start of hunting season. Every area allowed for hunting should have an administrator. Correct monitoring of wild fauna should be realized with the help of camera traps, which indicates the reality of the diffusion of animals. This can be indentified from the forestry of different cities of the area, to calculate the number of different species and their spreading and biology. We need to see the wild fauna not as a fortune that belongs to us, but as something we owe to our next generation. Earth is perfect, you cannot improve it, if you try to change it, you will break it, if you try to keep it, you'll lose it.

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CONTRIBUTION TO MACEDONIAN RED LIST OF FUNGI

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Abstract

Karadelev, M., Rusevska, K. (2013). Contribution to Macedonian Red List of fungi. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

The paper provides information about the Red List of fungi in Macedonia where the current IUCN Red List categories are put into practice. It includes 213 species of Ascomycota and Basidiomycota. The following IUCN criteria were implemented: Critically Endangered, (CR) – 21 species, Endangered (EN) – 30 species, Vulnerable (VU) – 71 species, Near Threatened (NT) – 40 species, Least Concern (LC) – 9 species and Data Deficient (DD) – 42 species. The main goals of this work are to upgrade the Preliminary red list of macromycetes in the Republic of Macedonia (Karadelev, 2000), to improve fungal conservation status and to accelerate proposals for legal measures in order to conserve fungal diversity.

Key words: Macedonia, conservation of fungi, Red List.

Извод

Караделев, М., Русевска, К. (2013) Придонес кон црвената листа на габи на Република Македонија. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 28, Скопје.

Главната цел на овој труд е изработка на Црвена листа на габи на Македонија што ќе придонесе за забрзување на постапките за преземање легални мерки и заштита на микодиверзитетот во Македонија. Таа претставува дополнување на Прелиминарната црвена листа на габи на Македонија (Karadelev, 2000). Во оваа листа се наведени 213 вида кои припаѓаат на типовите Ascomycota и Basidiomycota. Видовите се категоризирани според критериумите на IUCN, при што во категоријата критично загрозени (CR) има 21 вид, загрозени (EN) – 30 вида, ранливи (VU) – 71 вид, близу засегнати (NT) – 40 вида, најмалку загрижувачки (LC) – 9 вида и недоволно податоци (DD) – 42 вида.

Клучни зборови: Македонија, заштита на габи, Црвена листа.

Introduction

Fungi are a large and an ecologically very important group of organisms. Like the majority of other organisms living on our planet, fungi may also be threatened by human activities. They are mostly endangered by the disappearance and degradation of habitats, but there are also other important causes of threat such as pollution, climate change and excessive gathering of fruiting bodies of edible species. The preparation of Red List of Macedonian Fungi is essential step in their conservation.

The Preliminary Red List of macromycetes in the Republic of Macedonia (Karadelev 2000) included 67 species, all belonging to class Basidiomycetes. In that list, three threat categories were applied – a particularly rare or rare species in Macedonia, a species existing only in endangered or rare habitats and a particularly rare or rare species, endangered due to excessive exploitation. Its main goals were to initiate an important research in fungal conservation and to accelerate proposals for legal measures in order to conserve fungal diversity.

Thus, the Macedonian mycobiota in the last

10 years was quite well investigated. These data enabled preparation of contemporary Red List of Macedonian Fungi, where the current IUCN Red List categories (IUCN 2001, 2003a, b) were used. Data source used are as follows: exsiccates and notes from own studies, Macedonian collection of Fungi (MCF), data base (MAK FUNGI), as well as specimens from other collectors.

Macedonian Red List of Fungi (Table 1) includes the total of 213 species, both ascomycetes and basidiomycetes, as follows: 21 Critically Endangered (CR), 30 Endangered (EN), 71 Vulnerable (VU), 40 Near Threatened (NT), 9 Least Concern (LC) and 42 Data Deficient (DD).

Tab. 1. Macedonian Red List of Fungi

Таб. 1. Црвена листа на габи на Република Македонија

	Species	**IUCN category**	**IUCN criteria**
1	*Agaricus luteomaculatus*	DD	
2	*Agaricus urinascens*	NT	
3	*Albatrellus citrinus*	VU	D2
4	*Albatrellus pes-caprae*	VU	D1
5	*Amanita boudieri*	VU	D1
6	*Amanita caesarea*	EN	A2acd
7	*Amanita curtipes*	VU	D1
8	*Amanita dryophila*	DD	
9	*Amanita strobiliformis*	NT	
10	*Amanita vittadinii*	VU	B2a
11	*Amylostereum areolatum*	EN	D
12	*Antrodia gossypium*	CR	D
13	*Antrodia juniperina*	CR	C2a(i)
14	*Antrodia malicola*	NT	
15	*Antrodia variiformis*	CR	D
16	*Antrodiella citrinella*	CR	D
17	*Arrhenia spathulata*	NT	
18	*Artomyces pyxidatus*	NT	
19	*Asterophora parasitica*	NT	
20	*Aurantiporus fissilis*	VU	B2a
21	*Battarrea phalloides*	CR	B2ab(iv)
22	*Boletopsis leucomelaena*	VU	D2
23	*Boletus aereus*	VU	A2acd
24	*Boletus dupainii*	VU	D1
25	*Boletus impolitus*	VU	C1; D1
26	*Boletus lupinus*	EN	D
27	*Boletus luteocupreus*	EN	D
28	*Boletus pinophilus*	VU	A2acd
29	*Boletus regius*	VU	C1
30	*Boletus rhodopurpureus*	VU	A2ac
31	*Boletus satanas*	VU	A2ac
32	*Boletus torosus*	VU	D1
33	*Boletus pulchrotinctus*	EN	B2a
34	*Calocybe onychina*	DD	
35	*Campanella caesia*	DD	
36	*Cantharellus cibarius*	LC	
37	*Clathrus ruber*	NT	
38	*Clavaria falcata*	VU	A2ac
39	*Clavariadelphus pistillaris*	VU	A3acd
40	*Clavariadelphus truncatus*	VU	A3acd
41	*Clavulinopsis laeticolor*	VU	A2ac

	Species	IUCN category	IUCN criteria
42	*Cortinarius alnetorum*	VU	B2ab(iii)
43	*Cortinarius amarescens*	DD	
44	*Cortinarius balteatocumatilis*	DD	
45	*Cortinarius coerulescens*	DD	
46	*Cortinarius humicola*	DD	
47	*Cortinarius nanceiensis*	DD	
48	*Cortinarius odorifer*	LC	
49	*Cortinarius prasinus*	NT	
50	*Cortinarius rapaceus*	DD	
51	*Cortinarius rufo-olivaceus*	DD	
52	*Cotylidia diaphana*	CR	B2ab(iv)
53	*Craterellus cornucopioides*	NT	
54	*Creolophus cirrhatus*	VU	B2ab(iii)
55	*Cudonia circinans*	VU	D1
56	*Cystoderma superbum*	NT	
57	*Dacryobolus karstenii*	VU	D1
58	*Dendrocollybia racemosa*	CR	B2ab(iv)
59	*Dentipellis fragilis*	VU	D1
60	*Dichomitus albidofuscus*	VU	D1
61	*Dichostereum durum*	VU	D1
62	*Diplomitoporus flavescens*	VU	B2ab(iii,iv)
63	*Discina parma*	CR	D
64	*Disciotis venosa*	VU	D1
65	*Disciseda bovista*	CR	A4ac; B2ab(iii,iv); D;
66	*Disciseda candida*	CR	A4ac; B2ab(iii,iv); D;
67	*Endoptychum agaricoides*	EN	B2ab(iii,iv)
68	*Entoloma aprile*	VU	B2a
69	*Entoloma corvinum*	VU	A3c; D1
70	*Entoloma incanum*	VU	D1
71	*Epithele typhae*	DD	
72	*Erastia salmonicolor*	CR	D
73	*Exobasidium rhododendri*	VU	D2
74	*Faerberia carbonaria*	NT	
75	*Galerina jaapi*	CR	A4ac; C2a(i); D;
76	*Galerina sphagnorum*	CR	A4ac; C2a(i); D;
77	*Galerina tibiicystis*	CR	A4ac; C2a(i); D;
78	*Ganoderma pfeifferi*	EN	B2ab(iii,iv)
79	*Geastrum berkeleyi*	VU	D1
80	*Geastrum melanocephalum*	VU	D1
81	*Geastrum minimum*	VU	B2a
82	*Grifola frondosa*	EN	B2ab(iii,iv)
83	*Gyrodon lividus*	VU	B2ab(iii)
84	*Helvella atra*	EN	B2a
85	*Helvella ephippium*	DD	
86	*Hericium coralloides*	NT	
87	*Hericium erinaceus*	VU	B2ab(iii,iv)
88	*Hexagonia nitida*	VU	A2ac
89	*Heyderia abietis*	NT	
90	*Hohenbuehelia atrocoerulea*	DD	
91	*Hydnellum aurantiacum*	VU	D2
92	*Hydnellum caeruleum*	VU	D2
93	*Hydnellum spongiosipes*	EN	B2ab(iii,iv)
94	*Hydropus subalpinus*	DD	

	Species	IUCN category	IUCN criteria
95	*Hygrocybe ceracea*	DD	
96	*Hygrocybe helobia*	EN	B2ab(iii,iv)
97	*Hygrocybe lepida*	VU	D2
98	*Hygrocybe lilacina*	EN	B2ab(iii,iv)
99	*Hygrocybe punicea*	NT	
100	*Hygrocybe reae*	DD	
101	*Hygrocybe turunda*	DD	
102	*Hygrophorus marzuolus*	EN	B2ab(iii,v)
103	*Hygrophorus poetarum*	VU	C1
104	*Hymenochaete cruenta*	VU	D2
105	*Hyphoderma guttuliferum*	VU	D1
106	*Hyphoderma macedonicum*	EN	B2a
107	*Hyphodontia juniperi*	NT	
108	*Inocybe dunensis*	EN	B2ab(I,ii,iii)
109	*Inocybe posterula*	EN	B2ab(iii,iv)
110	*Inonotus obliquus*	VU	C2a(i)
111	*Inonotus tamaricis*	CR	C2a(I,ii)
112	*Junghuhnia separabilima*	DD	
113	*Kavinia alboviridis*	EN	D
114	*Kavinia himantia*	VU	D1
115	*Lactarius acris*	NT	
116	*Lactarius albocarneus*	NT	
117	*Lactarius azonites*	NT	
118	*Lactarius cyathuliformis*	DD	
119	*Lactarius deliciosus*	LC	
120	*Lactarius deterrimus*	NT	
121	*Lactarius lilacinus*	VU	D1
122	*Lactarius omphaliformis*	CR	B2ab(iii,iv)
123	*Lactarius sanguifluus*	LC	
124	*Lactarius semisanguifluus*	LC	
125	*Lactarius violascens*	NT	
126	*Lactarius volemus*	LC	
127	*Leccinum quercinum*	NT	
128	*Lentinus strigosus*	LC	
129	*Lenzites warnieri*	NT	
130	*Lenzitopsis oxycedri*	CR	D
131	*Lepiota grangei*	DD	
132	*Lepiota oreadiformis*	NT	
133	*Leucocortinarius bulbiger*	NT	
134	*Leucopaxillus compactus*	VU	D1
135	*Leucopaxillus giganteus*	VU	C1, D1
136	*Leucopaxillus lepistoides*	VU	B2b(ii,iii,iv,v)
137	*Limacella illinita*	NT	
138	*Lindtneria trachyspora*	VU	D1
139	*Lyophyllum transforme*	DD	
140	*Metulodontia nivea*	DD	
141	*Microglossum viride*	NT	
142	*Microstoma protracta*	DD	
143	*Mitrula paludosa*	DD	
144	*Morchella elata*	NT	
145	*Mutinus caninus*	NT	
146	*Mycena juniperina*	CR	C2a(i)
147	*Mycenastrum corium*	EN	B2ab(iii,iv,v)

	Species	IUCN category	IUCN criteria
148	*Mycoacia nothofagi*	DD	
149	*Myriostoma coliforme*	EN	D
150	*Myxomphalia maura*	DD	
151	*Omphalina baeospora*	VU	C1, D1
152	*Omphalina grossula*	EN	D
153	*Pachyella violaceonigra*	VU	D1
154	*Pachykytospora tuberculosa*	NT	
155	*Parmastomyces mollissimus*	DD	
156	*Peniophora erikssonii*	DD	
157	*Peniophora tamaricicola*	VU	B2ab(iii,iv,v)
158	*Perenniporia narymica*	DD	
159	*Perenniporia rosmarini*	EN	B2a
160	*Phaeomarasmius rimulincola*	DD	
161	*Phallus hadriani*	EN	C1, D
162	*Phallus impudicus var. togatus*	DD	
163	*Phellinus rimosus*	VU	D2
164	*Phellodon connatus*	EN	B2a
165	*Phellodon melaleucus*	EN	B2a
166	*Phylloporus rhodoxanthus*	NT	
167	*Phyllotopsis nidulans*	NT	
168	*Pisolithus arrhizus*	NT	
169	*Pithya cupressina*	VU	D2
170	*Pleurotus cornucopiae*	EN	C1
171	*Pleurotus eryngii*	EN	C1
172	*Podofomes trogii*	EN	B2ab(i,ii,iv)
173	*Polyporus umbellatus*	EN	C1
174	*Poronia punctata*	CR	C1; D
175	*Porphyrellus porphyrosporus*	NT	
176	*Pseudomerulius aureus*	DD	
177	*Pseudoomphalina compressipes*	DD	
178	*Pseudoomphalina kalchbrenneri*	DD	
179	*Pyrofomes demidoffii*	CR	C2a(i)
180	*Radiigera atrogleba*	VU	D2
181	*Ramariopsis clavuligera*	DD	
182	*Rhodophyllus whiteae*	VU	A3c; D1
183	*Rozites caperatus*	LC	
184	*Russula amethystina*	DD	
185	*Rutstroemia bulgarioides*	EN	B2ab(iii,iv)
186	*Sarcodon leucopus*	VU	B2a
187	*Sarcosphaera coronaria*	VU	B2a
188	*Scleroderma meridionale*	NT	
189	*Scleroderma polyrhizum*	NT	
190	*Skeletocutis alutacea*	DD	
191	*Skeletocutis odora*	VU	D2
192	*Skeletocutis tschulymica*	VU	D2
193	*Spathularia flavida*	VU	D1
194	*Steccherinum bourdotii*	VU	D1
195	*Steccherinum litschaueri*	NT	
196	*Steccherinum subcrinale*	VU	D1
197	*Suillus flavidus*	VU	D1
198	*Suillus sibiricus*	EN	B2a
199	*Tephrocybe atrata*	NT	
200	*Trametes ljubarskyi*	DD	

	Species	IUCN category	IUCN criteria
201	*Trichoglossum hirsutum*	VU	D1
202	*Tricholoma colossus*	DD	
203	*Tricholoma lascivum*	DD	
204	*Tulostoma caespitosum*	DD	
205	*Tulostoma fimbriatum*	NT	
206	*Tulostoma melanocyclum*	NT	
207	*Tulostoma squamosum*	LC	
208	*Urnula craterium*	VU	D1
209	*Verpa conica*	VU	A3acd
210	*Xeromphalina junipericola*	CR	B2a
211	*Xerula melanotricha*	NT	
212	*Xylobolus frustulatus*	VU	A2ac
213	*Xylobolus subpileatus*	VU	A2ac

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MACROFUNGI OF KARACAÖREN DAM (Bucak-Burdur, TURKEY) AND ITS SURROUNDINGS

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Abstract

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Within the framework of this study, 220 macrofungi specimens were collected at different localities on Karacaören (Bucak-Burdur) dam and its surroundings between 2010 and 2012, particularly during autumn and spring seasons. As a result of the field and laboratory studies, 105 taxa were identified; 14 of the reported taxa belong to the phylum of *Ascomycota* and 91 species belong to *Basidiomycota*. The dam is surrounded by *Pinus brutia* Ten. forests. Other prevalent trees in the research area are *Quercus coccifera* L., *Arbutus andrachne* L. and *Myrtus communis* L.. The climate is typically Mediterranean.

Keywords: macrofungi, taxonomy, Karacaören Dam, Burdur, Turkey.

Introduction

Karacaören hydroelectric power plant dam is built on the river Aksu. Karacaören Dam is 35 km away from Bucak district and 45 km to Antalya province. The altitude of the Karacaören Dam is 180 m.

The dam is surrounded by *Pinus brutia* Ten. forests. Other prevalent tree species in the research area are *Quercus coccifera* L., *Liquidambar orientalis* Mill. *Arbutus andrachne* L. and *Myrtus communis* L.. *Liquidambar orientalis,* known as oriental sweetgum, is an endemic taxon of the East Mediterranean. In Turkish it is called "günlük" because of the fragrance of the trees. Frankincense oil, which is obtained from these trees, is raw material oil for perfume industry.

The research area, situated in the Mediterranean Sea phytogeographical region has various macrofungi specimens.

The aim of this study was to determine the macrofungi taxa of Karacaören (Bucak-Burdur) Dam and its surroundings.

Materials and Methods

The macrofungi specimens of this study were collected around Karacaören (Bucak-Burdur) dam between the years of 2010 and 2012. In the research area, firstly the macrofungi were taken photographs of in their natural habitats, and the ecological and morphological characteristics of the macrofungi were noted. Afterwards, they were put in aluminum foil and taken to the fungarium and dried once spore prints were obtained. The identification of taxa was carried out according to the literature. Fungus names, authors, habitats, collecting dates, collector's names and collecting numbers were respectively given in a floristic list.

We identified the specimens using the literature about macrofungi by Sesli & Denchev (2009), Moser (1983), Breitenbach & Kränzlin (1984-2005), Bresinsky & Besl (1990), Dennis (1981), Ellis & Ellis (1990), Pace (1998), Grunert & Grunert (1984, 1991), Pacioni (1993), Jordan (1996), Riva (2003), Cannon & Kirk (2007), Phillips (1981), Smith & Smith (1996), Medardi (2006), Pegler (1987), Watling (1973, 1982), Watling & Gregory (1977, 1989), Winkler (1996), Dähncke (1993) and Jordan (2004).

After macrofungi samples were identified and dried, we protected them in polyethylen bags with their identity card. All macrofungi samples are deposited in the fungarium of Selçuk University, Fungarium of Mushroom Application and Research Centre, in Konya.

Results

The names of authors of macrofungus species were abbreviated according to http://www.indexfungorum.org/names/names.asp (Kirk & Ansell 1992). The coordinates were taken by GPS (Magellan Explorist XL).

ASCOMYCOTA

DERMATEACEAE

Mollisia melaleuca (Fr.) Sacc.
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 08.01.2011, Kaşık 2,804.

Tapesia fusca (Pers.) Fuckel
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,749.

DIATRYPACEAE

Diatrype disciformis (Hoffm.) Fr.
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 16.04.2011, Kaşık 2,963.

HELOTIACEAE

Bisporella citrina (Batsch) Korf & S. E. Carp.
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 16.05.2011, Kaşık 2,929.

HELVELLACEAE

Helvella crispa (Scop.) Fr.
Çandır village, Belentaşı locality, on debris, 41°44′672″N, 36°31′36″71E, 305 m, 09.01.2011, Kaşık 2,818.

Helvella lacunosa Afzel.
Çandır village, Belentaşı locality, on debris, 41°44′672″N, 36°31′36″71E, 305 m, 09.01.2011, Kaşık 2,819, Yazılı kanyon, on debris, 41°48′772″N, 36°31′59″71E, 354 m, 09.01.2011, Kaşık 2,858.

Helvella leucomelaena (Pers.) Nannf.
Çandır village, Karaguz locality, on debris, 41°42′575″N, 36°31′39″46E, 380 m, 09.01.2011, Kaşık 2,828.

MORCHELLACEAE

Morchella conica Krombh.
Kargı, Taşdibi village, burned area, 41°23′984″N, 36°30′67″19E, 291m, 16.04.2011, Kaşık 2,876.

Morchella elata var. ***elata*** Fr.
Kargı, Taşdibi village, burned area, 41°23′984″N, 36°30′67″19E, 16.04.2011, Kaşık 2,874.

Morchella esculenta (L.) Pers.
Kargı, Taşdibi village, burned area, 41°23′984″N, 36°30′67″19E, 16.04.2011, Kaşık 2,878.

PEZIZACEAE

Sarcosphaera coronaria (Jacq.) J. Schröt.
Çandır village, Boynuzlu locality, on debris, 41°42′896″N, 36°31′23″33E, 290 m, 19.03.2012, Kaşık 2,945.

PYRONEMATACEAE

Scutellinia scutellata (L.) Lambotte
Sığla forest, in soil, 41°37′403″N, 36°30′81″26E, 198 m, 08.01.2011, Kaşık 2,808.

SARCOSCYPHACEAE

Sarcoscypha coccinea (Gray) Boud.
Çandır village, Şahana locality, on debris, 41°43′178″N, 36°31′31″55E, 283 m, 08.01.2011, Kaşık 2,786.

XYLARIACEAE

Daldinia concentrica (Bolton) Ces. & De Not.
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 08.01.2011, Kaşık 2,802, Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 16.04.2011, Kaşık 2,891.

BASIDIOMYCOTA

AGARICACEAE

Agaricus bitorquis (Quel.) Sacc.
Çandır village, Şahana locality, on debris, 41°43′178″N, 36°31′31″55E, 283 m, 08.01.2011, Kaşık 2,787.

Crucibulum laeve (Huds.) Kambly
Çandır village, Karaguz locality, on debris, 41°42′575″N, 36°31′39″46E, 380 m, 09.01.2011, Kaşık 2,830.

Cyathus olla (Batsch) Pers.
Çandır village, Karaguz locality, on debris, 41°42′575″N, 36°31′39″46E, 380 m, 09.01.2011, Kaşık 2,831.

Cystodermella granulosa (Batsch) Harmaja
Çandır village, Karaguz locality, on debris, 41°42′575″N, 36°31′39″46E, 380 m, 09.01.2011, Kaşık 2,832.

Lycoperdon molle Pers.
Melikler Peninsula, on debris, 41°45′273″N, 36°31′09″84E, 280m, 17.04.2011, Kaşık 2,916.

Lycoperdon perlatum Pers.
Çandır village, Karaguz locality, on debris, 41°42′575″N, 36°31′39″46E, 380 m, 09.01.2011, Kaşık 2,836.

Macrolepiota excoriata (Schaeff.) Wasser
Çandır village, Şahana locality, on debris, 41°43′178″N, 36°31′31″55E, 283 m, 08.01.2011, Kaşık 2,793.

Macrolepiota procera var. ***procera*** (Scop.) Singer
Melikler Peninsula, on debris, 41°45′273″N, 36°31′09″84E, 280 m 09.01.2011, Kaşık 2,851.

AURICULARIACEAE

Auricularia auricula-judae (Bull.) Quel.
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,752.

Auricularia mesenterica (Dicks.) Pers.
Çoban çeşmesi, on stump, 41°33′433″N,

36°31′11″55E, 334 m 19.03.2012, Kaşık 2,948.
Exidia glandulosa (Bull.) Fr.
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,755.

BOLETACEAE
Boletus pulverulentus Opat.
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 22.10.2010, Kaşık 2,727.

DACRYMYCETACEAE
Calocera cornea (Batsch) Fr.
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 22.10.2010, Kaşık 2,729.
Dacrymyces variisporus McNabb
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 16.05.2011, Kaşık 2,931.

DIPLOCYSTIDIACEAE
Astraeus hygrometricus (Pers.) Morgan
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 04.02.2011, Kaşık 2,872.

ENTOLOMATACEAE
Entoloma incanum (Fr.) Hesler
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 22.10.2010, Kaşık 2,733.

FOMITOPSIDACEAE
Fomitopsis pinicola (Sw.) P. Karst.
Sığla forest, on stump, 41°37′403″N, 36°30′81″26E, 198 m, 19.03.2012, Kaşık 2,957.

GANODERMATACEAE
Ganoderma applanatum (Pers.) Pat.
Sığla forest, on stump, 41°37′403″N, 36°30′81″26E, 198 m, 19.03.2012, Kaşık 2,959.
Ganoderma lucidum (Curtis) P. Karst.
Sığla forest, on stump, 41°37′403″N, 36°30′81″26E, 198 m, 22.10.2010, Kaşık 2,738.

GEASTRACEAE
Geastrum fimbriatum Fr.
Çandır village, Karaguz locality, on debris, 41°42′575″N, 36°31′39″46E, 380 m, 09.01.2011, Kaşık 2,833.

GLOEOPHYLLACEAE
Gloeophyllum sepiarium (Wulfen) P. Karst.
Çandır village, Şahana locality, on debris, 41°43′178″N, 36°31′31″55E, 283 m, 08.01.2011, Kaşık 2,789.

GOMPHIDIACEAE
Chroogomphus helveticus (Singer) M. M. Moser
Melikler Peninsula, on debris, 41°45′273″N, 36°31′09″84E, 280 m 17.04.2011, Kaşık 2,913.
Chroogomphus rutilus (Schaeff.) O. K. Mill.
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 22.10.2010, Kaşık 2,730.
Gomphidius glutinosus (Schaeff.) Fr.
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 08.01.2011, Kaşık 2,809.

HYDNACEAE
Hydnum repandum L.
Melikler Peninsula, on debris, 41°45′273″N, 36°31′09″84E, 280 m 09.01.2011, Kaşık 2,848.

HYGROPHORACEAE
Hygrophorus agathosmus (Fr.) Fr.
Çandır village, Belentaşı locality, on debris, 41°44′672″N, 36°31′36″71E, 305 m, 08.01.2012, Kaşık 2,771.
Hygrophorus eburneus (Bull.) Fr.
Melikler Peninsula, on debris, 41°45′273″N, 36°31′09″84E, 280 m 09.01.2011, Kaşık 2,849.

HYMENOCHAETACEAE
Fuscoporia torulosa (Pers.) T. Wagner & M. Fisch
Çandır village, Boynuzlu locality, on stump, 41°42′896″N, 36°31′23″33E, 290 m, 17.04.2011, Kaşık 2,907.
Inonotus rheades (Pers.) Bondartsev & Singer
Sığla forest, on stump, 41°37′403″N, 36°30′81″26E, 198 m, 16.04.2011, Kaşık 2,898.

INOCYBACEAE
Crepidotus mollis (Schaeff.) Staude
Melikler Peninsula, on branches, 41°45′273″N, 36°31′09″84E, 280m 04.02.2011, Kaşık 2865.
Inocybe rimosa (Bull.) P. Kumm.
Melikler Peninsula, on debris, 41°45′273″N, 36°31′09″84E, 280 m 17.04.2011, Kaşık 2,915.

LYOPHYLLACEAE
Rugosomyces onychinus (Fr.) Raithelh.
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 16.04.2011, Kaşık 2,893.

MARASMIACEAE
Gymnopus dryophilus (Bull.) Murill
Kargı, Karadağ locality, on debris, 41°33′419″N, 36°30′76″38E, 330 m 22.10.2010, Kaşık 2,721.
Omphalotus olearius (DC.) Singer
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 16.04.2011, Kaşık 2,899.

MYCENACEAE
Mycena amicta (Fr.) Quel.
Çandır village, Boynuzlu locality, on debris, 41°42′896″N, 36°31′23″33E, 290 m, 08.01.2011, Kaşık 2,780.
Mycena epipterygia (Scop.) Gray
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 22.10.2010, Kaşık 2,740.

Mycena pura (Pers.) P. Kumm.
Çandır village, Karaguz locality, on debris, 41°42′575″N, 36°31′39″46E, 380 m, 09.01.2011, Kaşık 2,837.
Mycena renati Quel.
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,757.
Mycena stipata Maas Geest. & Schwöbel
Kargı, Karadağ locality, on debris, 41°33′419″N, 36°30′76″38E, 330 m 22.10.2010, Kaşık 2,718.
Panellus mitis (Pers.) Singer
Çandır village, Belentaşı locality, on branches, 41°44′672″N, 36°31′36″71E, 305 m, 09.01.2011, Kaşık 2823.
Xeromphalina cauticinalis (With.) Kühner & Maire
Çandır village, Belentaşı locality, on debris, 41°44′672″N, 36°31′36″71E, 305 m, 08.01.2012, Kaşık 2,777.

PAXILLACEAE
Paxillus involutus (Batsch) Fr.
40 geçit, on debris, 41°34′115″N, 36°31′21″55E, 449 m, 16.05.2011, Kaşık 2,920.

PHALLACEAE
Phallus impudicus var. ***impudicus*** L.
Çandır village, Boynuzlu locality, on debris, 41°42′896″N, 36°31′23″33E, 290 m, 08.01.2011, Kaşık 2,782, Çandır village, Belentaşı locality, on debris, 41°44′672″N, 36°31′36″71E, 305 m, 09.01.2011, Kaşık 2,825.

PHANEROCHAETACEAE
Terana coerulea (Lam.) Kuntze
Çandır village, Şahana locality, on branches, 41°43′178″N, 36°31′31″55E, 283 m, 08.01.2011, Kaşık 2,796.

PHYSALACRIACEAE
Armillaria mellea (Vahl) P. Kumm.
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 22.10.2010, Kaşık 2,725.

PLUTEACEAE
Pluteus cervinus (Schaeff.) P. Kumm.
Melikler Peninsula, near stump, 41°45′273″N, 36°31′09″84E, 280 m 17.04.2011, Kaşık 2,918.
Volvopluteus gloiocephalus (DC.) Justo
Melikler Peninsula, on debris, 41°45′273″N, 36°31′09″84E, 280 m 16.05.2011, Kaşık 2,925.

POLYPORACEAE
Daedaleopsis confragosa (Bolton) J. Schröt.
Sığla forest, on stump, 41°37′403″N, 36°30′81″26E, 198 m, 16.05.2011, Kaşık 2,933.
Fomes fomentarius (L.) J. Kickx f.
Sığla forest, on stump, 41°37′403″N, 36°30′81″26E, 198 m, 22.10.2010, Kaşık 2,736, Sığla forest, on stump, 41°37′403″N, 36°30′81″26E, 198 m, 16.04.2011, Kaşık 2,895.
Hexagonia nitida Durieu & Mont.
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 16.04.2011, Kaşık 2,896.
Lentinus tigrinus (Bull.) Fr.
Sığla forest, on stump, 41°37′403″N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,756.
Polyporus arcularius (Batsch) Fr.
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,762.
Polyporus brumalis (Pers.) Fr.
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 16.04.2011, Kaşık 2,903.
Trametes hirsuta (Wulfen) Lloyd
40 geçit, on debris, 41°34′115″N, 36°31′21″55E, 449 m, 16.05.2011, Kaşık 2,922.
Trametes versicolor (L.) Lloyd
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,767, Çandır village, Şahana locality, on branches, 41°43′178″N, 36°31′31″55E, 283 m, 08.01.2011, Kaşık 2,798, Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 08.01.2011, Kaşık 2,816.
Trichaptum abietinum (Dicks.) Ryvarden
Çandır village, Şahana locality, on branches, 41°43′178″N, 36°31′31″55E, 283 m, 08.01.2011, Kaşık 2,799, Çandır village, Boynuzlu locality, on branches, 41°42′896″N, 36°31′23″33E, 290 m, 08.01.2011, Kaşık 2,784.

PSATHYRELLACEAE
Coprinellus disseminatus (Pers.) J. E. Lange
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 16.05.2011, Kaşık 2,930.
Coprinellus domesticus (Bolton) Vilgalys, Hopple & Jacq. Johnson
Çandır village, Boynuzlu locality, on branches, 41°42′896″N, 36°31′23″33E, 290 m, 16.04.2011, Kaşık 2,884.
Parasola plicatilis (Curtis) Redhead, Vilgalys & Hopple
Çandır village, Boynuzlu locality, on branches, 41°42′896″N, 36°31′23″33E, 290 m, 17.04.2011, Kaşık 2,906.
Psathyrella candolleana (Fr.) Maire
Çandır village, Boynuzlu locality, on branches, 41°42′896″N, 36°31′23″33E, 290 m, 17.04.2011, Kaşık 2,909, Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 16.05.2011, Kaşık 2,936.
Psathyrella tephrophylla (Romagn.) M.M. Moser
Çandır village, Boynuzlu locality, on branches, 41°42′896″N, 36°31′23″33E, 290 m, 17.04.2011, Kaşık 2,912.

RHIZOPOGONACEAE
Rhizopogon luteolus Fr.

Melikler Peninsula, on debris, 41°45′273″N, 36°31′09″84E, 280 m 19.03.2012, Kaşık 2,951.
Rhizopogon roseolus (Corda) Th. Fr.
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 22.10.2010, Kaşık 2,743.

RUSSULACEAE
Lactarius deliciosus (L.) Gray
Çandır village, Belentaşı locality, on debris, 41°44′672″N, 36°31′36″71E, 305 m, 08.01.2012, Kaşık 2,772.
Russula delica Fr.
Melikler Peninsula, on debris, 41°45′273″N, 36°31′09″84E, 280 m 16.05.2011, Kaşık 2,923.
Russula emetica (Schaeff.) Pers.
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 08.01.2011, Kaşık 2,814.

SCHIZOPHYLLACEAE
Schizophyllum commune Fr.
Çandır village, Belentaşı locality, on branches, 41°44′672″N, 36°31′36″71E, 305 m, 08.01.2012, Kaşık 2775, Kargı, Karadağ locality, on debris, 41°33′419″N, 36°30′76″38E, 330 m 16.04.2011, Kaşık 2,888.

SCLERODERMATACEAE
Pisolithus arhizus (Scop.) Rauschert
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,759.
Scleroderma bovista Fr.
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 08.01.2011, Kaşık 2,815.
Scleroderma polyrhizum (J. F. Gmel.) Pers.
Çandır village, Karaguz locality, on debris, 41°42′575″N, 36°31′39″46E, 380 m, 09.01.2011, Kaşık 2,840.

STEREACEAE
Stereum hirsutum (Willd.) Pers.
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,765.
Stereum ochraceo-flavum (Schwein.) Sacc.
Melikler Peninsula, on branches, 41°45′273″N, 36°31′09″84E, 280 m 19.03.2012, Kaşık 2,955.

STROPHARIACEAE
Agrocybe dura (Bolton) Singer
Çandır village, Boynuzlu locality, on debris, 41°42′896″N, 36°31′23″33E, 290 m, 17.04.2011, Kaşık 2,904.
Galerina badipes (Pers.) Kühner
Melikler Peninsula, among debris, 41°45′273″N, 36°31′09″84E, 280 m 04.02.2011, Kaşık 2,866.
Galerina paludosa (Fr.) Kühner
Çandır village, Şahana locality, among debris, 41°43′178″N, 36°31′31″55E, 283 m, 08.01.2011, Kaşık 2,788.
Hebeloma crustuliniforme (Bull.) Quel.
Yazılı kanyon, on debris, 41°33′419″N, 36°30′76″38E, 330m 09.01.2011, Kaşık 2863.
Hypholoma fasciculare (Huds.) P. Kumm.
Çandır village, Belentaşı locality, among debris, 41°48′772″N, 36°31′59″71E, 354 m, 09.01.2011, Kaşık 2822.
Psilocybe coprophila (Bull.) P. Kumm.
Kargı, Taşdibi village, burned area, 41°23′984″N, 36°30′67″19E, 16.04.2011, Kaşık 2,879.

SUILLACEAE
Suillus bellini (Inzenga) Watling
Çandır village, Belentaşı locality, on debris, 41°44′672″N, 36°31′36″71E, 305 m, 09.01.2011, Kaşık 2,827.
Suillus collinitus (Fr.) Kuntze
Sığla forest, on debris, 41°37′403″N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,746.
Suillus granulatus (L.) Roussel
Kargı, Karadağ locality, on debris, 41°33′419″N, 36°30′76″38E, 330 m 22.10.2010, Kaşık 2,724.
Suillus grevillei (Klotzsch) Singer
Yazılı kanyon, on debris, 41°48′772″N, 36°31′59″71E, 354 m, 09.01.2012, Kaşık 2,944.
Suillus luteus (L.) Roussel
Çandır village, Karaguz locality, on debris, 41°42′575″N, 36°31′39″46E, 380 m, 09.01.2011, Kaşık 2,841.

TREMELLACEAE
Tremella mesenterica Retz.
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 22.10.2010, Kaşık 2,745.

TRICHOLOMATACEAE
Clitocybe gibba (Pers.) P. Kumm.
Yazılı kanyon, on debris, 41°48′772″N, 36°31′59″71E, 354 m, 09.01.2011, Kaşık 2,859.
Infundibulicybe geotropa (Bull.) Harmaja
Melikler Peninsula, among debris, 41°45′273″N, 36°31′09″84E, 280 m 09.01.2011, Kaşık 2,847.
Melanoleuca graminicola (Velen.) Kuhner &Maire
Melikler Peninsula, among debris, 41°45′273″N, 36°31′09″84E, 280m 04.02.2011, Kaşık 2,869, Çandır village, Karaguz locality, on debris, 41°42′575″N, 36°31′39″46E, 380 m, 09.01.2012, Kaşık 2,938.
Resupinatus trichotis (Pers.) Singer
Sığla forest, on branches, 41°37′403″N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,763.
Tricholoma caligatum (Viv.) Ricken
Melikler Peninsula, among debris, 41°45′273″N, 36°31′09″84E, 280 m 09.01.2011, Kaşık 2,855.
Tricholoma fracticum (Britzelm.) Kreisel
Çandır village, Karaguz locality, on debris, 41°42′575″N, 36°31′39″46E, 380 m, 09.01.2011, Kaşık 2,843.

Tricholoma terreum (Schaeff.) P. Kumm.
Çandır village, Belentaşı locality, on debris, 41°44′672″N, 36°31′36″71E, 305 m, 08.01.2012, Kaşık 2,776.

Discussion

As a result of the field and laboratory studies, 105 macrofungi taxa belonging to 43 families were identified from Karacaören (Bucak-Burdur) dam and its surroundings between 2010 and 2012. Through the current study, 14 taxa were collected from the phylum of *Ascomycota*. These species constituted 13.3% of all taxa recorded. From the phylum of *Basidiomycota,* 91 species were collected, and these species constituted 86.7% of all taxa recorded; 38 of them are edible, 59 are inedible, and 8 are more or less poisonous.

In the research area, the number of macrofungi species by families is as follows: *Polyporaceae* 9, *Agaricaceae* 8, *Mycenaceae* and *Tricholomataceae* 7, *Strophariaceae* 6, and the other families have fewer than 6 taxa each.

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MACROFUNGI OF GÜNDOĞMUŞ DISTRICT (ANTALYA, TURKEY)

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Abstract

Öztürk, C., Aktaş, S., Alkan, S., Kaşık, G. & Eroğlu, G. (2013). Macrofungi of Gündoğmuş District (Antalya, TURKEY). Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

Within the framework of this study, 170 macrofungi specimens were collected from different localities in Gündoğmuş (Antalya) district between 2011 and 2012, particularly during the autumn and spring seasons. As a result of the field and laboratory studies, 96 taxa were identified and categorized as edible, poisonous and non-edible. Nine of the reported taxa belong to the phylum of *Ascomycota* and 87 species belong to *Basidiomycota*. Important dominant trees in the research area are *Juniperus sp.* L., *Pinus brutia* Ten., *Abies cilicica* (Antoine & Kotschy) Carrière, *Quercus coccifera* L., *Arbutus andrachne* L., *Platanus orientalis* L. and *Ficus carica* L.. The climate is typically Mediterranean.

Keywords: macrofungi, taxonomy, Gündoğmuş, Antalya, Turkey.

Introduction

In the north and east the research area borders on Konya, in the west on Manavgat, in the south on Alanya and in the northwest on Akseki.

Gündoğmuş (Antalya) district is 230 km away from Konya province. It is located in the Toros Mountains. The altitude of the Gündoğmuş (Antalya) district is 1,100 m. Alara stream passes through the study area.

The vegetation in the research area consists of *Juniperus sp.* L., *Pinus brutia* Ten., *Abies cilicica* (Antoine & Kotschy) Carrière, *Quercus coccifera* L., *Arbutus andrachne* L., *Platanus orientalis* L. and *Ficus carica* L. The species *Platanus orientalis* L., *Salix babylonica* L. and *Myrtus communis* L. are common near the stream.

Various macrofungi specimens were identified in the research area situated in the Mediterranean Sea phytogeographical region.

The aim of this study was to determine the macrofungi taxa of Gündoğmuş (Antalya) district.

Materials and Methods

Within the framework of this study macrofungi specimens were collected from different localities in Gündoğmuş (Antalya) district between 2011 and 2012, particularly during the autumn and spring seasons.

For identification of macrofungi, we used reagents (Melzer's reagent, 3% KOH, 30% KOH, nitric acid, kongo red, cotton blue, anylin, etc.). Microscopic and macroscopic features of the samples were determined in the laboratory with two types of microscope (light microscope and binocular microscope). Furthermore, a computer program (Leica Application Suite program with Leica DM1000 microscope) was used to take photographs of fungal spores, basidia, asci, etc. for their identification. The following literature was used for identification: Sesli & Denchev (2009), Moser (1983), Breitenbach & Kränzlin (1984-2005), Bresinsky & Besl (1990), Dennis (1981), Ellis & Ellis (1990), Pace (1998), Grunert & Grunert (1984, 1991), Pacioni (1993), Jordan (1996), Riva (2003), Cannon & Kirk (2007), Phillips (1981), Smith & Smith (1996), Medardi (2006), Pegler (1987), Watling (1973, 1982), Watling & Gregory (1977, 1989), Winkler (1996), Dähncke (1993) and Jordan (2004).

All identified and dried macrofungi samples are housed at Selçuk University, Fungarium of Mushroom Application and Research Centre, in Konya.

Results

The species names are according to http://www.indexfungorum.org/names/names.asp (Kirk & Ansell 1992). The coordinates have been taken by GPS (Magellan Explorist XL).

ASCOMYCOTA
CALOSCYPHACEAE
Caloscypha fulgens (Pers.) Boud.
Orta Alan plateau, on debris, 40°81′622″N, 36°40′91″26E, 1362 m, 10.05.2012, Öztürk 714.

HELVELLACEAE
Helvella acetabulum (L.) Quel.
Senirçalı, on debris, 40°75′990″N, 36°40′72″42E, 1032 m, 14.05.2011, Öztürk 507.
Helvella leucomelaena (Pers.) Nannf.
Karadere, on debris, 40°76′204″N, 36°40′61″00E, 950 m, 18.04.2011, Öztürk 486, Kara İsa village, on debris, 40°73′896″N, 36°42′62″72E, 945 m, 18.04.2011, Öztürk 476, Senirçalı, on debris, 40°75′990″N, 36°40′72″42E, 1032 m, 14.05.2011, Öztürk 508.

MORCHELLACEAE
Morchella conica Krombh.
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 14.05.2011, Öztürk 524.
Morchella esculenta (L.) Pers.
Kara İsa village, on debris, 40°75′990″N, 36°40′33″93E, 1032 m, 18.04.2011, Öztürk 478, Çayırözü, on debris, 40°73′896″N, 36°42′62″72E, 945 m, 14.05.2011, Öztürk 492.

PEZIZACEAE
Sarcosphaera coronaria (Jacq.) J. Schröt.
Kara İsa village, on debris, 40°73′896″N, 36°42′62″72E, 945 m, 18.04.2011, Öztürk 481, Senirçalı, on debris, 40°75′990″N, 36°40′72″42E, 1032 m, 14.05.2011, Öztürk 509, Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 14.05.2011, Öztürk 526, Toklu yatağı, on debris, 40°75′526″N, 36°41′52″24E, 1226 m, 14.05.2011, Öztürk 539.

PYRONEMATACEAE
Scutellinia scutellata (L.) Lambotte
Kara İsa village, in soil, 40°73′896″N, 36°42′62″72E, 945 m, 10.05.2012, Öztürk 709.
Geopora arenosa (Fuckel) S. Ahmad
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 14.05.2011, Öztürk 538.

SCLEROTINIACEAE
Ciboria rufofusca (O. Weberb.) Sacc.
Orta Alan plateau, on debris, 40°81′622″N, 36°40′91″26E, 1362 m, 10.05.2012, Öztürk 715.

BASIDIOMYCOTA
AGARICACEAE
Agaricus bitorquis (Quel.) Sacc.
Çürük, among debris, 40°23′722″N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 584.
Agaricus campestris L.
Çürük, among debris, 40°23′722″N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 585.
Bovista plumbea Pers.
Senirçalı, on debris, 40°75′990″N, 36°40′72″42E, 1032 m, 14.05.2011, Öztürk 513, Nar Ağacı plateau, Karasini locality, among grass, 40°74′380″N, 36°41′90″94E, 1278 m, 15.05.2011, Öztürk 554, Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 22.10.2011, Öztürk 623.
Crucibulum laeve (Huds.) Kambly
Orta Alan plateau, on branches, 40°81′622″N, 36°40′91″26E, 1362 m, 23,10.2011, Öztürk 685.
Cystodermella granulosa (Batsch) Harmaja
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 22.10.2011, Öztürk 627.
Lycoperdon lividum Pers.
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 22.10.2011, Öztürk 630.
Lycoperdon molle Pers.
Çürük, among debris, 40°23′722″N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 593.
Lycoperdon perlatum Pers.
Çürük, among debris, 40°23′722″N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 598.
Macrolepiota excoriata (Schaeff.) Wasser
Çürük, among debris, 40°23′722″N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 599.
Macrolepiota procera var. procera (Scop.) Singer
Çürük, among debris, 40°23′722″N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 600.

AMANITACEAE
Amanita caesarea (Scop.) Pers.
Çürük, among debris, 40°23′722″N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 587.
Amanita ovoidea (Bull.) Link
Güney Yaka plateau, on debris, 40°79′771″N, 36°40′51″61E, 786 m, 23,10.2011, Öztürk 654.

AURICULARIACEAE
Auricularia auricula-judae (Bull.) Quel.
Orta Alan plateau, on stump, 40°81′622″N, 36°40′91″26E, 1362 m, 23,10.2011, Öztürk 683.
Exidia glandulosa (Bull.) Fr.
Çürük, on branches, 40°23′722″N, 36°39′79″27E, 800 m, 14.05.2011, Öztürk 498.

BANKERACEAE
Boletopsis leucomelaena (Pers.) Fayod
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 22.10.2011, Öztürk 621.

Sarcodon imbricatus (L.) P. Karst.
Çürük, among debris, 40°23′722″N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 609.

CANTHARELLACEAE
Cantharellus cibarius Fr.
Çürük, among debris, 40°23′722″N, 36°39′79″27E, 800 m, 18.04.2011, Öztürk 475.
Cantharellus cinereus (Pers.) Fr.
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 14.05.2011, Öztürk 527.

DACRYMYCETACEAE
Dacrymyces stillatus Nees
Senirçalı, on branches, 40°75′990″N, 36°40′72″42E, 1032 m, 14.05.2011, Öztürk 518.
Dacrymyces variisporus McNabb
Çürük, on branches, 40°23′722″N, 36°39′79″27E, 800 m, 14.05.2011, Öztürk 496, Senirçalı, on branches, 40°75′990″N, 36°40′72″42E, 1032 m, 14.05.2011, Öztürk 520.

DIPLOCYSTIDIACEAE
Astraeus hygrometricus (Pers.) Morgan
Çukuroluk locality, on debris, 40°73′072″N, 36°41′31″36E, 1253 m, 22.10.2011, Öztürk 578.

ENTOLOMATACEAE
Entoloma hirtipes (Schumach.) M. M. Moser
Orta Alan plateau, on debris, 40°81′622″N, 36°40′91″26E, 1362 m, 22.10.2011, Öztürk 615.

FOMITOPSIDACEAE
Antrodia juniperina (Murrill) Niemela & Ryvarden
Senirçalı, on branches, 40°75′990″N, 36°40′72″42E, 1032 m, 14.05.2011, Öztürk 510, Soğuksu waterfall, on stump, 40°68′472″N, 36°42′44″69E, 921 m, 15.05.2011, Öztürk 563.

GEASTRACEAE
Geastrum fimbriatum Fr.
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 14.05.2011, Öztürk 529, Karadere, on debris, 40°76′204″N, 36°40′61″00E, 950 m, 23,10.2011, Öztürk 669.
Geastrum rufescens Pers.
Çürük, among debris, 40°23′722″N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 588.
Geastrum schmidelii Vittad.
Karadere, on debris, 40°76′204″N, 36°40′61″00E, 950 m, 23,10.2011, Öztürk 668.

GLOEOPHYLLACEAE
Gloeophyllum sepiarium (Wulfen) P. Karst.
Soğukoluk, on stump, 40°79′649″N, 36°41′17″35E, 1487 m, 14.05.2011, Öztürk 534.

GOMPHACEAE
Gomphus clavatus (Pers.) Gray
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 22.10.2011, Öztürk 628.
Ramaria flava (Schaeff.) Quel.
Orta Alan plateau, on debris, 40°81′622″N, 36°40′91″26E, 1362 m, 10.05.2012, Öztürk 722.
Ramaria botrytis (Pers.) Ricken
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 22.10.2011, Öztürk 632.

GOMPHIDIACEAE
Chroogomphus rutilus (Schaeff.) O. K. Mill.
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 22.10.2011, Öztürk 624.

HERICIACEAE
Hericium coralloides (Scop.) Pers.
Nar Ağacı plateau, Karasini locality, among grass, 40°74′380″N, 36°41′90″94E, 1278 m, 14.05.2011, Öztürk 505.

HYDNANGIACEAE
Laccaria laccata (Scop.) Cooke
Çürük, among debris, 40°23′722″N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 589.

HYGROPHORACEAE
Hygrophorus agathosmus (Fr.) Fr.
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 22.10.2011, Öztürk 644.
Hygrophorus eburneus (Bull.) Fr.
Orta Alan plateau, on debris, 40°81′622″N, 36°40′91″26E, 1362 m, 23.10.2011, Öztürk 688.
Hygrophorus ligatus Fr.
Orta Alan plateau, on debris, 40°81′622″N, 36°40′91″26E, 1362 m, 23.10.2011, Öztürk 689.

HYMENOCHAETACEAE
Phellinus conchatus (Pers.) Quel
Senirçalı, on stump, 40°75′990″N, 36°40′72″42E, 1032 m, 14.05.2011, Öztürk 521.
Phellinus pomaceus (Pers.) Maire
Cizre, on almond tree, 40°81′793″N, 36°40′67″27E, 979 m, 10.05.2012, Öztürk 706.

INOCYBACEAE
Crepidotus mollis (Schaeff.) Staude
Güney Yaka plateau, on branches, 40°79′771″N, 36°40′51″61E, 786 m, 23,10.2011, Öztürk 662.
Inocybe rimosa (Bull.) P. Kumm.
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 14.05.2011, Öztürk 530.

LYOPHYLLACEAE
Lyophyllum decastes (Fr.) Singer
Orta Alan plateau, on debris, 40°81′622″N, 36°40′91″26E, 1362 m, 23.10.2011, Öztürk 691.

MARASMIACEAE
Baeospora myosura (Fr.) Singer
Güney Yaka plateau, on pine cone, 40°79′771″N, 36°40′51″61E, 786 m, 23,10.2011, Öztürk 658.
Gymnopus dryophilus (Bull.) Murill
Senirçalı, on branches, 40°75′990″N, 36°40′72″42E, 1032 m, 14.05.2011, Öztürk 517, Çayırözü, on debris, 40°74′735″N, 36°42′62″72E, 1101m, 14.05.2011, Öztürk 495.
Marasmius oreades (Bolton) Fr.
Çürük, among debris, 40°23′722″N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 605.

MYCENACEAE
Mycena epipterygia (Scop) Gray
Orta Alan plateau, on debris, 40°81′622″N, 36°40′91″26E, 1362 m, 23.10.2011, Öztürk 695.
Mycena pura (Pers.) P. Kumm.
Karadere, on debris, 40°76′204″N, 36°40′61″00E, 950 m, 23,10.2011, Öztürk 677.
Mycena renati Quel.
Orta Alan plateau, on debris, 40°81′622″N, 36°40′91″26E, 1362 m, 23.10.2011, Öztürk 692.
Panellus mitis (Pers.) Singer
Çürük, on branches, 40°23′722″N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 606, Karadere, on branches, 40°76′204″N, 36°40′61″00E, 950 m, 23,10.2011, Öztürk 672.
Xeromphalina cauticinalis (With.) Kühner & Maire
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 14.05.2011, Öztürk 533.

PAXILLACEAE
Paxillus involutus (Batsch) Fr.
Soğuksu waterfall, in soil, 40°68′472″N, 36°42′44″69E, 921 m, 15.05.2011, Öztürk 569.

PLEUROTACEAE
Hohenbuehelia petaloides (Bull.) Schulzer
Güney Yaka plateau, on debris, 40°79′771″N, 36°40′51″61E, 786 m, 23,10.2011, Öztürk 663, Çukuroluk locality, on debris, 40°73′072″N, 36°41′31″36E, 1253 m, 23.10.2011, Öztürk 645.
Pleurotus eryngii var. eryngii (DC.) Quel.
Güneycik plateau, mycorrhizal with çakşır, 40°85′773″N, 36°41′32″98E, 1700 m, 15.05.2011, Öztürk 540.
Pleurotus ostreatus (Jacq.) P. Kumm.
Orta Alan plateau, on stump, 40°81′622″N, 36°40′91″26E, 1362 m, 23.10.2011, Öztürk 696.

PLUTEACEAE
Pluteus romellii (Britzelm.) Sacc.
Orta Alan plateau, near stump, 40°81′622″N, 36°40′91″26E, 1362 m, 23.10.2011, Öztürk 698.

POLYPORACEAE
Cerrena unicolor (Bull.) Murrill
Güney Yaka plateau, on branches, 40°79′771″N, 36°40′51″61E, 786 m, 23,10.2011, Öztürk 659.
Fomes fomentarius (L.) J. Kickx f.
Çürük, on stump, 40°23′722″N, 36°39′79″27E, 800 m, 14.05.2011, Öztürk 499, Harmanak, on *Populus* sp., 40°77′305″N, 36°40′85″63E, 1185 m, 15.05.2011, Öztürk 545, Orta Alan plateau, on stump, 40°81′622″N, 36°40′91″26E, 1362 m, 10.05.2012, Öztürk 717.
Lentinus tigrinus (Bull.) Fr.
Soğuksu waterfall, on stump, 40°68′472″N, 36°42′44″69E, 921 m, 15.05.2011, Öztürk 567.
Polyporus brumalis (Pers.) Fr.
Çürük, on branches, 40°23′722″N, 36°39′79″27E, 800 m, 14.05.2011, Öztürk 501.
Trametes hirsuta (Wulfen) Lloyd
Karadere, on branches, 40°76′204″N, 36°40′61″00E, 950 m, 23,10.2011, Öztürk 678.
Trametes versicolor (L.) Lloyd
Orta Alan plateau, on stump, 40°81′622″N, 36°40′91″26E, 1362 m, 23.10.2011, Öztürk 700.
Trichaptum abietinum (Dicks.) Ryvarden
Soğukoluk, on branches, 40°79′649″N, 36°41′17″35E, 1487 m, 14.05.2011, Öztürk 537.

PSATHYRELLACEAE
Coprinellus micaceus (Bull.) Vilgalys, Hopple & Jacq. Johnson
Nar Ağacı plateau, Karasini locality, among debris, 40°74′380″N, 36°41′90″94E, 1278 m, 15.05.2011, Öztürk 558.
Coprinopsis picacea (Bull.) Redhead, Vilgalys & Moncalvo
Orta Alan plateau, among debris, 40°81′622″N, 36°40′91″26E, 1362 m, 23.10.2011, Öztürk 684.
Panaeolus papilionaceus var. papilionaceus (Bull.) Quel.
Orta Alan plateau, among grass, 40°81′622″N, 36°40′91″26E, 1362 m, 22.10.2011, Öztürk 617.

RHIZOPOGONACEAE
Rhizopogon luteolus Fr.
Güney Yaka plateau, among debris, 40°79′771″N, 36°40′51″61E, 786 m, 23,10.2011, Öztürk 665, Çürük, among debris, 40°23′722″N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 608, Çukuroluk locality, among debris, 40°73′072″N, 36°41′31″36E, 1253 m, 22.10.2011, Öztürk 649.
Rhizopogon roseolus (Corda) Th. Fr.
Karadere, among debris, 40°76′204″N, 36°40′61″00E, 950 m, 18,04.2011, Öztürk 488.

RUSSULACEAE
Lactarius deliciosus (L.) Gray
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 22.10.2011, Öztürk 629.
Russula delica Fr.
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E,

1487 m, 22.10.2011, Öztürk 636.
Russula emetica (Schaeff.) Pers.
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 22.10.2011, Öztürk 638.
Russula ochroleuca Fr.
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 22.10.2011, Öztürk 635.
Russula turci Bres.
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 22.10.2011, Öztürk 639.

SCHIZOPHYLLACEAE
Schizophyllum commune Fr.
Kara İsa village, on debris, 40°73′896″N, 36°42′62″72E, 945 m, 18.04.2011, Öztürk 483, Soğuksu waterfall, on branches, 40°68′472″N, 36°42′44″69E, 921 m, 15.05.2011, Öztürk 572.

STEREACEAE
Stereum hirsutum (Willd.) Pers.
Çürük, on branches, 40°23′722″N, 36°39′79″27E, 800 m, 14.05.2011, Öztürk 503, Senirçalı, on branches, 40°75′990″N, 36°40′72″42E, 1032 m, 14.05.2011, Öztürk 522, Orta Alan plateau, on stump, 40°81′622″N, 36°40′91″26E, 1362 m, 23.10.2011, Öztürk 699.

STROPHARIACEAE
Agrocybe dura (Bolton) Singer
Orta Alan plateau, in grass, 40°81′622″N, 36°40′91″26E, 1362 m, 23.10.2011, Öztürk 681.
Galerina marginata (Batsch) Kühner
Orta Alan plateau, in moss, 40°81′622″N, 36°40′91″26E, 1362 m, 23.10.2011, Öztürk 687.
Hebeloma crustuliniforme (Bull.) Quel.
Orta Alan plateau, among debris, 40°81′622″N, 36°40′91″26E, 1362 m, 23.10.2011, Öztürk 719.

SUILLACEAE
Suillus bellini (Inzenga) Watling
Karadere, among debris, 40°76′204″N, 36°40′61″00E, 950 m, 23,10.2011, Öztürk 674.
Suillus collinitus (Fr.) Kuntze
Çürük, among debris, 40°23′722″N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 613.
Suillus grevillei (Klotzsch) Singer
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 22.10.2011, Öztürk 641.
Suillus luteus (L.) Roussel
Çukuroluk locality, on debris, 40°73′072″N, 36°41′31″36E, 1253 m, 23.10.2011, Öztürk 652.
Suillus placidus (Bonord.) Singer
Karadere, among debris, 40°76′204″N, 36°40′61″00E, 950 m, 23,10.2011, Öztürk 675.

TREMELLACEAE
Tremella mesenterica Retz.
Nar Ağacı plateau, Karasini locality, on branches, 40°74′380″N, 36°41′90″94E, 1278 m, 15.05.2011, Öztürk 559.

TRICHOLOMATACEAE
Clitocybe gibba (Pers.) P. Kumm.
Senirçalı, on debris, 40°75′990″N, 36°40′72″42E, 1032 m, 14.05.2011, Öztürk 515.
Infundibulicybe geotropa (Bull.) Harmaja
Köprülü, on debris, 40°64′110″N, 36°42′75″24E, 929 m, 15.05.2011, Öztürk 549.
Tricholoma anatolicum H. H. Doğan & Intini
Soğukoluk, on debris, 40°79′649″N, 36°41′17″35E, 1487 m, 22.10.2011, Öztürk 643.
Tricholoma stans (Fr.) Sacc.
Orta Alan plateau, among debris, 40°81′622″N, 36°40′91″26E, 1362 m, 22.10.2011, Öztürk 703.
Tricholoma terreum (Schaeff.) P. Kumm.
Orta Alan plateau, among debris, 40°81′622″N, 36°40′91″26E, 1362 m, 22.10.2011, Öztürk 704.

Discussion

As a result of the field and laboratory studies, 96 macrofungi taxa belonging to 40 families were identified from Gündoğmuş (Antalya) district between 2011 and 2012. During this study nine species were collected from the phylum of *Ascomycota*, and they comprise 9.4% of all recorded species; 87 species were collected from the phylum of *Basidiomycota,* and these species comprise 90.6% of all recorded species; 47 of them are edible, 41 are inedible, and 8 are more or less poisonous.

In the research area, the number of macrofungi species by families is as follows: *Agaricaceae* 10 while *Mycenaceae*, *Russulaceae*, *Suillaceae* and *Tricholomataceae* 5 each. The other families have fewer than 4 taxa.

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GREENHOUSE GASEMISSIONS FROM LIVESTOCK IN THE REPUBLIC OF MACEDONIA, ENTERIC FERMENTATION AND MANURE MANAGEMENT, IN THE PERIOD 2006-2010

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Апстракт

Џабирски, В., Порчу, К., Коцевски, Д. & Ѓорѓиевски С. (2013). Емисија на стаклени гасови од добиток во Република Македонија, ентерична ферментација и управување со ѓубриво, во периодот 2006-2010. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 28, Скопје.

Проценатa на емисијата на стаклени гасови од сточарството во Република Македонија, за периодот од 2006 до 2010 година, беше калкулирана согласно со примена на Tier 1 методата. Во трудот се опфатени следните гасови: метан, азотен оксид и CO_2- еквивалент од ентерична ферментација и менаџмент со арското ѓубривото од подсекторот сточарство. Изворот на податоци беше базата за регистрација на видовите домашни животни и нивната дистрибуција за секој плански регион (2007-2010) и Статистичкиот годишник на Република Македонија. Податоците за вкупната годишна емисија на метан од ентеричната ферментација и менаџметот со арскот ѓубриво за периодот од 2006-2010 беше во границите од 27,31 Gg (2006) и 26,41 Gg (2007), со најниски вредности во 2009 (25,49 Gg). Во зависност од системот за управување со арското ѓубриво, највисоки вредности на екскреција на азот (цврсто складирање и суво изѓубрување) беа забележани во 2010 (10,43 kt/N/годишно). Скоро идентична вредност на екскреција на азот од пасишта и испусти беше забележана во 2007 и 2008 година (9,54 и 9,53 kt/N/годишно, респективно). Најниска вредност за анализираниот период (8,82 kt/N/годишно) беше забележана во 2009, а највисока вредност од 14,58 во 2006. Во овој период, највисока вредност (3,33 kt/N/годишно) за останатиот тип на управување со арското ѓубриво беше регистрирана во 2007.

Клучни зборови: метан, азотен оксид и CO_2- еквивалент

Abstract

Dzabirski, V., Porcu, K., Kocevski, D. & Gjorgievski S. (2013). Greenhouse gasemissions from livestock in the Republic of Macedonia, enteric fermentation and manure management, in the period 2006-2010. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

The estimation of greenhouse gas emission from livestock in the Republic of Macedonia for the period from 2006 to 2010 is performed according to applying the Tier 1 method for calculation of estimations. This article includes the following gasses: Methane, Nitrogen oxide and CO_2-eq from sub sector domestic livestock enteric fermentation and manure management. The data sources are based on the animals' registration records for livestock species distribution in each planning region (2007-2010) and Statistical Yearbooks of the republic of Macedonia. Annual methane emission from enteric fermentation and manure management is in the range between 27.31 Gg (2006) and 26.41Gg (2007), with lowest value in 2009 (25.49 Gg). Depending on the animal waste management system the highest value of nitrogen exertion (solid storage and drylot) was observed in 2010 (10.43kt/N/yr). An almost similar value of nitrogen excretion from pasture and paddock was observed in 2007 and 2008 (9.54 and 9.53 kt/N/yr, respectively). Lowest value for nitrogen excretion from pasture and paddock was noted in 2009 (8.82 kt/N/yr) and the highest value in 2006 (14.58 kt/N/yr). In this period, the highest value (3.33 kt/N/yr) for other type of animal waste management system was recorded in 2007.

Key words: methane, nitrous oxide and CO_2- equivalent,

Introduction

At global level livestock, as a separate sector of the overall agriculture, is developing quite faster than other sectors. Sector provides livelihoods to approximately 1.3 billion people and contributes about 40% of global agricultural production, but also the sector represents a renewable energy source as an essential source of manure for farmers. According to the Food and Agriculture Organization (FAO, 2006), livestock exploits even 30% of the total surface of the Earth, mostly through constant use of pastures. A significant proportion (33%) of total arable land is used to produce animal feed. The livestock sector is also one of the main causes of deforestation, especially in Latin America where 70% of the forests are converted to pastures. As a result of the increased prosperity of the human population the consumption of milk and meat has increased each year, expectations are that meat production will be two time higher, from 299 million tons in 1999/01 to 465 million tons in 2050, while milk production is expected to increase from 580 to 1043 million tones. Above mentioned expectations indicate an intensification of production which is expected to have significantly impact on the environment trough higher emission of greenhouse gases (GHGs). Livestock sector generates 18% more greenhouse gases (converted into CO_2 equivalent) than overall transport on the planet and at the same time represents a major source of land and water degradation. Livestock sector through emissions of: methane, ammonia and nitrous oxide significantly affect the environment. Sector generates 65% of nitrous oxide (which has 296 times greater global warming potential than CO_2) emissions associated with the activities of human populations. The largest percentage of nitric oxide emission is due to manure management. Out of all the activities of the human populations, as much as 37% of the emission of methane (methane has 23 greater global warming potential of CO_2) is attributed to the livestock sector, and that it is a result of the digestive system of ruminants. In addition to the emissions of the previous two gases, taking into account all activities of human populations, even 64% of ammonia (significantly contributes to acid rain) are result of the livestock sector. As a result of its own rapid development the livestock sector significantly affect the environment, therefore the environmental impact of the sector must be cut by half in order to avoid increasing the degree of damage beyond the current level.

GHGs differ in their reemission capacity and heat absorption. Generally it can be noted that the emission of certain GHGs is quite low but certain gases posses' greater heat capacity retention, that specific feature is named as global warming capacity. Differences in global warming capacities can be

Tab. 1. Livestock number-entrance data

Livestock	2006	2007	2008	2009	2010
Dairy Cattle	164,013	166,307	162,338	164,75	175,77
Non-dairy Cattle	91,417	87,459	91,135	87,771	84,117
Sheep	1248,801	817,536	816,604	755,356	778,404
Goats	63,579	126,452	133,017	94,016	75,709
Horses Mules & Asses	0	31,036	30,936	29,418	26,661
Swine	167,116	255,146	246,874	193,84	190,552
Poultry	2585,327	2263,894	2226,055	2117,89	1994,852

Tab. 2. Emission factors for methane from enteric fermentation and manure management

Livestock	Emissions factor for eneteric fermentation (kg/head/yr)	Emissions factor for manure managament (kg/head/yr)
Dairy Cattle	81	6
Non-dairy Cattle	56	4
Buffalo	55	3
Sheep	5	0.1
Goats	5	0.11
Horses	18	1.1
Swine	1	4
Poultry	0	0.012

Tab. 3. Total annual emission of methane

Year	Emissions from enteric fermentation (t/yr)	Emissions from manure management (t/yr)	Total annual emissions from domestic livestock (Gg)
2006	25.13	2.17	27,31
2007	23.90	2.51	26,41
2008	23.80	2.46	26,27
2009	23.23	2.24	25,49
2010	23.88	2.28	26,17

Tab. 4. Total annual nitrogen excretion

Animal Waste Management System (AWMS)	Nitrogen Excretion $Nex_{(AWMS)}$ (kt /N/yr)				
	2006	2007	2008	2009	2010
Solid storage & drylot	10.06	10.07	9.98	10.00	10.43
Pasture range and paddock	14.5	9.54	9.53	8.82	9.09
Other	2.60	3.32	2.38	2.70	2.61
Total	27.28	22.94	23.06	20.72	22.14

illustrated trough difference in period of degradation of methane and N_2O compared with CO_2 (in 20 years period of time 1 kg of CH_4 will have same effect as 56 kg of CO_2).

This paper shows the greenhouse gas emissions from livestock production sector in the Republic of Macedonia in the period 2006 -2010.

Material and methods

Entrance data (Tab. 1) in this research, which were used to calculate GHGs emission, were based on official statistical data published in statistical annuals of Republic of Macedonia(SSO, 2006, 2007, 2008, 2009 and 2010). Data is processed according to the Tier 1 method, which is actually a simplified method of calculation of greenhouse gas emissions (Greenhouse Gas Inventory Reference Manual, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. OECD, IEA 1997). As a method Tier 1 is using readily available statistical data and default emission factors, which assume a linear relation between the intensity of the process and the resulting emissions. The Tier 1 method includes the following data: number of each animal species regarding breeding category, data for climate condition in the analyzed region, which in turn define emission factors/coefficients. The application of sophisticated method requires detailed information about livestock sector.

CH_4 emission generated from enteric fermentation and manure management are calculated by using emission factors by the type of animals (Tab. 2).

Results

Data for total annual emission of methane (enteric fermentation and manure management) in the period 2006-2010 are shown in table 3. Annual methane emission is higher form enteric fermentation than emission from manure management. Highest value from enteric fermentation was noted in 2006 were from manure management in 2007. Total annual emission was highest in 2006.

Data for nitrogen excretion and emission from animal waste management system (AWMS) are shown in table 4 and table 5. Highest value for nitrogen excretion (14.5 kt/N/yr) and nitrogen emission (0.46 Gg) was noted from pasture range and paddock AWMS (table 4 and table 5). Nitrogen emissions and excretion from solid storage and drylot were almost constant in the analyzed period (table 4 and 5). Emission and excretion of nitrogen (Table 4 and 5) from other types of AWMS were quite lower than previously mentioned types of AWMS, highest excretion (3.32 kt/N/yr) and emission (0.26 Gg) values for this type of AWMS was noted in 2007.

Carbon dioxide equivalent (CO_2-eq) represent a metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). Highest value (573.45 kt) for CO_2-eq from enteric fermentation were noted in 2006 while CO_2-eq emission from all types of AWMS were highest (231.9 kt) in 2007 (Table 6).

Discussion

Ruminants have the unique ability to digest plant material which contains high levels of cellu-

Tab. 5. Total annual nitrogen emission

Animal Waste Management System (AWMS)	Total Annual Emissions of N_2O (Gg)				
	2006	2007	2008	2009	2010
Solid storage & drylot	0,32	0,32	0,31	0,31	0,33
Pasture range and paddock	0,46	0,30	0,30	0,28	0,29
Other	0,20	0,26	0,19	0,21	0,21
Total	0,98	0,88	0,80	0,80	0,83

Tab. 6. CO_2-eq emission

Annual CO_2-eq emission	Year				
	2006	2007	2008	2009	2010
Enteric fermentation (kt)	573.45	554.61	551.73	535.04	549.64
Animal Waste Management System AWMS (kt)	207.13	231.9	206.89	211.34	213.27

lose. Therefore, an integral component of the whole process of feed digestion is the formation of methane. Although during enteric fermentation CH_4 formation is inevitable, however certain foods and a properly balanced diet significantly affect the level of formation of CH_4 during enteric fermentation. Methane emission during the enteric fermentation mainly (87%) is result of rumen activity and lower amount of the small intestine (13%) (Murray et al., 1976). Intermediate products of microbial flora of the rumen are converted into methane from methanogenic bacteria (Moss et al., 2000).The following factors have a significant impact on methane emission: animal type, age, size, quantity of feed, fodder and fodder intake. Furthermore, the lactation periods and proficiency levels of animals have a meaningful impact (Jungbluth et al., 2001). Using feed with higher crude fiber (hay and straw) results in higher production of CH_4 in terms of feeds with a lower level of crude fiber. Additional reduction in the formation of CH_4 during the enteric fermentation can be achieved through the use of granular foods (corn, barley or wheat). Improperly balanced feed, like lack of protein or minerals would also result in an increased level of CH_4 production. Apart from the type of feed, correctly balanced feed and farming technology directly affects the amount of produced CH_4. Breeding technology has particular impact in cattle breeding, where the formation and emission of CH_4 is lower at fixed breeding system (using balanced diet and use a greater level of grains) in respect of pasture breeding (Ominski and Wittenberg, 2006).

If we compare CH_4 emissions from enteric fermentation in the analyzed period (2006-2010) generally there has been a trend of decreasing of the emission values. Although the values are quite close, the highest value for this parameter is noted in 2006 (25.13 t/yr) while the lowest value was recorded in 2009 (23.23 t/yr). Compared with the data Dzabirski et al. (2008) it can be concluded that the emission of methane from enteric fermentation in the period 2003-2005 and analyzed period is almost unchanged. Small variations in the number of domestic animals, unchanged breeding technology but also composition of the diet of animals directly affect the volume of CH_4 emissions from enteric fermentation. The high value of CH_4 emission in 2006 is result of high sheep number in the country, which according to official data was 1,248,801 heads (SSO, 2006).

During the manure management CH_4 emission is also present, which is still significantly lower than emissions from enteric fermentation. Main component of the manure is the organic matter which under the influence of methanogenic bacteria is digested to methane. Methane emission calculation between different manure management systems primarily is based on: amount of manure (depending on the type, category and number of animals) as well as fraction of manure which is anaerobic decomposed (connected to the climate conditions in the region) (Dzabirski et al., 2008).

Highest value for emissions from manure management is notated in 2007 (2.51 t/yr) while the lowest value was recorded in 2006 (2.17 t/yr). Emissions from enteric fermentation were highest in 2006 and hence the emission of methane from manure is supposed to be the highest in the same year, but unfortunately the lack of official data for the total number of equine and their exclusion from the further data processing significantly affects the value of emission. Compared with the data from Dzabirski et al. (2008) we have noticed a slight increase

in CH_4 emissions from manure management in the analyzed period, where the authors note the highest value in 2003 (21.70 t/yr). Total methane emission (Gg) in the analyzed period shows highest value (27.31 Gg) in 2006. While in the remaining period of the emission is approximately same (Table 3). Higher methane emission in 2006 is due to the higher sheep number.

More factors (management system, composition of manure, the type of bacteria responsible for manure decomposition, presence of oxygen and fluid in the manure management systems) significantly affect N_2O production during the manure management process. Aerobic decomposition of manure is characterized with increased N_2O emissions, transformation of N_2O in NO results in a reduction of ozone. Lowest value (9.98 kt/N/yr) for nitrogen excretion from solid storage and dry lot during the analyzed period (2006-2010) was noted in 2008. Values obtained for the analyzed period have higher values compared with data of Dzabirski et al. (2008) as a result of slight increasing of the number of bovine in the country. Reducing the sheep number in Macedonia directly affects nitrogen excretion from pastures and paddock. Highest value for nitrogen excretion from pastures and paddock was observed in 2006 (14.57 kt /N/yr) which is two times lower compared with data from RFNCCC, 1994 (28.80 kt/N/yr) but about the same with the data observed from Dzabirski et al. (2008) during the 2003-2005 period. Lowest value for this parameter was observed in 2008, when sheep number in the country had lowest number (755356 heads). Annual variation in the number of domestic animals (poultry, horses and pigs) directly correlate with the excretion of nitrogen from these species. In this group of animals, the highest emission (3.32 kt/N/yr) was observed in 2008. The data for analyzed period had approximately same values with the values observed from Dzabirski et al. (2008). Annual N_2O emissions (Gg) are primarily determined by the manure management system. Highest value (0.33 Gg) for the N_2O emission during solid storage and dry lot was noted in 2010. In this system of manure management linear emission was observed for the analyzed period (Table 5). N_2O excretion from pasture range and paddock has decreasing trend (Table 5), primarily as a result of reducing sheep number. The highest value (0.46 Gg) was observed in 2006, while the lowest (0.28 Gg) in 2009. Compared with the analyzed period, Dzabirski et al. (2008) in the period 2003-2005 had noted higher values for the N_2O excretion from pasture range and paddock. Namely noted emission were ranging from 0.45 Gg in 2003 and 2005, respectively with highest value (0.53 Gg) in 2004. In the analyzed period N_2O emission from the other types of livestock (pigs, horses and poultry) animals showed very low emission values, ranging from 0.19 Gg in 2008 to 0.26 Gg in 2007.

Different gases have different global warming capacity, and their capacity can be defined as the effect of a gas on climate change. Universal standard unit of measurement by which the various gases can be assessed is CO_2-eq that enables converting greenhouse gases into a common unit of measurement. Highest value for CO_2-eq in the analyzed period (Table 6) from enteric fermentation (573.51 kt) was observed in 2006 and for manure management (231.90 kt) was present in 2007. Lowest values for CO_2-eq emission from enteric fermentation were observed in 2009 and 2010, 535.04 kt and 549.64 kt respectively. CO_2-eq emission in analyzed period has approximately close values ranging from 206.89 (2008) up to 231.90 kt in 2007. Comparing the data of the analyzed period (2006-2007) with data from previous years (2003-2005) can be seen that CO_2-eq emissions from manure management is twice higher, as CO_2-eq from enteric fermentation shows approximately equal values with the exception of 2006. The obtained parameters for the CO_2-eq emissions (kt) is significantly lower compared to the values (600 to 700 kt) for emission of CO_2-eq which were observed in the period 1990 - 1997 (Dzabirski et al., 2008).

Conclusion

The main influence of GHGs emission level from livestock has an annual livestock number as well as breeding categories in each species. Data for the period 2006-2010 show downward trend in greenhouse gas emissions. Applications of modern breeding technology, balanced feed as well better feed quality in the future are main objectives in order to reduce GHGs emission from the subsector. Application of further more sophisticated methods for estimation of GHGs is tidily connected with application of system for integrated administration as well with possession and application of sophisticated equipment. No major difference of GHG emission from analyzed period compared to period 2003-2005, except for 2006 (due to higher sheep number).

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MANAGING POULTRY DIET COMPOSITION TO REDUCE PHOSPHORUS EXCRETION AND ENVIRONMENTAL POLLUTION

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Abstract

Kocevski, D., Georgievski, S., Dzabirski, V., Bunevski, Gj., Vukovic, V. & Porcu, K. (2013). Managing poultry diet composition to reduce phosphorus excretion and environmental pollution. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

Phosphorus (P) is one of the essential nutrient for maintaining egg production and egg shell quality in laying hens. The study was conducted to follow the environmental impacts and production results (egg laying percentage and egg shell quality) of modification of the layer's feeding formulation, by lowering the level (on average 0.5%) of inorganic phosphorus sources (Mono-Calcium-Phosphate, MCP) and exogenous phytase (Ronozyme P 5000) supplementation at a level of 0.01%. Two flocks of Hisex Brown layers were fed with isoprotein and isocalloric diets with (+) or without (-) added exogenous phytase enzyme, maintaining estimated total and available phosphorus phase feeding level (Phase0, >28; Phase1, 28-50 and phase2, >50 weeks of age) according the recommended requirements. Production data as well as egg quality parameters (especially eggshell strength) were followed and P levels were analyzed in the feed and in the faeces, to follow the balance between added and digested P. No differences in the production parameters (297.96 versus 297.99 egg number/hen housed) and shell strength 3851.05±897.19 versus 3928.67±913.13 g/cm^2 were found in the Phytase(-) and Phytase(+) groups, respectively. Designed feeding formulas with added phytase contained on average 0.5% lower level of MCP or 200g/bird, which for the farm having 100000 layers is 20t MCP/cycle. Expressed in terms of pure P, 4for this farm level .4t or in total 44 tons less P will be delivered to the environment from Macedonian egg production flock (1milion layers). Manure of the hens fed diet supplemented with phytase has 0.06% less P or 30g/bird/cycle, or expressed in terms of farm with 100000 layers, there are additionally 3 tons less P runoffs in the environment. Phytase supplementation of the layer's feed is a useful tool in lowering the environmental pollution with P without significant changes in the number and quality of eggs produced.

Key words: poultry, nutrition, phosphorus, phytase, environment, pollution

Апстракт

Коцевски, Д., Георгиевски, С., Џабирски, В., Буневски, Ѓ., Вучковиќ, В. и Порчу, К. (2013). Регулирање на составот на оброкот на живината со цел намалување на екскрецијата на фосфорот и загадувањето на животната средина. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 28, Скопје.

Фосфорот (P) е еден од есенцијалните хранливи материи за одржување на јајцепроизводството и квалитетот на лушпата на јајцата кај несилките. Студија е дизајнирана за да се следат влијанијата врз животната средина и производните резултати (процент на несивост и квалитет на лушпата на јајцата) при модифицирање на формулацијата на смеската за исхрана на несилките, преку намалување на нивото (просечно 0,5%) на изворот на неорганski Фосфор (Моно-Калциум-Фосфат, МЦП) и додавање на егзогена фитаза (Ronozyme P 5000) на ниво од 0,01%. Две јата на Hisex Brown несилки се хранети со изопротеински и изокалорични смески со (+) или без (-) додадена егзогена фитаза, одржувајќи го нивото на вкупен и искористлив фосфор во смеските за исхрана во различните фази од производниот циклус (Фаза0, >28; Фаза1, 28-50 и Фаза2, >50 недели возраст) согласно препорачаните потреби. Производните податоци како и парамет-

рите за квалитет на јајцата (посебно цврстината на лушпата) се следени а нивото на P во смеските и изметот анализирани со цел да се следи балансот помеѓу доданиот и дигестираниот P. Не се забележани разлики во производните параметри (297,96 vs 297,99 јајца/вселена несилка) и цврстината на лушпата на јајцата (3851,05±897,19 vs 3928,67±913,13 g/cm^2) кај групите несилки хранети со смески без додадена фитаза (-) и со додадена фитаза (+), респективно. Дизајнираните формулации за смеските со додадена фитаза содржеа во просек 0,5% помалку MCP или околу 200g/птица, што на ниво на целата фарма која има100000 несилки изнесува 20 t MCP/циклус. Изразено во чист P, 4.4 за фарма со оваа големина или вкупно 44 тона помалку P би се депонирало во околината од целото јато на несилки во P. Македонија (1 милион несилки). Изметот на несилките хранети со смеска со додадена фитаза содржеше 0,06% помалку P или 30g/птица/циклус, или изразено на ниво на фарма со 100000 несилки ова се додатни 3 тона помалку P депониран во животната средина. Додавањето фитаза во смеските за исхрана на несилките е корисна алатка за намалување на загадувањето на животната средина со P, без значајни промени во бројот и квалитетот на произведените јајца.

Клучни зборови: живина, исхрана, Фософор, фитаза, животна средина, загадување

Introduction

Phosphorus (P) is one of the essential nutrient for maintaining egg production and egg shell quality in laying hens. Inputs of P needed to support egg production, are in direct relation to manure P contents, which after its use as fertilizer contaminates land and consequently water resources with P contributing to eutrophication processes. Therefore, careful tuning of input-output nutrient ratio is needed aiming at reducing the amount of phosphorus excreted by layers. One of the approaches is directed towards lowering feed P content but increasing its utilization, without compromising production performance. Exogenous phytase enzyme supplementation in the diet is one of the management techniques that made this approach feasible.

Necessary levels of P in poultry diets come from vegetables (grains) and animal by-product feedstuffs, but the most valuable and bio-available part comes from inorganic phosphorus supplements (Mono, Di or Three Calcium-Phosphates). This inorganic part is an obligatory ingredient because grain sources (corn, barley, wheat, soya e.t.c) contain organically-bound phosphorus salts of phytic acid (phytate phosphorus) ,which is almost unavailable for the metabolism of birds, and very limited amount of P in nonphytate form (Klis et al, 1996; Kornegay 1996; Angel et al., 2002;). Since birds lack phytase and the endogenous enzyme that is necessary for digestion of phytic acid salts molecules, they are unable to utilize the phytate-bound phosphorus, which is excreted in the faeces and load the soil through poultry manure fertilization of the land.

Many research experiments were conducted based on supplementing diets with an exogenous phytase enzyme, thus helping phytate-bound P utilization, aiming at reducing fecal P content without affecting production level (Gordon and Roland, 1997; Boling et al., 2000; Lim et al., 2003; Liebert et al., 2005; Liu et al, 2007; Rubio et al 2009; Skřivan et al, 2010; Meyer and Parsons 2011; Singh et al, 2011).

Feeding layers with diets containing only 0.1% available phosphorus has negative effect on production records. Supplementation of feed with enzyme phytase has substantially improved egg production, and as an additional effect minimum level of excreta phosphorus was noticed in the research of Koelkebeck and Boling, 2009. Francesch et all, (2005) which in their experiment has overcome the adverse effects of a low P (1.3 or 1.1 g/kg NPP) diets (reduced egg production, weight gain, feed consumption) with microbial phytase supplementation, concluding that layers fed with low NPP diets supplemented with phytase performed equally as layers fed with control diets (3.2 g/kg of NPP), reducing excreta P content to 49%. Panda at all (2005) conducted nutrition experiment feeding Leghorn layers with different levels of non-phytate P (NPP) with the lower than recommended level supplemented with 500 FTU per kg diet microbial phytase. They found no significant difference in hen day egg production, food intake, food efficiency, shell weight, shell thickness, shell strength and tibia strength egg weight, specific gravity and Haugh units, finally concluding that addition of 500 FTU of microbial phytase/kg diet can allow reduction of NPP content to 1.2g/kg in the layer diet. Such approach has lead to significant reduction of nitrogen and phosphorus load of the soil through manure use as fertilizer.

The basic idea for the realized experiment was to perform industry scale experiment on a layer farm in the Republic of Macedonia and to confirm the already published data showing that phytase supplementation of laying hen diets improves production performance and decreases the amount of phosphorus excreted in the manure, leading to substantially reduced amount of phosphorus load in the soil.

Materials and methods

The study was conducted to follow the environmental impacts and production results (egg laying percentage and egg shell quality) of modifica-

tion of the layer's feeding formulation, by lowering the level (on average 0.5%) of inorganic phosphorus sources (Mono-Calcium-Phosphate, MCP) and exogenous phytase (Ronozyme P 5000) supplementation to a level of 0.01%. Two farm houses were populated with Hisex Brown pullets at 16 weeks of age, fed and managed according to the recommendation until the point of lay. One week before the start of the production, two flocks were annotated to different feeding regimes keeping all the other in-house environmental and management conditions similar. Such design enables layers to be fed with isoprotein and isocalloric diets with (+) or with out (-) added exogenous phytase enzyme, maintaining estimated total and available phosphorus phase feeding level (Phase0, >28; Phase1, 28-50 and phase2, >50 weeks of age) according to the recommended requirements (Table 1) just by decreasing or increasing inorganic partition of the Phosphorus source in the feed (Mono Calcium Phosphae-MCP).

Production data as well as egg quality parameters (especially eggshell strength) were followed and P levels were analyzed in the feed and in the faeces, to follow the balance between added and excreted level of nutrient, especially Phosphorus, and to estimate the digestibility of it as a base for optimization of the input-output level of nutrients.

Egg size (weight) and strength analyses were performed in the laboratory for testing marketing egg quality at the Institute for animal biotechnology of the Faculty of agricultural science and food, using Eggshell Gauge (Robotmation Co. Ltd., Tokyo, Japan). This equipment offers unbiased, computerized measure of the physical characteristics of eggshell (egg breaking strength).

Chemical analyses were performed using standard laboratory procedures (ISO5983-1 for N-crude protein and ISO6491, 1998 for P).

Results and discussion

The results obtained after finishing the production cycle (395 days) showed that hens performed quite similarly under the designed feeding regimes

Tab. 1. Nutrient composition of different diets (phase feeding) used in the experiment

	Diet F0 -	Diet F0 +	Diet F1 -	Diet F1 +	Diet F2 -	Diet F2 +
Ingredient	**%**	**%**	**%**	**%**	**%**	**%**
Corn	42.76	43.65	44.49	45.70	44.58	45.49
Barley	5.00	5.00	9.20	9.20	10.00	10.00
Soya been meal	30.42	30.25	24.43	23.97	23.75	23.58
Rape seed meal	4.00	4.00	4.80	4.80	5.00	5.00
Vegetable oil	5.81	5.51	5.20	4.84	4.28	3.97
Limestone	9.56	9.56	9.56	9.63	10.20	10.25
Salt	0.26	0.26	0.27	0.27	0.22	0.22
Sodium bicarbonate	0.21	0.21	0.17	0.17	0.29	0.29
MCP	1.50	1.03	1.20	0.73	1.04	0.56
DL-Methionine 98%	0.10	0.10	0.13	0.13	0.10	0.10
Enzyme – Ronensime phytase 5000 (+ or -)	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.01**
Betaine – Methionine	0.05	0.05	0.02	0.02	0.03	0.02
Cholin – Chloride	0.08	0.08	0.03	0.03	0.01	0.01
Vit.-Min. premix	0.50	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00	100.00
ME KCal / kg	2740.00	2740.00	2750.00	2740.00	2700.00	2690.00
Dry matter	89.00	89.00	88.80	88.80	88.70	88.70
Humidity	11.00	11.00	11.20	11.20	11.30	11.30
Crude ash	13.87	13.44	13.51	13.07	14.00	13.58
Crude fat	7.48	7.20	6.94	6.60	6.04	5.76
Crude proteins	17.95	17.96	16.27	16.17	16.14	16.15
Crude fiber	4.20	4.22	4.18	4.19	4.21	4.23
Lysine	0.96	0.96	0.85	0.85	0.83	0.83
Methinine	0.44	0.44	0.39	0.39	0.39	0.39
Met + Cystine	0.75	0.75	0.68	0.68	0.68	0.68
Ca	3.80	3.80	3.80	3.80	4.00	4.00
P (total)	**0.67**	**0.57**	**0.60**	**0.50**	**0.57**	**0.47**
P available	0.39	0.30	0.33	0.25	0.30	0.21
P Phytase liberated	0.00	0.09	0.00	0.08	0.00	0.09
P avail + P Phyt liber	0.39	0.39	0.33	0.33	0.30	0.30
P organic	0.03	0.02	0.03	0.02	0.02	0.02

Diet F0 +, F1 + and F2 + = diets supplemented with Phytase
Diet F0 -, F1 - and F2 - = diets without Phytase

that is in-line with the previously published results (Ciftci et al, 2005; Liebert et al, 2005). Daily laying percentage (81.02% vs 80.83%), as well as number of egg produced per hen housed (297.96 vs 297.99), for F– and F+ groups were close to the technological level and without noticeable difference between groups (Table 2).

Analyses of shell strength (parameter that directly reflects any unbalance between Ca and P level in the feed) performed during the production cycle revealed no significant differences between feeding regimes groups. Egg shell strength of the samples of eggs that were collected from all three feeding phases were on average 3731.4 and 3832.08 for the first phase of production (>28 weeks of age), 3898.26 and 4018.00 for the second phase (age 28-50 weeks), 4041.60 and 3946.80 for the third phase (>50 weeks of age) for both groups (without added phytase – F- and with added phytase – F+), respectively (Table 3).

Chemical analyses of the diets according to formulated feeding formulas with or without added enzyme phytase and manure of the hens feed with these ratios are presented in Table 4. Feeding formulas with added phytase contained on average 0.5% lower level of MCP or 200g/bird, which for the farm having 100000 layers is 20t MCP/cycle (Table 1). Expressed in terms of pure P, for this farm level 4t, or in total 44 tons less P will be delivered to the environment from Macedonian egg production flock (1milion layers).

Manure of the hens fed diet supplemented with phytase has 0.06% less P or 30g/bird/cycle or, expressed in terms of farm with 100000 layers, it is additionally 3 tons less P runoffs in the environment (Table 5). Our data show much lower effect of phytase in the reduction of the P content of the manure compared to published results of Francesch et all, (2005), but the overall effect is still positive.

Tab. 2. Production parameters of two flocks

	Control farmhouse F -	**Phytase supplemented feed farmhouse F +**
Feed consumption/hen housed	41.99	41.66
Number of egg produced/hen housed	297.96	297.99
Average production %	81.02	80.83

Tab. 3. Shell strength g/cm^2 (at different production phase and average)

	Diet F0 -	**Diet F0 +**	**Diet F1 -**	**Diet F1 +**	**Diet F2 -**	**Diet F2 +**	**Average F -**	**Average F +**
Average	3731.40	3832.08	3898.26	4018.00	4041.60	3946.80	**3890.42**	**3932.29**
Maximum	5352.00	5305.00	5269.00	5632.00	4820.00	5517.00	**5352.00**	**5632.00**
Minimum	1748.00	1672.00	1791.00	1880.00	2750.00	2558.00	**1748.00**	**1672.00**
STD	1075.87	896.81	769.02	983.55	692.78	832.66	**897.19**	**913.13**

Tab. 4. Average values of chemical analyses of the different diets and manure of the layers

DIETS						
	Diet	**Diet**	**Diet**	**Diet**	**Diet**	**Diet**
	F0 -	**F0 +**	**F1 -**	**F1 +**	**F2 -**	**F2 +**
Dry matter	90.13	89.47	90.26	89.89	89.58	90.22
Humidity	9.87	10.53	9.74	10.11	10.42	9.78
P (total)	0.62	0.98	0.66	0.75	0.50	0.76
N	2.65	3.35	2.73	3.16	2.71	2.69
MANURE						
Dry matter	77.38	81.01	70.52	77.88	72.03	75.09
Humidity	22.62	18.99	29.48	22.12	27.97	24.91
P (total)	0.41	0.49	0.63	0.41	0.50	0.46
N	0.69	0.52	0.94	0.49	0.82	0.62

Tab. 5. Average values of the effect of phytase in reducing the output of P in the manure

Average content of P in the manure of layers fed with diet without phytase	**0.51%**
Average content of P in the manure of layers fed with diet supplemented with phytase	**0.45%**
DIFFERENCE – EFFECT OF PHYTASE	**0.06%**

Good shell strength could be attributed to the effect of the supplemented enzymes that affect digestibility of P, but also to increasing the availability of P in the intestines. The more P is available, the (due to breakage of phytin salt molecules) more resorption is improved and final result is better shell strength even in the elderly hens (at the end of laying cycle) when shell strength usually drops as a result of lower capacity for P resorption.

Based on the results obtained, it could be concluded that phytase supplementation of the layer's feed is useful tool in lowering the environmental pollution with P without significant changes in the number and quality of egg produced.

Conclusion

Formulated diets where, due to exogenic phytase enzyme supplementation, lower inorganic P levels were needed, contained on average 0.5% lower level of MCP or 200g/bird/cycle. Calculated for the farm having 100 000 layers, this is reduction of 20t MCP/cycle. If this value of inorganic P source is expressed in terms of pure P, around 4t less P will be loaded to the environment. If this is applied to all layer farms in Macedonia, 44 tons less P will be delivered to the environment from Macedonian egg production flock (1milion layers) in total. Manure of the hens fed diet supplemented with phytase has 0.06% less P or 30g/bird/cycle or expressed in terms of farm with 100000 layers it is additionally 3 tons less P runoffs in the environment. Adding enzyme Phytase in the layer's feed could be one of the tools for lowering the environmental pollution with P without significant changes in the number and quality of egg produced.

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RESTRICTIVE FEEDING AS A MANAGEMENT TOOL FOR REDUCED MANURE PRODUCTION AND ENVIRONMENTAL POLLUTION FROM A LAYER FARM

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Апстракт

Коцевски, Д., Ѓорѓиевски, С., Џабирски, В., Буневски, Г., Вуковиќ, В. & Порчу, К. (2013). Рестриктивно хранење како управувачки алат за намалување на продукцијата на отпадоци и загадување на околината од фарми. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 28, Скопје.

Ad libitum исхраната е најчесто користениот метод на исхрана во технологијата на одгледување на несилки со цел да се обезбеди целосна експресија на генетскиот потенцијал на високопродуктивните генотипови несилки. Количината на произведен измет кој се исфрла во животната средина обично е во директна врска со консумираната храна. Дизајниран е опит со цел да се истражи ефектот на рестриктивната техника на исхрана врз производните параметри и животната средина. Несилки од ISA Brown провиниенција, на иста возраст се сместени во два објекта во слични услови на одгледување. Рестриктивна исхрана (контролирана количина на дневно консумирана храна) на несилките во едниот од објектите е спроведен по навршување на 40 недели возраст, додека во другиот објект вообичаената *ad libitum* технологија на исхрана е задржана се до крајот на експлоатационият период (80 неделна возраст). Нутритивниот состав на смеските е дефиниран во согласност со препорачаните потреби и возраста на несилките. Производните резултати (број и големина на јајца), морталитет, консумација на храна, конверзија на храна и параметрите за квалитетот на јајцата се следени кај обете групи. Не се забележани разлики во производните параметри (81.59 vs 80.55% интензитет на несивост; 2.355 vs 2.299 kg храна/kg јајчена маса; 143.87g vs 140.44g храна/произведено јајце and 61.08g vs 61.08g маса на јајца) кај контролната (*ad libitum*) група и групата на која е применета рестриктивна исхрана, соответно. Како резултат на намалениот внес на храна (1kg храна/кокошка) намалено количество на измет (1kg) е произведен што придонесува помало количество на P (1kg x 0.016 x 0.44 = 0.007kg или 7g/несилка/циклус) да биде исфрлен во животната средина. Изразено во термини на Македонското јато несилки (1милион несилки)околу 7 тона помалку P ќе се исфрли во животната средина. Применетата техника на рестриктивна исхрана резултираше со намалена консумација на храна, намалени производни трошоци, намалено загадување на животната средина без да влијае на производните параметри.

Клучни зборови: живина, исхрана, рестриктивна исхрана, животна средина, загадување

Abstract

Kocevski, D., Georgievski, S., Dzabirski, V., Bunevski, G., Vukovic, V. & Porcu, K. (2013). Restrictive feeding as a management tool for reduced manure production and environmental pollution from a layer farm. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

Ad libitum feeding is the most usual feeding management practice in egg production technology aiming at expressing the full genetic potential of high egg producing layer genotypes. Quantity of manure produced and disposed in the environment is usually in direct relation to the feed consumed. Trial was designed to explore the effect of restrictive feeding technique and the effect of such treatment on the environment and production parameters. ISA Brown layers of same age were placed in two farm houses under similar environmental conditions. Re-

strictive (controlled quantity of daily feed consumed) feeding of the layers was applied in one of the farm house, starting from 40 weeks of age onward, while in the other farm house usual *ad libitum* feeding technique was maintained through the exploitation period (80 weeks of age). Nutrient composition of the feed was defined according the recommended requirements and age of the layers. Production data (number and size of the eggs), mortality, feed consumption, feed conversion and egg quality parameters were followed in both groups. No differences in the production parameters (81.59 vs 80.55% laying percentage; 2.355 vs 2.299 kg feed/kg egg mass; 143.87g vs 140.44g feed/egg produced and 61.08g vs 61.08g egg size) were revealed in the control (*ad libitum*) and restrictive feeding group, respectively. As a result of the lower feed intake (1kg of feed/hen) lower quantity of manure (1kg) was produced leading to lower quantity of P (1kg x 0.016 x 0.44 =0.007kg or 7g/hen/cycle) disposed to the environment. Expressed in terms of Macedonian egg production flock (1milion layers) roughly 7 tons less P runoffs in the environment. Applied restrictive feeding technique resulted in lower feed consumption, lower production costs, less environmental pollution without affecting the productivity parameters.

Key words: poultry, nutrition, restrictive feeding, environment, pollution

Introduction

The most usually used feeding technique in layers is *ad libitum* feeding that leads to overconsumption, buildup of excessive body fat, less efficient production and at the end excessive manure production and unnecessary environmental pollution. Many attempts have been made to introduce techniques of restricted or limited feeding, technique that is common in broiler breeding flocks.

Swanson and Johnston (1975), based on the previous studies, come to conclusions that layer stock (in their case Leghorns) expresses a tendency to over consume on full-feeding programs. They suggested restriction at early age before peak of production of 12 to13% in feed quantity if possible, without negative effects on egg production records and with substantial economic savings, but their technology of restriction was based on limited time for consuming of feed (several periods of one hour when the birds have access to feed and the rest of the time feeders are closed for the hens) and not direct control of the quantity consumed. Later Swanson and Kuney (1979), reported similar conclusions but in favor of later stage (after 40 weeks of age) restriction applied gradually to reduce the stress of restriction.

Kuney and Enos (1980), also performed a comparison trial with layers fed under restriction (time-limited feeding), relative to *ad libitum*-fed. Restrictions were on the levels of 11% and 8% during the first lay cycle and 12% and 10% during the second cycle. They reported that restrictive feeding programs significantly improved feed efficiency causing non-significant depressions in rate of lay and an increased shell thickness.

The effects of the four quantitatively restriction (feeding 105 g/bird/day) feeding programs initiated at different stages of production on performance and economic returns of White Leghorn layers were analyzed by Cunningham and Polte (1984). They concluded that early feed restriction resulted in reduced egg production and size while restriction started at age of 38 and 45 weeks lead to egg production comparable to the *ad libitum* fed hens and lower feed costs. Cunningham (1984), performed experiment designated to compare production records of White Leghorn layers under different restriction feeding schemes (*ad libitum* feeding from 20 to 64 weeks of age, feeding 105 g/bird/day starting at 36 weeks to 64 weeks, feeding 105 g/bird/day from 36 to 53 weeks of age followed 95 g/bird/day to 64 weeks and feeding approximately 95 g/bird/day continuously from 36 weeks).

Reasonable restriction feeding program offering 105g/bird/day starting at week 36 resulted in comparable results to full feeding program and all the others negatively influence egg number and size.

Materials and methods

The trial was designed aiming at reducing the environmental impacts of the egg producing operation through management technique of controlled daily feed allowances for the layers after the age of 40 weeks when their genetic background for high egg production and high egg size lead to a tendency of producing oversized eggs under *ad libitum* feeding technique.

ISA BROWN pullets, (16818 pullets in control farm house and 17587 in the trial farm house) were housed under similar environmental and management conditions. Phase feeding techniques using formulas based on the recommended nutrient levels (table 1) was practiced. Phase0 formulated feed was used for feeding the birds until the age of 28 weeks followed by Phase1 feed formula up until week 40, when the trial group was subjected to restrictive feeding technique. This design actually means that two flocks were kept under same condition (*ad libitum* feeding technique) till age of 40 weeks when the trial farm house flock was subjected to gradual feed restrictions. Feed restriction was applied as a control of the daily allowance of feed (Diet F1-up to 50 weeks of age and F2 – >50weeks) calculating the final desired feed consumed, but aiming to keep the production results on a reasonable level (as the con-

trol birds feed *ad libitum)*.

Production data were followed to revealed that the control feeding technique leads to lower feed consumption, lower manure production, but without influencing the egg production (in terms of numbers and size) therefore is comparable with *ad libitum* feeding technique.

Tab. 1. Nutrient composition of different diets (phase feeding) used in the experiment

	Diet F0	Diet F1	Diet F2
Ingredient	**%**	**%**	**%**
Corn	43.00	44.55	44.07
Barley	5.00	9.00	11.00
Soya been meal	34.15	29.61	28.65
Vegetable oil	5.70	5.00	4.00
Limestone	9.50	9.53	10.00
Salt	0.25	0.28	0.24
Sodium bicarbonate	0.22	0.17	0.29
MCP	1.46	1.21	1.11
DL-Methionine 98%	0.10	0.10	0.10
Betaine – Methionine	0.04	0.02	0.03
Cholin – Chloride	0.08	0.03	0.01
Vit.-Min. premix	0.50	0.50	0.50
Total	100.00	100.00	100.00
ME KCal / kg	2750.00	2750.00	2720.00
Dry matter	88.90	88.90	88.80
Humidity	11.10	11.10	11.20
Crude ash	13.55	13.50	13.89
Crude fat	7.48	7.01	6.01
Crude proteins	17.99	16.45	16.01
Crude fiber	4.10	4.10	4.20
Lysine	0.95	0.85	0.83
Methionine	0.45	0.40	0.39
Met + Cystine	0.75	0.67	0.67
Ca	3.77	3.81	3.98
P (total)	0.68	0.61	0.60
P available	0.40	0.35	0.33

Results and discussion

Layers from both groups performed quite well and close to the technological levels presented in the ISA Brown manuals. Production records from the both flocks (table 2) were inline to support the theory of control feeding techniques. Namely, average daily feed consumption was lower in trial flock (113.12 vs 117.39 in control group), leading to better feed conversion (2.299 vs 2.355) and lower feed spent per egg produced (3.4g less feed in favour of trial group).

Egg size, as the most important parameter, was followed in both groups and no actual differences were found between both groups (61.08g vs 61.08g).

All data suggested that no significant differences in the production parameters (81.59 vs 80.55% laying percentage) were revealed in the control (*ad libitum*) and restrictive feeding group, respectively, so such feeding technique is approved to be used after 40 weeks of age in layers.

As could be seen from the table 3 the hens from the trial flock consumed 41.85kg and the control ones 42,87kg of feed (based on the hen housed number) and as a result of the lower feed intake (1kg of feed/hen housed) lower quantity of manure (1kg) was produced leading to lower quantity of P (1kg x 0.016 x 0.44 =0.007kg or 7g/hen/cycle) disposed to the environment.

If these values, of pollution reduction, are applied on the number of layers in R. Macedonia (1milion layers), roughly 7 tons less P runoffs in the environment.

These data suggest that restrictive feeding technique as a management tool resulted in lower feed consumption, lower production costs, less environ-

Tab. 2. Production parameters of two flocks

	Control flock	Trial flock
Average daily feed consumption (g)	117.39	113.12
Number of eggs / hen housed	301.66	300.89
Kg eggmass / hen housed	18.20	18.20
Feed conversion - kg feed / kg egg mass	2.355	2.299
Average egg weight (g)	61.08	61.08
Average laying intensity %	81.59	80.55
Feed spent (g) / egg	143.87	140.44

Table 3. Quantity of feed consumption during the trial

	Control flock	Trial flock
Avrage number of layers in the trial period	15016	15986
Total Quantity of feed consumed	720950kg	735990 kg
Quantity of feed spent / average number of layers	48kg	46.01 kg
Quantity of feed spent / housed number of layers	42.87	41.85

mental pollution without affecting the productivity parameters and that it is appropriate to be applied if egg producers will have to reduce environmental pollution without any detrimental effects to the production data, thus to the profitability of the industry.

Table 4. Average values for chemical composition of the feces and manure of layers

Characteristics	Feces (fresh)	Manure
Average body weight kg	1.850	1.850
Period of exploitation (days)	365	365
Specific weight kg/m^3	993.000	993.000
Humidity %	85.000	65.000
Total Nitrogen Content %	1.350	1.400
NH3-N Amonia Nitrogen %	0.330	0.700
P_2O_5 %	1.050	1.600
Pure Phosphorus (P)	**0.462**	**0.704**
K_2O %	0.600	1.000
Ca %	2.050	2.050
Mg %	0.210	0.270
S %	0.210	0.350
Na %	0.180	0.140
Cl %	1.000	0.200
Mn %	0.008	0.014
B %	0.002	0.001
Zn %	0.007	0.015
Cu %	0.001	0.002

Conclusion

Applied restrictive feeding technique, or more precisely stated, control level of feeding with designated quantity of feed after 40 weeks of age could be successful management tool for reducing the environmental pollution, without affecting the production parameters and at the same time cutting down the production costs, therefore leading to better profitability of the layer operations.

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СОДРЖИНА НА ТЕШКИ МЕТАЛИ ВО ПОЧВИ ОД НЕГОТИНСКО

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Извод

Андреевски, М., Мукаетов, Д., Попоска, Х. (2013). Содржина на тешки метали во почви од неготинско. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 28, Скопје.

Цел на истражувањата е да се испита содржината на вкупните и достапни форми тешки метали (Cu, Fe, Mn и Zn) во регосол и рендзина образувани врз лапорец. Во атарот на с. Тимјаник (Неготинско) на локалитетот Цуцка, на површина од 11 ha е ископан еден почвен профил на регосол (профил 1) и еден профил на рендзина (профил 2). Растворањето на почвените проби е извршено со концентрирана HCl и HNO_3 во однос 3:1, а определувањето на тешките метали е извршено со атомски емисионен спектрометар со индуктивно спрегната плазма Varian 715ES. Достапните форми на тешки метали се екстрахирани по DTPA методот а определувањето е извршено со електротермички атомски апсорбционен спектрометар Varian SpectrAA 614Z. Во испитуваните почви, содржината на вкупен бакар е нешто повисока од референтните вредности, (освен хор.C на профил 2 каде е пониска од референтните вредности) но многу пониска од интервентните вредности. Содржината на вкупен цинк е пониска од референтните вредности. Со достапен бакар почвените проби се средно до многу високо обезбедени, со достапно железо многу ниско до средно обезбедени, со достапен манган многу ниско до високо обезбедени и со достапен цинк многу ниско до ниско обезбедени. Од добиените податоци може да се констатира дека нема опасност од контаминација на почвата со овие тешки метали.

Клучни зборови: регосол, рендзина, бакар, железо, манган, цинк

Abstract

Andreevski, M., Mukaetov, D., Poposka, H. (2013). Content of heavy metals in soil types from the area of Negotino. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

The scope of the investigations was to determine the quantity of total and available forms of heavy metals (Cu, Fe, Mn and Zn) in regosol and rendzina soils formed on marl. In the area of village Timjanik (Negotino) at the locality Cucka, on area of 11 ha, two soil profiles has been excavated, one profile of regosol (profile 1) and another soil profile of rendzina soils (profile 2). The digestion of the soil samples was performed in concentrated. HCl and HNO_3 in a ratio 3:1; the quantity of heavy metals was determined by use of atomic emission spectrometer with inductive coupled plasma (AES-ICP) Varian 715ES. The available forms of heavy metals are extracted with the DTPA method, while the determination has been performed on electrothermal AAS Varian SpectrAA 614Z. It has been detected that in the investigated soils the total quantities of copper are slightly higher than the referent values, (except in hor. C of profile 2 where the quantities are lower than the referent values) but much less than the intervene values. Total quantity of zinc is lower than the referent values. The quantities of available copper are in the ranges of medium to very high, of iron are between very low to medium, the quantities of easy available manganese vary in a broad ranges of very low to high, while the quantities of available zinc are very low to low. Out of the data gained during our examinations it can be concluded that there is no possible threat of contamination of the investigated soils with heavy metals.

Key words: regosol, rendzina, copper, iron, manganese, zinc

Вовед

Во овој труд се изнесени податоци за механичкиот состав, некои хемиски својства и содржината на вкупните и достапни форми на бакар, железо, манган и цинк во регосол и рендзина од Неготинско. Податоци за содржината на вкупни форми на бакар, железо, манган и цинк во почви од Тиквешкиот регион се сретнуваат во трудовите на Savić et al. (1968); Савиќ и др. (1970); Јекиќ и др. (1970, 1972); Митрикески и др. (2000); Андреевски и др. (2008, 2009). Најдетални истражувања за содржината на вкупни форми на бакар, железо, манган и цинк во почви од Тиквешкиот регион се извршени од страна на Stafilov et al. (2008, 2010). Овие истражувачи извршиле испитувања на 31 хемиски елементи, на површина од 360 km^2, при што се земени почвени проби од 172 локации на длабочина од 0-5 cm и од 20-30cm. Од погоре изнесеното може да се констатира дека по однос на содржината на вкупни форми на тешки метали, Тиквешкиот регион е еден од најпроучените во Република Македонија.

Помалубројни се податоците за достапни форми на железо, манган, бакар и цинк во почви од Тиквешијата. Податоци за содржината на достапни форми на манган, бакар и цинк во почви од Тиквешијата се сретнуваат во трудовите на Savić et al. (1968), Савиќ и др. (1970) и Јекиќ и др. (1970, 1972). Андреевски и др. (2008) соопштуваат податоци за содржината на достапно железо во ригосоли образувани со риголување на алувијални почви од околина на металуршкискиот комбинат ФЕНИ.

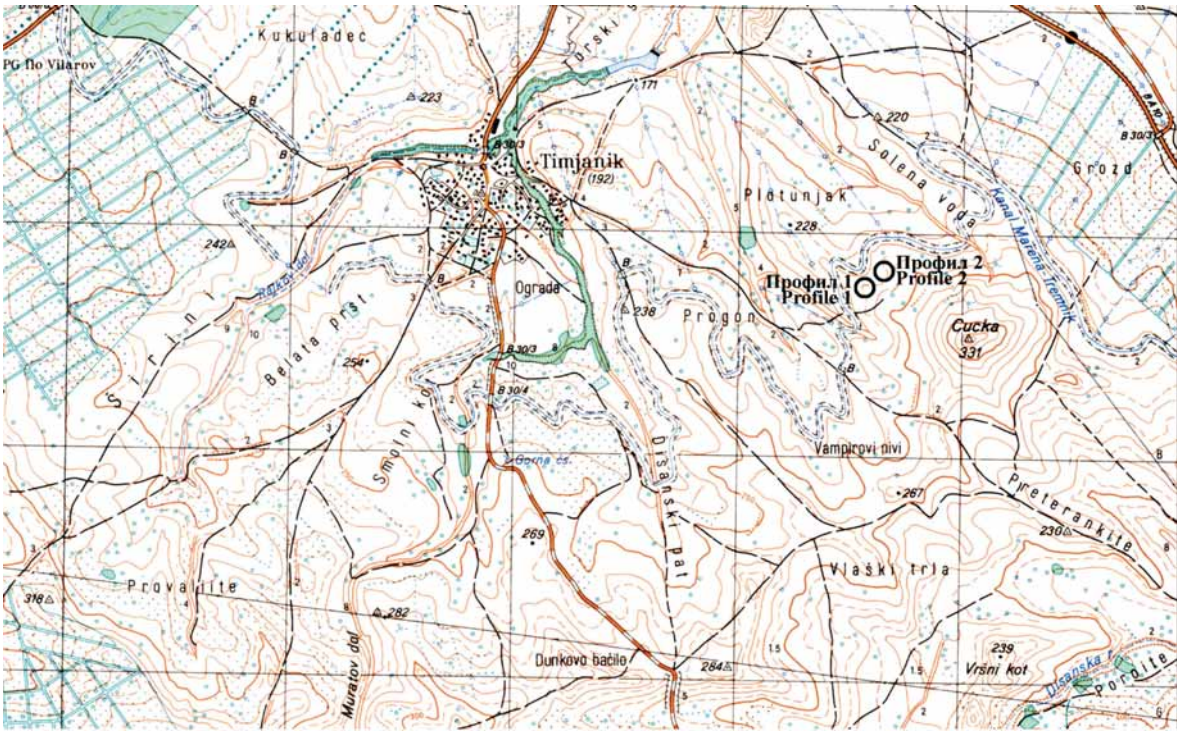
Според новопредложената класификација на почвите на Република Македонија (Филиповски 2006) профил 1 спаѓа во големата група почви ентисоли, почвен тип регосол, поттип карбонатен, вариетет врз лапорци или лапорести глини или лапорести варовници, форма глинеста. Профил 2 е класиран на следниот начин: голема група почви молисоли, почвен тип рендзина, поттип карбонатна, вариетет врз лапорци, лапорести и меки нечисти варовници, форма глинеста.

Цел на овој труд е да се испита содржината на вкупните и достапни форми на бакар, железо, манган и цинк во регосол и рендзина образувани врз лапорец, со што ќе се даде придонес за добивање подобра претстава за содржината на овие тешки метали во почвите на Република Македонија. Една од целите на овој труд е да се испита и влијанието на педогенетските процеси и апсолутната и релативната старост на почвите врз дистрибуцијата на тешките метали по длабочина на профилот.

Материјал и методи

Теренските истражувања се извршени според предложените методи од Filipovski ed. (1967) и Митрикески и др. (2001).

Механичкиот состав на почвата е определен со пипет методата (Resulović ed. 1971). Содржината на карбонати во почвата е определена



Сл. 1. Локација на профилите
Fig. 1. Location of the profiles

волуметриски со помош на шајблеров калциметар (Митрикески и др. 2001). pH на почвениот раствор е определена електрометриски со стаклена електрода во водена суспензија и во суспензија на 1 M KCl (Митрикески и др. 2001). Леснодостапните форми на P_2O_5 и K_2O се определени по AL методата (Džamić et al. 1996). Содржината на хумус е определена врз база на вкупниот јаглерод по методата на Тјурин, модифицирана од Симаков (Орлов и др. 1981). Растворањето на почвените проби е извршена со „царска вода“, (концентрирана HCl и HNO_3 во однос 3:1) според Džamić et al. (1996), а определувањето е извршено со атомски емисионен спектрометар со индуктивно спрегната плазма Varian 715ES, Достапните форми на тешки метали се екстрахирани по DTPA-методот (Page ed. 1982) а определувањето е извршено со електротермички атомски апсорбционен спектрометар Varian SpectrAA 614Z.

Истражувано подрачје

Во атарот на с. Тимјаник (Неготинско) на локалитетот Цуцка (Слика 1) на површина од 11 ha е ископан еден почвен профил на регосол (профил 1) и еден профил на рендзина (профил 2). Регосолот и рендзината се образувани од иста матична стена - лапорец. Испитуваните почви се копани во прелог, а во поблиското минато се одгледувале поледелски култури. Испитаните почви се распространети на надморска височина од околу 210 до 220 m. Релјефот на испитуваните почви е брановидно-брдски со инклинација од 3-5%.

Резултати и дискусија

1. Механички состав и хемиски својства

Податоците за механичкиот состав и некои хемиски својства на испитуваните почви се презентирани на Табели 1 и 2.

2. Содржина на вкупни форми на Cu, Fe, Mn и Zn

Во Табела 3 е прикажана содржината на вкупните форми на Cu, Fe, Mn и Zn во испитува-

Таб. 1. Механички состав на некои почвени типови од Неготинско (во % од ситноземот)
Tab. 1. Mechanical composition of some soils from the area of Negotino (in % of fine earth)

Број на Профил (Profile No)	Хоризонт и длабочина (Horizon and depth) [cm]	Крупен песок (Coarse sand) [0.2 - 2mm]	Ситен песок (Fine sand) [0.02 - 0.2mm]	Крупен + ситен песок (Coarse + fine sand) [0.02 - 2mm]	Прав (Silt) [0.002 - 0.02mm]	Глина (Clay) [<0.002mm]	Прав + глина (Silt + clay) [<0.02mm]
1	(A)p 0-30	0.22	3.88	4.10	40.60	55.30	95.90
1	C 30-60	0.35	4.95	5.30	34.20	60.50	94.70
1	C 60-74	0.04	3.06	3.10	33.30	63.60	96.90
	C/R						
2	Ap 0-35	1.25	11.65	12.90	42.50	44.60	87.10
2	C 35-62	3.93	89.47	93.40	5.00	1.60	6.60
	C/R						

Таб. 2. Хемиски својства на некои почви од Неготинско.
Tab. 2. Chemical properties of some soil types from Negotino area.

Број на Профил (Profile No)	Хоризонт и длабочина (Horizon and depth) . [cm]	$CaCO_3$ [%]	Хумус (Humus) [%]	pH		Леснодостапни (Easy available) mg/100g soil	
				H_2O	nKCl	P_2O_5	K_2O
1	(A)p 0-30	36.65	1.46	7.95	7.10	12.04	28.09
1	C 30-60	39.10	1.10	8.30	7.40	9.41	18.06
1	C 60-74	39.91	1.05	8.40	7.50	10.72	17.26
	C/R						
2	Ap 0-35	19.54	4.24	7.90	7.10	3.39	23.28
2	C 35-62	39.10	0.98	8.00	7.00	6.40	10.03
	C/R						

Таб. 3. Содржина на вкупни форми тешки метали во некои почви од Неготинско
Tab. 3. Content of total forms heavy metals in some soils from Negotino area

Број на профил Profile No.	Хоизонт и длаб. во cm Horizon and depth in cm	Вкупна содржина во mg/kg Total content in mg/kg			
		Cu	Fe	Mn	Zn
1	(A)p 0-30	38.0	24564	576	49.4
1	C 30-60	38.7	25140	565	52.4
1	C 60-74	45.4	24529	504	52.7
	C/R				
2	Ap 0-35	62.8	46036	634	67.8
2	C 35-62	18.0	11655	344	21.4
	C/R				
Референтни вредности Referent value		36			140
Интервентни вредности Intervent value		190			720

ните почви. За споредба на добиените резултати ќе ги користиме референтните холандски стандарди (Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer 2010). Од табела 3 може да се види дека содржината на вкупен бакар во испитуваните почвени проби е повисока од референтните вредности (освен. Хор.С на проф. 2), но многу пониска од интервентните вредности, што значи дека не постои опасност од контаминација на почвата и растенијата со овој метал. Во смолници од Тиквеш, Savić et al. (1968) констатирале содржина на вкупен бакар од 20,8 до 44,2 mg kg^{-1} почва, а Андреевски и др. (2009) од 17,78-58,84 mg kg^{-1}. Содржина на вкупен бакар од 26,4 до 30,4 mg kg^{-1} почва во циметните шумски почви од неготинско констатирале Јекиќ и др. (1972), во регосол од Пепелиште (неготинско) од 35,2 до 38,4 mg kg^{-1} почва (Јекиќ и др. 1970) и во алувијална почва од Росоман (кавадаречко) од 4,8 до 7,2 mg kg^{-1} почва (Савиќ и др.1970). Содржината на вкупен бакар од Тиквешкиот регион од 172 површински почвени проби (0-5 cm) и исто толку подповршински почвени проби (20-30 cm) се движи од 8,1 до 230 mg kg^{-1} (Stafilov et al. 2010).

Содржината на вкупно железо во почвата се движи во многу широки граници зависно од типот на почвата од 0,01% до 22% (Kastori 1990). Во испитуваните почви содржината на вкупно железо се движи од 1,16 до 4,60 % што е во рамките на литературните податоци. Во ригосолите од околина на с. Возарци (Кавадаречко), Андреевски и др. (2008) констатирале содржина на вкупно железо од 2,88 до 3,51%. Содржината на вкупно железо од Тиквешкиот регион од 172 површински почвени проби (0-5 cm) и исто толку подповршински почвени проби (20-30 cm) се движи од 1,1 до 4,2% (Stafilov et al. 2010).

Содржината на вкупен манган во испитуваните почви се движи од 344 до 633 mg kg^{-1}. Според Pendias-Kabata (2000) светскиот просек за почвите изнесува 437 mg kg^{-1}. И покрај тоа што манганот може да биде концентриран во различни хоризонти, обично овој елемент се акумулира во површинските хоризонти како резултат на фиксацијата од органската материја (Pendias-Kabata 2000). И од нашите резултати може да се види дека содржината на вкупен манган е највисока во хор.Ар на проф. 2 (највисока содржина на хумус). Максимално дозволени концентрации за Mn во земјоделските почви се сметаат 1500 mg kg^{-1} (Pendias-Kabata 2000). Испитуваните почви содржат значително помалку вкупен манган и нема опасност од токсичност. Во смолниците од Тиквеш констатирана е содржина на вкупен манган од 448 до 920 mg kg^{-1} (Savić et al. 1968); во алувијалните почви покрај Црна Река од околина на Росоман од 280 до 320 mg kg^{-1} (Савиќ и др. 1970); во регосол врз лапорец од Пепелиште од 682 до 728 mg kg^{-1} (Јекиќ и др. 1970) и во циметна шумска почва од Неготинско од 580 до 628 mg kg^{-1} почва (Јекиќ и др. 1972). Содржина на вкупен манган (344 почвени проби) од 220 до 3100 mg kg^{-1} почва е констатирана од Stafilov et al. (2010).

Содржината на вкупен цинк варира во граници од 21,37 до 67,77 mg kg^{-1} почва и е значително пониска од референтните вредности. Ова значи дека не постои опасност од контаминација на почвата и растенијата со цинк. Според Lindsay 1982 во: Kastori (1997) вкупната содржина на цинк во почвата се движи помеѓу 10 и 300 mg kg^{-1} , просечно 50 mg kg^{-1} . Смолниците од Тиквеш содржат од 22 до 40 mg kg^{-1} почва вкупен цинк (Savić et al 1968), од 43,27 до 92,02 mg kg^{-1} (Андреевски и др. 2009), алувијалните почви на Црна Река од 24,8 до 32,0 mg kg^{-1} (Савиќ и др.1970), регосол врз лапорец од 60 до 76,0 mg kg^{-1} (Јекиќ и др. 1970), циметна шумска почва од неготинско од 24,8 до 48,8 mg kg^{-1} (Јекиќ и др. 1972) и черноземи од Тиквеш од 102,06 до 163,02 mg kg^{-1} (Митрикески и др. 2000). Stafilov et al. (2010) констатирале содржина на вкупен цинк од 22 до 170 mg kg^{-1} почва.

Содржината на вкупен бакар и цинк во проф. 1 (регосол) е пониска во површинскиот хоризонт (A)p во споредба со матичниот супстрат, што значи дека нема антропогена контаминација.

Од Таб. 3 може да се види дека содржината на вкупен бакар и цинк во хоризонтот Ap на профил 2 е повисока од хоризонтот (A)p на профил 1 што се должи на повисоката содржина на хумус и биолошката акумулација на овие тешки метали. Рендзината (профил 2) е апсолутно и релативно постара почва од регосолот (профил 1) која настанала со негова еволуција, па заради ова дошло до биолошка акумулација во хумусно-акумулативниот хоризонт. Ова значи дека со педогенетски процеси дошло до прераспределба на тешките метали во рендзината. Од сето погоре кажано може да се констатира дека при оценатa за евентуална антропогена контаминација со тешки метали пореално е ваква проценка да се прави на апсолутно и релативно помлади почви.

3. Содржина на достапни форми на Cu, Fe, Mn и Zn

Во табела 4 е прикажана содржината на достапни форми тешки метали Cu, Fe, Mn и Zn во испитуваните почви. Овие тешки метали се неопходни микроелементи во исхраната на растенијата и нивниот недостаток може да предизвика пореметувања во растот и развитококот, а при поголем недостаток и изумирање на растенијата. Спротивно на ова, доколку овие микроелементи се присутни во високи концентрации може да дојде до фитотоксичност.

Од податоците од табелата може да се констатира дека испитуваните почви се средно до многу високо обезбедени со достапен бакар. Според Savić et al. (1968) смолниците од неколку региони во Република Македонија, меѓу кои и тиквешкиот се богато обезбедени со достапен бакар, алувијалните почви од околина на Росоман (кавадаречко) средно обезбедени (Савиќ и др. 1970), регосол врз лапорец од Пепелиште (неготинско) ниско обезбеден (Јекиќ и др. 1970) и циметна шумска почва од неготинско богато обезбедена (Јекиќ и др. 1972).

Со достапно железо испитуваните почви се многу ниско до средно обезбедени. Содржината на $CaCO_3$ во испитуваните почви е висока, па заради ова содржината на достапно железо е незадоволителна, со ризик од појава на железна хлороза кај некои земјоделски култури. Андреевски и др. (2008) соопштуваат податоци за достапно железо во ригосолите од околина на металургискиот комбинат ФЕНИ кои се движат од 7,98 до 15,12 mg kg^{-1} почва.

Испитуваните почвени проби се многу ниско до долна граница на високо обезбедени со достапен манган. Содржината на достапен манган се намалува по длабочина на профилот. Според Kastori (1990) содржината на достапен манган опаѓа по длабочината. Во алкални почви и добро аерирани како испитуваните претежно се образуваат тешко растворливи манганови соединенија. Набивањето на почвата, дождовите, наводнувањето, употребата на органски ѓубрива, погодуваат на одвивање на редукциони процеси и со тоа ја зголемуваат достапноста на манганот (Kastori 1990). Смолниците од неколку региони во Република Македонија, меѓу кои и тиквешкиот се добро до богато обезбедени со достапен манган (Savić et al. 1968), алувијалните почви од околина на Росоман (кавадаречко) средно до богато обезбедени (Савиќ и др.1970), регосол врз лапорец од Пепелиште (неготинско) средно до богато обезбеден (Јекиќ и др. 1970) и циметна

Таб. 4. Содржина на достапни форми тешки метали во некои почви од Неготинско
Tab. 4. Content of available forms heavy metals in some soils from Negotino area

Број на профил Profile No.	Хоризонт и длабочина во cm Horizon and depth in cm	Достапни форми во mg/kg Available forms in mg/kg			
		Cu	Fe	Mn	Zn
1	(A)p 0-30	1.42	4.44	13.22	0.34
1	C 30-60	1.22	4.36	3.86	0.30
1	C 60-74	2.24	5.64	3.58	0.52
	C/R				
2	Ap 0-35	3.36	12.88	13.56	0.36
2	C 35-62	0.86	2.80	4.94	0.16
	C/R				
многу ниско / very low		<0,3	0-5	0-4	<0.5
ниско	low	0.3-0.8	5-10	4-8	0.5-1.0
средно	medium	0.9-0.1.2	11-16	9-12	1.1-3.0
високо	high	1.3-2.5	17-25	13-30	3.1-6.0
многу високо / very high		>2.5	>25	>30	>6.0

шумска почва од неготинско многу богато обезбедена (Јекиќ и др. 1972).

Најнеповолна е обезбеденоста со достапен цинк. Испитуваните почви се многу ниско до долна граница на ниско обезбедени со достапен цинк (Табела 4), и се должи на високите pH вредности и содржината на $CaCO_3$. Растворливоста на цинкот нарочито е ниска на почви со висока pH вредност како и во присуство на $CaCO_3$ (Kastori 1990). Сиромашно обезбедени со достапен цинк се смолниците од тиквешкиот регион (Savić et al. 1968), алувијалните почви од околина на Росоман (Савиќ и др.1970), регосол врз лапорец од Пепелиште (Јекиќ и др. 1970) и циметна шумска почва од неготинско (Јекиќ и др. 1972). Од нашите и од податоците на другите истражувачи на почвите од Тиквешкиот регион може да се констатира дека обезбеденоста со достапен цинк е незадоволителна.

Заклучок

Врз основа на извршените истражувања можат да се извлечат следните заклучоци:

- Содржината на вкупен бакар и цинк во почви од атарот на с. Тимјаник (Неготинско), профил 1 (регосол) е пониска во површинскиот хоризонт (A)p во споредба со матичниот супстрат, што значи дека нема антропогена контаминација.
- Содржината на вкупен бакар и цинк во хоризонтот Ap на профил 2 (рендзина) е повисока од хоризонтот (A)p на профил 1 (регосол) што се должи на повисоката содржина на хумус и биолошката акумулација на овие тешки метали.
- При давање на оценка за антропогена контаминација на почва, пореални се вредностите за содржината на тешки метали во апсолутно и релативно помлади почви.
- Испитаните почви се одликуваат со висока содржина на глина, високи pH вредности и голема содржина на $CaCO_3$, што влијае на намалување на достапноста на испитуваните тешки метали.

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Summary

In this article, data on mechanical composition, some chemical properties and total and available forms of copper, iron, manganese and zinc in regosol and rendzina formed on marl in the area of Negotino, are presented. Main goal of this investigation is to determine the total content and available forms of some heavy metals (Cu, Fe, Mn and Zn) and the influence of pedogenetic processes and relative age of the examined soils on the distribution of heavy metals in depth of the soil profile. The results of investigation show that the content of total copper are slightly higher than the referent values, but much less than the intervene values. Total quantity of zinc is lower than the referent values. Total quantity of manganese is lower than the MAC. Content of total copper and zinc in profile 1 (regosol) is lower in surface horizon (A)p, compared with parent material, which means that no anthropogenic contamination. The quantities of available copper are in the ranges of medium to very high, of iron are between very low to medium, the quantities of easy available manganese vary in a broad ranges of very low to high, while the quantities of available zinc are very low to low. High content of clay, high pH values and high content of $CaCO_3$ influence on reduction of availability on investigated heavy metals. The total content of copper, iron, manganese and zinc is higher in the cultivated top soil of rendzina soil (absolutely and relatively pedogeneticly older soil than regosols) in comparison to the cultivated top soil of regosols as a result of the biological accumulation of heavy metals.

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THE BIOACCUMUALTION OF SOME METALS IN SOIL AND SPECIES *Stachys recta* L. AND *Stachys scardica* (Griseb.) Hayek ON ONE SERPENTINE LOCALITY (SERBIA)

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Abstract

Branković, S., Glišić, R., Đelić, G., Stanković, M., Đekić, V. (2013). The bioaccumualtion of some metals in soil and species *Stachys recta* L. and *Stachys scardica* (Griseb.) Hayek on one serpentine locality (Serbia). Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

The determination of the metals in soil and plants is very important in monitoring of environmental contamination. The aim of presented research was to assess the content of eleven metals (Ca, Mg, Fe, Mn, Cu, Zn, Ni, Pb, Cd, Co, and Cr) in species *Stachys recta* L. and *Stachys scardica* (Griseb.) Hayek, as well as in serpentine soil. In soil, metal concentrations had the following order: Mg>Fe>Ca>Ni>Cr >Mn>Co>Zn>Pb>Cu>Cd. The results showed that the concentrations of all examined metals were higher in soil than in plants (excepting Ca). The species had BCA<1 (except for Ca). This study exhibited different metal concentration in investigated plant species, depending on kinds of metal, and that metal uptake does not necessarily correlate with metal content in the soil. It is generally regarded that the bioavailability of metals to plants is closely related to their chemical specialization, rather than their total concentration in soils. This is probably due to diverse metal uptake mechanisms of plants and to some disparities in their transport properties, resulting in differences in the metal concentrations in plants.

Key words: metals, bioaccumulation, *Stachys.*

Introduction

Serpentine substrates cover quite large areas in the Balkans, more than in other parts of Europe (Brooks 1987). They exist as large blocks or as small outcrops separated from other geological formations, in Central Bosnia and Western and Central Serbia, and extend towards North, Central and South-Eastern parts of Albania and further to the serpentine formations in the regions of Epirus and Thessaly in Greece. Some fairly isolated serpentine „islands" occur in the North-Eastern Serbia and Greece and in the northern part of Macedonia. Small quantities of serpentine bedrock are distributed in South-Western, South and Central parts of Bulgaria, mainly in the Eastern and Central Rhodopean mountains (Bani et al. 2010).

The serpentine flora of the Balkans is characterized by a relatively high degree of endemism. Biodiversity in this area is high, with a great number of interesting local and regional endemics. More than 300 endemic taxa occur on serpentine in the Balkans. The greatest concentration of serpentine endemic species in the Balkans is in the mountains of the western part of the peninsula in the territories of Bosnia, Serbia, Albania and North Greece (Riter-Studnička 1968). According to Stevanović et al. (2003), there are 335 Balkan endemic vascular plant taxa growing on serpentine, 123 of which are obligate serpentinophytes.

In spite of the fact that ultramafic soils cover substantial areas at many locations in Serbia, there is little information's instead their flora and biogeochemistry in small outcrops or in small serpentine sites. The adaptive responses of plants to contaminated environment with metals are efficient processes that include many physiological, molecular, genetic and ecological traits. A fuller knowledge of the species, their morphological, physiological and ecological similarities and differences provide a more comprehensive knowledge of the systematics, distribution, ecology and environmental adaptations, and

Fig. 1. Researched area

other features or characteristics of the species of the same genus. This research provides a small contribution to the understanding of environmental adaptation of species from genus *Stachys,* on serpentine substrates. The estimation of genetic variation between plants in the ability to accumulate metals is of both practical and theoretical importance. In addition, hyperaccumulator plants play a potential role in remediation and sustainable management of soils polluted or contaminated with different metals.

The aims of this study were to determine content and accumulation of eleven metals (Ca, Mg, Fe, Mn, Cu, Zn, Ni, Pb, Cd, Co, and Cr) in species *Stachys recta* L. and *Stachys scardica* (Griseb.) Hayek and serpentine soil where they were grown.

Material and methods

The researched area is located in the village Kamenica (Central Serbia) (Figure 1). The investigated site is at 359 m above sea level, and is centered on 74° 76' 284" N, 48° 29' 864" E (read by GPS Garmin-etrex, vista HCx).

The field work was conducted during March-August 2011, when two species of genus *Stachys* (*S. recta* and *S. scardica*), together with their associated soils, were collected.

Six soil replications near roots of researched plants were collected from 1 to 10 cm depth. This depth corresponds to the major rooting zone of the herbs and small shrubs (Reeves et al. 2007). Soil samples were initially air-dried and stone pieces were removed, sieved to 2 mm, and stored at 4 °C until analysis. Sub-samples of 10 g were ground to pass a 70-mesh sieve (< 215 μm) and then oven-dried at 105 °C for 24h.

Identification of plant material was performed in the laboratory of the Institute of Biology and Ecology, Faculty of Science in Kragujevac, in accordance with standard keys for determination: Javorka and Csapody (Javorka and Csapody 1979), Flora of the Republic of Serbia (Josifović 1972) and Flora Europaea (Tutin et al. 1964). Identified plant material was elutriated in distilled water, then dried at room temperature and in dryer (Binder/Ed15053), at 105ºC for 24 hours and prepared for chemical analysis by standard procedures.

Eleven metals (Ca, Mg, Fe, Mn, Cu, Zn, Ni, Pb, Cd, Co and Cr) were analyzed in soil and whole plants. Chemical analysis of soil and plant samples were done by SRPS EN 12506:2007; SRPS EN 13656:2008 methods (www.jus.org.rs). The metal concentrations in soil and plant samples were determined by inductively coupled plasma-mass atomic emission spectrometry (ICP-OES iCAP 6500, ICP-20100908), directly from the solution. The detection limits for Ca, Mg, Fe, Mn, Cu, Zn, Ni, Pb, Cd, Co and Cr in plant material were: 0.0087, 0.007, 0.0053, 0.0051, 0.0056, 0.0055, 0.006, 0.003, 0.0027, 0.0054 and 0.0053 $mgkg^{-1}$, respectively. The detection limits for Ca, Mg, Fe, Mn, Cu, Zn, Ni, Pb, Cd, Co and Cr in soil were: 0.009, 0.007, 0.0056, 0.0065, 0.0076, 0.0051, 0.0059, 0.0089, 0.003, 0.0079 and 0.0092 $mgkg^{-1}$, respectively. The six replications of one sample were prepared for both, soil and all plants. The mean values of metal concentrations were calculated. Biological Absorption Coefficient (BAC) was calculated for each metal by dividing the total content of metal in plant by its total content in soil (Kabata-Pendias 2001). The contents of metals in soil and plant materials were expressed in $mgkg^{-1}$ of dry matter ($mgkg^{-1}$ d.m.).

Tab. 1. The mean concentrations[1] of Ca, Mg, Fe, Mn, Cu, Zn, Ni, Pb, Cd, Co, Cr (mgkg^{-1} d.m.) in soil and species Stachys recta and Stachys scardica

	Ca	Mg	Fe	Mn	Cu
SOIL	1109.083±6.139	59603.585±312.001	35709.918±320.899	288.863±6.378	6.108±0.295
STREC	3427.435±17.711	5261.595±29.486	113.494±1.290	14.062±0.105	3.505±0.038
STSCA	4610.417±23.099	2889.167±27.734	140.813±1.459	34.317±0.465	4.142±0.108

	Zn	Ni	Pb	Cd	Co	Cr
SOIL	23.124±0.147	931.492±23.773	13.205±0.085	1.407±0.006	33.648±0.085	485.236±10.770
STREC	11.812±0.112	39.542±0.297	3.692±0.277	0.021±0.002	0.185±0.004	1.348±0.019
STSCA	17.942±0.135	11.600±0.090	0.201±0.012	0.014±0.001	0.315±0.004	1.879±0.044

[1]The mean value (n=6) ± standard deviation; SOIL – *soil*; STREC – *S. recta;* STSCA – *S. scardica*

Differences of metal concentrations between plant species, and in soil and plants were examined using one-way ANOVA. The Pearson correlation coefficient analysis was prepared in order to check if differences existed between different combination of investigated plant species and soil*plants. In this study, the statistical analysis of data was performed using the computing package called Statistical Package for Social Science (SPSS 10 for Windows).

Abbreviations:

STREC - *Stachys recta* L.; STSCA- *Stachys scardica* (Griseb.) Hayek; BCA - Biological Absorption Coefficient.

Results

Generally, the results of this study showed that the mean concentrations of investigated metals (Table 1) were far higher in the soil samples than in plant samples (except for Ca).

The serpentine soil contained 1109.083 mg Ca kg^{-1} d.m., and its content in plant species ranged 3427.435-4610.417 mg Ca kg^{-1} d.m. The mean concentrations of Mg and Fe in soil samples (59603.585 and 35709.918 mgkg^{-1} d.m., respectively) were significantly higher than in the plant samples. The mean concentrations of Mg in plant samples varied from 2889.167 to 5261.595 mgkg^{-1} d.m., and the concentration of Fe from 113.494 to 140.813 mgkg^{-1} d.m. The mean concentrations of Mn in plant samples varied from 14.062 to 34.317 mgkg^{-1} d.m. and in soil it 288.863 mgkg^{-1} d.m. The content of Cu varied from 3.505 to 4.142 mgkg^{-1} d.m. in plant samples and in soil it was 6.108 mgkg^{-1} d.m. The content of Zn ranged 11.812-17.942 mgkg^{-1} d.m. in plant samples and it was 23.124 mg Zn kg^{-1} d.m. in soil. The range of Ni concentration was 11.600-39.542 mgkg^{-1} d.m. in plant samples and in soil the concentration of Ni was 931.492 mgkg^{-1} d.m. The Pb content in plants varied from 0.201 to 3.692 mgkg^{-1} d.m. The mean concentration of Pb in soil samples was 13.205 mgkg^{-1} d.m. The Cd content in plant and soil was the lowest and ranged 0.014-1.407 mgkg^{-1} d.m. The mean concentration of Co in plant samples varied from 0.185 to 0.315 mgkg^{-1} d.m. and in soil it was 33.648 mg Co kg^{-1} d.m. The chromium concentrations were 1.348-1.8796 mgkg^{-1} d.m. in plant samples and 485.236 mgkg^{-1} d.m. in soil.

The ratio of Ca to Mg is presented in Figure 2. The Ca:Mg ratio in soil samples was 0.019 and in plant samples varied from 0.651 to 1.596. In soil samples metal concentrations had the following order: Mg>Fe> Ca>Ni>Cr>Mn>Co>Zn>Pb>Cu>Cd. Obtained data showed that the content of investigated metals in plants depends on plant species. The trend of metal accumulation in plants was: Mg>Ca>Fe>Mn>Ni>Zn >Cu>Pb>Cr>Co>Cd.

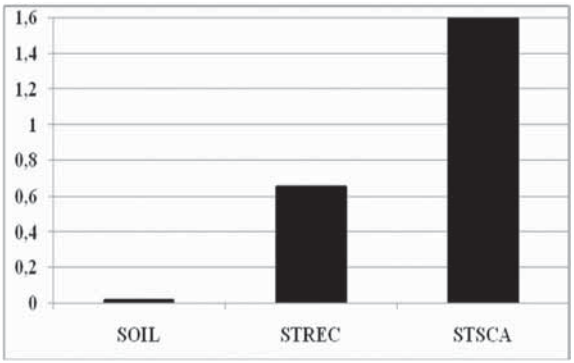

Fig. 2. The Ca:Mg ratio

The Biological Absorption Coefficient (BAC), also known as the plant uptake factor, is widely used for comparision of different plants. In our study, the value of BCA varied from 0.003 to 4.157 (Figure 3). The BCA was below 1, as well as the both investigated species which have showed BCA>1 for Ca.

The results obtained from the ANOVA test (Table 2) presented that very high statistically significant differences ($p \leq 0.001$) existed in the content of metals between soil samples and investigated species, as well as between investigated species.

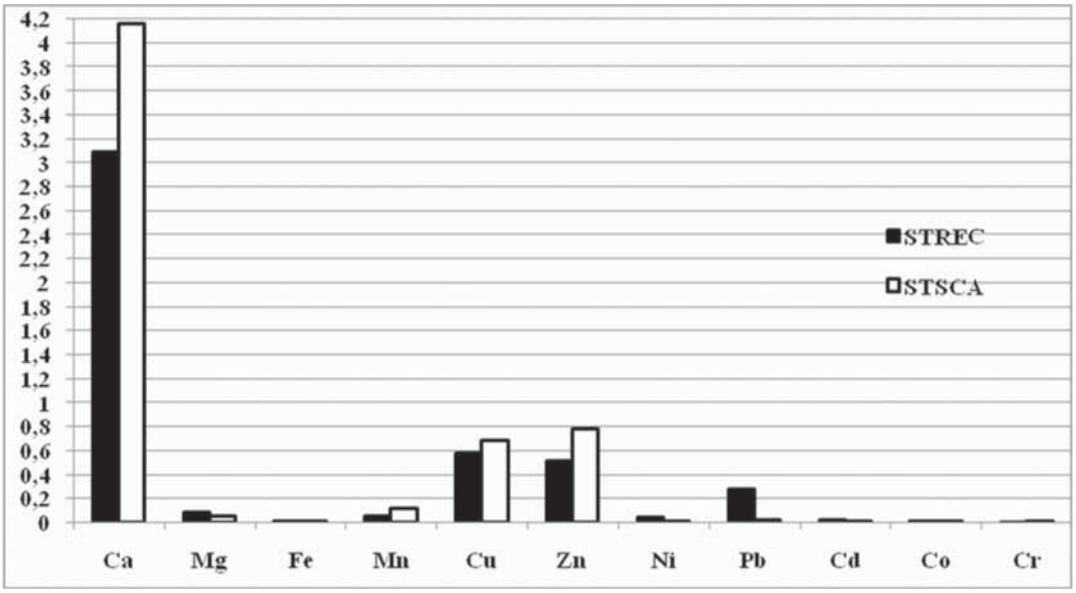

Fig. 3. Biocencentration factors

Tab. 2. The difference in metal concentrations between soil and plant, and between plants

soil/plant pairs	SOIL*STREC		SOIL*STSCA		STREC* STSCA		SOIL *(STREC,STSCA)	
metal	F-value	p-level	F-value	p-level	F-value	p-level	F-value	p-level
Ca	91779.9	***	128768.0	***	9910.83	***	128.9	***
Mg	180405.3	***	196702.0	***	20609.39	***	11354.1	***
Fe	73827.7	***	73714.1	***	1180.07	***	156693.7	***
Mn	11135.5	***	9506.5	***	10832.77	***	3123.7	***
Cu	458.0	***	234.1	***	184.61	***	194.3	***
Zn	22608.2	***	4050.1	***	7335.84	***	38.5	***
Ni	8444.9	***	8983.6	***	48466.61	***	10162.5	***
Pb	6457.3	***	138364.9	***	948.94	***	219.4	***
Cd	260292.7	***	284826.5	***	37.85	***	345297.3	***
Co	930510.4	***	923925.5	***	3166.04	***	823647.9	***
Cr	12111.6	***	12084.9	***	734.51	***	25771.7	***

F – value; p – level: (p≤0.05 (*), p≤0.005 (**), p≤0.001(***); SOIL – *soil*; STREC – *S. recta;* STSCA – *S. scardica*

Correlation analysis has been used to establish different relationships: (1) between soil and tested plant in content of metals and (2) between investigated plant species in uptake of metals (Table 3). The results obtained from the Pearson correlation coefficient analysis were indicatingthat very high positive or negative correlation existed between plants and soil*plant depending on calculated combination of plant and soil. In addition, results also showed that high negative correlation existed between investigated species in content of Cd, as well as between soil and both researched species in content of Zn.

Discussion

Metal content of soil is dependent on natural and anthropogenic sources in the local ecosystems. The concentration of metals in uncontaminated soil is primarily related to the geology of the parent material from which the soil was formed. The determination of metals in soils and plants isvery important in monitoring of environmental pollution. Therefore, the plants (with their selective absorption of certain ions and sedentary nature) are suitable biological monitors in ecosystem quality studies.

The results of our research showed that serpentine soil contained 1109.083 mg Ca kg^{-1} d.m. As means of plans, species *S. scardica* showed the highest content of Ca (4610.4173 mg Ca kg^{-1} d.m.). The results of this study are in accordance with previous findings of some researches (Robinson et al. 1997; Shallari et al. 1998; Reeves et al. 2007).

The findings of some researchers showed that among the limiting, stress factors that make ultramafic soils unfavourable substrates for plant growth, the low Ca:Mg quotients (commonly about 0.1)

Tab. 3. The Pearson correlation coefficient analysis of metal concentrations between soil and plant species, and between plant species

	Ca	Mg	Fe	Mn	Cu	Zn	Ni	Pb	Cd	Co	Cr
SOIL*STREC	1.00	-1.00	-1.00	-1.00	-0.99	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
SOIL*STSCA	1.00	-1.00	-1.00	-1.00	-0.98	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
STREC* STSCA	1.00	-1.00	1.00	1.00	0.97	1.00	-1.00	-0.99	-0.89	1.00	0.99
SOIL*(STREC,STSCA)	0.94	-1.00	-1.00	-1.00	-0.96	-0.84	-1.00	-0.97	-1.00	-1.00	-1.00

r - correlation coefficient; (0-0.3): no correlation; 0.3-0.5: low correlation; 0.5-0.7: medium correlation; 0.7-0.9: high correlation; 0.9-1.0: very high correlation); SOIL – *soil*; STREC – *S. recta;* STSCA – *S. scardica*

was very important (Brady et al. 2005.). Our results showed low Ca:Mg (0.019) ratio in soil. Similar results were described by many authors (Robinson et al. 1997; Shallari et al. 1998). However, our results also showed high Ca:Mg ratio in species *S. scardica* and high biological absorption coefficient of Ca for both investigated species. The serpentine-tolerant species survive on soils with depleted levels of Ca because they are still able to absorb quantities of Ca without taking up excessive quantities of Mg. O'Dell et al. (2006) suggested that the ability of plants to maintain high leaf Ca:Mg by selective translocation of Ca and/or inhibited transport of Mg from roots is a key evolutionary change needed for survival on serpentine soils. The uptake of Mg comes at a cost to the plant so that the uptake of other element nutrients is forfeited. The heightened level of Mg in serpentine soils and its antagonistic behavior toward other elements could be the most important factor in serpentine syndrome. Perhaps, it is a key for relatively low concentration of Mg in all investigated species.

The iron concentration in the soil from locality Kamenica was 35709.918 ($mgkg^{-1}$ d.m.). Our results are in agreement with earlier findings that serpentine soils contain high amounts of iron (Reeves et al. 2007; Bech et al. 2008). According to Allen (1989), 40-500 $mgkg^{-1}$ and to Market (1992), 5-200 $mgkg^{-1}$ concentrations of Fe are considered as toxic to plants. However, in this study, the Fe concentrations found in plants investigated were within previous cited data. The metal phytoavailability depends on the form of the element in soil and on the considered plant species. However, even in the case of testing the same species, the metal uptake does not necessarily correlate with metal content in the soil.

According to Adriano (2001), regular Mn content for most of soil types ranges from 500-1000 $mgkg^{-1}$. However, our results presented lower concentration of Mn (288.863 $mgkg^{-1}$ d.m.) in soil. The concentration of metals in soil may exceeds or were below the normal ranges depend on the local geology, and serpentine soils content high levels of potentially phytotoxic elements Ni, Cr, Co, and sometimes Mn and/or Cu. However, to fulfill its metabolic functions, Mn is only necessary at low concentration (20 $mgkg^{-1}$ d.m.). The manganese has a range between 20 and 300 $mgkg^{-1}$ in most plants, while its level may be as high as 1500 $mgkg^{-1}$, without harm to some plant (Pais and Jones 2000). Therefore, comparing our data with the previous cited, we could say that investigated species contained lower concentration of Mn. This is probably due to antagonism in uptake between Fe and Mn, as well as in the existence of very high negative significant correlations between soil and plant species in content of Mn.

Kabata-Pendias (2001) reported that Cu levels of various soils ranged 1-200 $mgkg^{-1}$. In our study, the mean concentration of Cu in soil samples was 6.108 $mgkg^{-1}$ d.m. Kabata-Pendias (2001) also, reported that Cu levels of various plants from unpolluted regions in different countries changed between 2.1 and 8.4 $mgkg^{-1}$. Therefore, comparing our data for zinc content in the soils samples with the findings of some researches (Shallari et al. 1998; Bech et al. 2008), we could say that it was lower (23.124 $mgkg^{-1}$ d.m.). However, the results obtained in our study are in accordance with literature data that copper availability to plants might be reduced due to high iron content in soil solution. In well-aerated soil Fe occurs mostly in the form of Fe^{3+} oxides or hydroxides, which are known as efficient sorbents for inorganic cations such as Cu (Živković et al. 2011).

Kabata-Pendias (2001) has reported that regular Zn content for most of soil types ranges from 1-800 $mgkg^{-1}$. Therefore, comparing our data for zinc content in the soil samples with the findings of some researches (Shallari et al. 1998; Bech et al. 2008), we could say that it was lower (23.124 $mgkg^{-1}$ d.m.). Also, some authors (Brunetti et al. 2009) have reported that the normal Zn content in plants (15-150 $mgkg^{-1}$) and the maximum value (300 $mgkg^{-1}$) of Zn limits in foodstuff were not exceeded. In our study, all investigated species had lower concentration of Zn than previous cited.

The total Ni concentrations of serpentine soils are generally in the range 500-8000 $mgkg^{-1}$ (Ghaderian et al. 2007). Therefore, our data are in accordance with previous findings of some researches (Shallari et al. 1998; Reeves et al. 2007). Some authors have described that the normal plants and crop species generally contain 1-5 mg Ni kg^{-1} (Reeves, 1992;

Chaney et al, 2008) and suffer significant phytotoxicity below 100 mg Ni kg^{-1}. The concentrations of Ni in the leaves of plants on serpentine soils are slightly elevated, usually to about 10-100 $mgkg^{-1}$, compared to plants growing on normal soils (0.2-5 $mgkg^{-1}$) (Reeves 1992). In our study the species *S. scardica* have showed lower (more than 3 times) concentration of Ni than *S. recta*. According to Chaney et al. (2008), Ca addition to high Mg serpentine soils with very low Ca:Mg ratio may reduce Ni phytotoxicity. These observations agree with those obtained by other authors (Zayed and Terry 2003) who found that Ca:Mg quotient is a relatively important factor in Ni uptake. As a general rule, increasing solution of Ca inhibits plant uptake of Ni and other divalent cations. However, a number of serpentine plants are able to accumulate extraordinary concentrations of Ni in their above-ground parts, especially in the leaves (Ghaderian et al. 2007). Nickel is mainly stored in the leaves, and is particularly concentrated in epidermal cell vacuoles, trichome bases, and the lower parts of the trichome pedicle. The uptake and accumulation of pollutants vary from plant to plant and also from species to species within a genus.

On average, the Earth's crust is estimated to contain about 15 ppm of Pb, with parent rocks, contributing to the natural content (Bech et al. 2008). Kabata-Pendias (2001) reported that Pb levels of various soils ranged 2-200 $mgkg^{-1}$. Our results are in accordance with previous cited data (Robinson et al. 1997; Reeves et al. 2007). Kabata-Pendias (2001) also reported that Pb content in plants grown in uncontaminated areas varied in between 0.05 and 3.0 $mgkg^{-1}$. Some authors have reported that Pb concentration in plants ranged from 10 to 25 $mgkg^{-1}$ (Carranza-Ălvarez et al. 2008). The results obtained in our study showed that investigated species had concentration of Pb within normal range for plants. The toxicity of Pb is strongly dependent on the Pb:Ca ratio of the cation exchange complex of the soil. Ca effectively counteracts Pb toxity, most probably through inhibition of the uptake and the accumulation of Pb in the root.

Kabata-Pendias (2001) reported that Cd levels of various soils ranged 0.001-2.5 $mgkg^{-1}$. Our results showed concentration of 1.407 mg Cd kg^{-1} d.m in soil. The cadmium is considered to be toxic in the environment at low levels. The low concentration of Cd in investigated plant species was probably due to antagonism in uptake among metals. So, the cadmium adsorption was likely more affected by the presence of Ca and Cu, so that the mobility of Cd may be greatly increased due to such competition. Additionally, the Cd mobility was negatively correlated with the clay content, which means that the competitive adsorption may be the predominant process in Cd bonding in these soils (Kabata-Pendias, 2001).

The results obtained in our study were showed 33.648 mg Co kg^{-1} d.m. in soil samples. Similar results were described by some authors (Robinson et al. 1997; Reeves et al. 2007). Cobalt frequently interacts antagonistically with Ni, Fe and Mn in plants, and antagonistic interaction between Ni and Co are observed for some species under specific experimental conditions (Tappero et al. 2007). These factors could be reason for different Co accumulation and concentration in investigated plant species, as well as the fact that metal concentrations in plants vary with plant species.

High Ni and Cr concentrations were observed only at the serpentine sites where soils were derived from gabbros and ultrabasic rocks generally rich in Fe, Ni and Cr (Shallari et al. 1998). The results obtained in our study showed 485.236 mg Cr kg^{-1} d.m. in soil. According to Brunetti et al. (2009), in the investigated soil samples Cr concentrations ranged from 36.18 to 115.15 $mgkg^{-1}$. The chromium is the pollutant with highest total contents in soils, but it showed only average extractability of 0.008% (Zayed and Terry 2003), because nearly all the soil Cr was in a more resistant fraction (less soluble forms). In the serpentine soils with high Cr concentrations, it is often in form of chromite, an unalterable mineral, and so Cr remains not bioavailable. This is just one factor that affects the uptake of Cr. Chromium is a toxic, nonessential element for plants; hence, there is no specific mechanism for its uptake. Possible pathway could involve the carriers used for the uptake of essential metals for plants metabolism. According to Reeves and Baker (2000), the normal values of Cr in plants is 2-5 $mgkg^{-1}$. However, our findings showed that Cr concentrations in plants ranged from 1.346 to 1.879 $mgkg^{-1}$, which are in accordance with some published data (Živković et al. 2011 showed regular Cr content in plants usually ranges from 0.006 to 18 $mgkg^{-1}$). However, metal bioavailability of plants is influenced by various factors, such as pH, temperature, redox potential, chemical speciation, seasonal changes, sediment type, salinity, and organic matter.

Soils are preferred monitoring tools, because of the fact that they show less variation in time and space, allowing more consistent assessment of spatial and temporal contamination (Keshav et al. 2011). The content of metals in the soil depends on numerous factors, such as: specific ability of some plants to over-accumulate various toxic metals, chemical and physical characteristics of soil and metal interactions.

An organism is expected to reflect environmental pollution if it has the ability to take up elements proportionally to their concentration in the environment (Ravera et al. 2003). This study exhibited different metal concentration in investigated plant species, depending on kind of metals and plant species. In spite of the fact that very high correlation

in metal uptake between plants exist; and plan and soil, it seems that species *S. recta* (serpentine-obligate plants) and *S. scardica* (serpentine-facultative plants) have had different metal mechanisms of uptake, accumulation and concentration. Metal uptake by plants depends on the bioavailability of the metal in soils, which in turn depends on the retention time of the metal, as well as the interaction with other elements and substances.

Metal accumulation by plants is affected by many factors. In general, variations in plant species, the growth stage of the plants and element characteristics control absorption, accumulation and translocation of metals (Ahmad et al. 2011). However, plant communities on serpentine soils are adapted to toxic concentrations of metals. The adaptive responses of plants to contaminated environmentwith metals are efficient processes that include many physiological, molecular, genetic and ecological traits. These features give to certain species the ability to survive or hyperaccumulate the toxic metals.

The results of presented study revealed different metal accumulation between species from genus *Stachys*. The species *S. scardica* showed better accumulation of almost all investigated metals (except Mg, Ni, Pb and Cd) than *S. recta.* However, plants reveal a variable and sometimes specific ability to absorb element from soil. The response of plants to the chemistry of the environment is controlled by several external and biochemical factors. Three general uptake characteristics can be distinguished in plants: accumulation, indication, and exclusion. In spite of the fact that a huge difference in metal uptake between plant species exist, the chemical analysis of plants is a promising tool to study chemical properties and changes in the biosphere.

Conclusions

The aims of this study were to determine the contentof eleven metals in species *S. recta* and *S. scardica* and in serpentine soil. The mean concentrations of investigated metals were higher in the soil than in plant (except for Ca). The metal uptake does not necessarily correlate with metal content in the soil. This study exhibited different metal accumulation between species from genus *Stachys*, depending on kind of metals and plant species. The species *S. scardica* howed better accumulation of almost all investigated metals (except Mg, Ni, Pb and Cd) than *S. recta.* In spite of existence of very high correlation in metal uptake between plants, and plants and soil, it seems that species *S. recta* serpentine-obligate plants and *S. scardica* serpentine-facultative plants have had different metal mechanisms of uptake, accumulation and concentration of metals depending on type of metals and plant species. It is generally regarded that the bioavailability of metals is closely related to their chemical speciation, rather than total concentration in soils.

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НИВОТО НА ЕКОЛОШКОТО ОБРАЗОВАНИЕ КАЈ УЧЕНИЦИТЕ ОД СРЕДНИТЕ УЧИЛИШТА ВО РЕПУБЛИКА МАКЕДОНИЈА

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Апстракт

Србиновски, М., Исмаили, М. и Јонузи И. (2013). Нивото на еколошкото образование кај учениците од средните училишта во Република Македонија. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 28, Скопје.

Училиштата како општествено одговорни системи за развој на граѓанството, би требало да се ангажираат околу развојот на когнитивните, афективните и психо-моторните вештини за да се стекнат учениците со способности за донесување одговотни одлуки во врка со животната средина.

Овој труд е обид да се детерминира нивото на знаењата на учениците, ставовите, емоциите и личната подготвеност за преземање акција за заштита на нивната животна средина. Истото е сторено со помош на 5 инструменти со релативно добри метриски карактеристики на примерок од 484 ученици од 19 средни училишта во Република Македонија.

Средното ниво на еколошка едуцираност на учениците изнесува околу 44,18% од максималното ниво (100%), што значи дека истото е на ниско ниво.

Клучни зборови: еколошко образование, ученици, средни училишта, Република Македонија

Abstract

Srbinovski, M., Ismaili, M. & Jonuzi, I. (2013). Students' environmental education level in the Macedonian secondary schools. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

Schools as one of the social systems responsible for the development of citizenry should be charged with developing cognitive, affective and psycho-motor skills to equip students with the ability to make environmentally responsible decisions.

This paper is an attempt to determine the level of students' knowledge, attitudes, emotions and personal willingness for taking action to protect their environment. The same is done with 5 instruments with relatively good metric characteristics on sample of 484 students from 19 secondary schools in the Republic of Macedonia.

The average environmental education of the examiners is about 44.18% of the maximum (100%), which means that it is low level.

Key words: environmental education, students, secondary schools, The Republic of Macedonia.

Вовед

Тргнувајќи од потребата за дефинирање на актуелната состојба и перспективите на еколошкото образование и воспитание во нашите училишта, пристапивме кон едно вакво истражување. Со тоа сакавме да дадеме скромен придонес на полето на подобрување на ова наставно подрачје, затоа што некои предходни истражувања покажуваат дека еколошкото образование и воспитание се наоѓаат во специфична положба (Ismaili et al., 2009; Јонузи и др., 2009; Јонузи

, 2009; Србиновски, 2002, 2003а, 2003б, 2004а, 2004б, 2005а, 2005б, 2007, 2012), Srbinovski et al., 2009а, 2009б, 2010, 2007, 2011, 2012 итн.).

Непостоењето на планиран и стратешки пристап во ова наставно-воспитно подрачје, негативно се одразува врз нивото на еколошката едуцираност на учениците. Во вакви услови не можеме да очекуваме дека знаењата на учениците ќе прераснат во правилен однос кон животната средина. Во прилог на оваа констатација одат и резултатите од извршените мерења на постигањата на учениците на полето на екологијата во Република Македонија. Загрижува фактот дека некои параметри од еколошката едуцираност на учениците во изминатиот период не само што стагнираат, туку и бележат пад.

Сето ова упатува на постоење на една парадоксална ситуација. Имено, иако од една страна имаме тенденција на преземање на одредени мерки за подобрување на воспитно-образовниот систем, од друга страна пак, имаме недоволна еколошка едуцираност на учениците. Ова за нас беше и главната инспирација да се зафатиме со утврдување на нивото на еколошката едуцираност на учениците од нашата република.

Методи

Предмет на ова истражување е еколошкото образование и воспитание на учениците од средните училишта во Република Македонија. Главната цел на истражувањето е да се утврди нивото на еколошката оспособеност на учениците преку когнитивната, вредносната, афективната и конативната компонента. Тргнувајќи од фактот дека последниве години се преземаат низа активности за подобрување на квалитетот на воспитно-образовниот процес, а со тоа и подрачјето на заштита и унапредување на животната средина, претпоставуваме дека еколошката едуцираност на учениците е на потребното ниво.

Поаѓајќи од поставените цели и задачи на истражувањето, се определивме за конструкција на следните инструменти: Прашалник за ученикот (ПУ-1), Тест на знаење (ТЗ-2), Скала на вредности на еколошката ориентација (СВ-3), Скала на задоволство (СЗ-4) и Скала на активација (СА-5). Добиените инструменти се со релативно добри метриски карактеристики.

Во истражувањето беа опфатени 484 испитаници од 19 гимназии од 18 населени места во Република Македонија. Популацијата ја сочинуваа ученици гимназијалци од завршните класови (Табела 1).

Таб. 1. Ученици по училишта.

Tab. 1. Students by schools.

Училиште School	**Место Place**	**Ученици Students**
Mirce Acev	Prilep	24
“M.M.Brico”	M. Kamenica	32
“Rade J. Korcagin”	Skopje	31
“Kiril Pejcinovic”	Tetovo	18
“Kosta Susinov”	Radovis	33
“M.M.Brico”	Delcevo	28
“Pance Poposki”	Gostivar	30
“Ljupco Santov”	Kocani	21
“Niko Nestor”	Struga	20
“Jane Sandanski”	Strumica	21
“Goce Delcev “	Kumanovo	27
“Josif Josifoski”	Gevgelija	24
“Sv. Naum Ohridski”	M. Brod	21
“Sv. Kliment Ohridski”	Ohrid	26
“Zefljus Marku”	Skopje	30
“Sv. Kiril i Metodij”	Negotino	16
“Dobri Daskalov”	Kavadarci	21
“Koco Racin”	Veles	32
“Josip Broz”	Битола	29
	Вкупно/Total	**484**

Резултати и дискусија

На тестот на знаење учениците средно освоија 34.71% од максималниот број можни поени. Вредностите на стандардната девијација укажуваат дека испитаниците се изразито хомогени во поглед на своите еколошки знаења. Најголем број ученици точно одговорија на следниве прашања: Кој предизвикува глобално затоплување на биосферата (56.46%), Преку кои процеси се произведуваат органски материи во природата (54.33%). Што е популација (53.40). Како ги делиме организмите според начинот на исхрана во природата (52.85%) итн. Од друга страна пак, учениците мошне слабо одговорија на следниве прашања: Кои се продуктите на фотосинтезата (13.81%), Познавање на ограничувачките фактори (15.06%), Разликување на основните типови животни средини (19.62%), Познавањето на биотичките фактори (21.83), Познавањето на абиотичките фактори (23.99%) итн.

Најголемиот дел од испитаниците сметаат дека своите знаења се на ниво “се сеќавам дека нив сум ги учел” и “имам чувство дека нив ги знам но не можам да ги искажам” Односно, тие веруваат дека најчесто своите знаења од екологијата ги усвојуваат до степен на препознавање. Во прилог на оваа констатација одат и резултатите од предходните истражувања на други автори (на пример Србиновски, 2005в итн.).

Според резултатите од скалата на вредности можеме да констатираме дека испитаниците се позитивно еколошки определени. Карактеристично е дека ниту за едно тврдење испитаниците немаат просечни 5 бода, а од друга страна пак, за 6 тврдења просечните бодови се под 4. Најголем број испитаници главно и сосема се сложуваат со тврдењето "Заштитувајќи ја природата, се заштитуваме самите себе си и нашите поколенија" (аритметичка средина 4,15) што зборува за високо вреднување на еколошката рамнотежа како предуслов за опстанок на човекот. Најголем дел од учениците човекот го сметаат за најодговорен фактор за заштита на животната средина, а тоа се забележува од аритметичката средина за предпоследното тврдење "Човекот е најодговорен фактор за заштита на животната средина" која изнесува 3.91. Тука би го издвојиле високиот процент на испитаници кои сосема или воглавно се сложуваат со тврдењето "Природата е наше заедничо богатство и затоа треба да се грижиме за неа" чија аритметичка средина изнесува 3.79. Радува податокот дека поголем дел од учениците сметаат дека развојот на општеството е поврзан и зависен од тоа како ние се однесуваме кон животната средина. Тоа имплицитно зборува дека младите го респектираат и прифаќаат концепот за одржлив развој. Затоа тие високо го оцениле тврдењето "Не треба да се штедат средствата кога е во прашање заштитата на околината" со аритметичка средина 3.73.

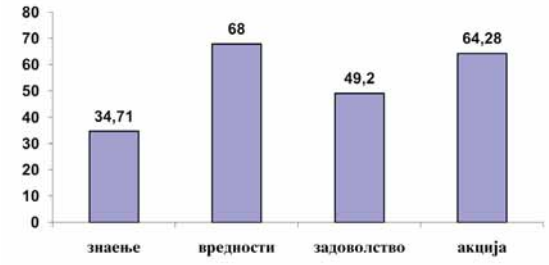
Загрижува малиот процент на ученици кои правилно го вреднуваат тврдењето "Напредокот на човештвото се огледа во тоа колку човекот ја искористил природата". Со ова тврдење воглавно или целосно се сложуваат околу 40 %. Едностраното третирање на природата само како извор на ресурси и не водењето сметка за природните закони, може да има далекусежни несогледиви последици во поглед на нарушувањето на еколошката рамнотежа во природата, што може да го доведе под знак прашалник опстанокот на целиот жив свет, а со тоа и на човекот. Мошне мал дел од учениците делумно или целосно се сложуваат со тврдењео "Единтвена шанса да се преживее на нашата планета е еколошкиот разум". Тоа недвосмислено говори дека младите се свесни дека опстанокот на планетава е условен од поголем број фактори, кои повеќе или помалку допираат и навлегуваат во сферата на еколошката наука. Сепак поголемиот дел од испитаниците сметаат дека човекот треба да биде привилегиран во природата, односно дека неговото однесување може да биде послободно и одредено од неговата волја. Секако дека ова не е во склад со основните еколошки принципи и начела. Исто така околу 200 ученици сметаат дека "Многу работи во животот на човекот се поважни од еколошките".

Според резултатите од скалата на задоволство, учениците најмалку се задоволни од односот на надлежните органи и институции (аритметичка средина 2.23), чистотата на реките (воопшто не задоволни – 46.49%, главно незадоволни 29.96%, аритметичка средина 2.25). Потоа следуваат грижата на државата за природата во пракса (воопшто не задоволни – 36.78%, главно незадоволни 20.66%, аритметичка средина 2.28).) и чистотата на воздухот (воопшто не задоволни – 29.34%, главно незадоволни 31.20%, аритметичка средина 2.34).

Испитаниците најмногу се задоволни од квалитетот на храната (воопшто незадоволни– 12.19%, главно незадоволни 22.52%, аритметичка средина 2.51). Потоа, од уреденоста на туристичките места (воопшто не задоволни – 15.91%, главно незадоволни 17.98%, аритметичка средина 2.88), чистотата на училиштето и училишниот двор (воопшто не задоволни – 27.07%, главно незадоволни 29.96%, аритметичка средина 2.25), квалитетот на водата за пиење (воопшто не задоволни – 28.31%, главно незадоволни 24.79%, аритметичката средина е 2.49) итн.

Врз база на добиените резултати од Скалата на активација можеме да констатираме дека поголемиот дел од учениците се подготвени активно да учествуваат во заштитата и унапредувањето на животната средина во која живеат. Повеќето од половината испитаници (56%) се изјасниле дека се подготвени колективно да се ангажираат во активностите за унапредување на нивната животна сердина. Од друга страна пак, не е мал и процентот на ученици кои имаат индиферентан однос (12.85%). Тоа значи дека овие ученици не сакаат да учествуваат во заштитата, бидејќи се бара одредена активност. Со други збоови, нивната акциона подготвеност е пониска од она што општеството го бара.

На Слика 1 е прикажана еколошката едуцираност на учениците во поглед на сите 4 испитувани параметри.

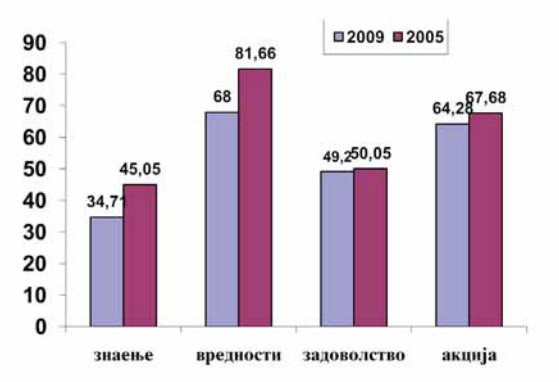


Сл. 1. Нивото на еколошката едуцираност на учениците.

Fig. 1. Students' level of environmental education.

Забележуваме дека кај испитаниците најсилно се развиени вредносната и конативната компонента, а најслабо се развиени когнитивната и афективната компонента. Средно земено, еколошката едуцираност на гимназијалците од Република Македонија изнесува 44.18% од максималната вредност (100%).

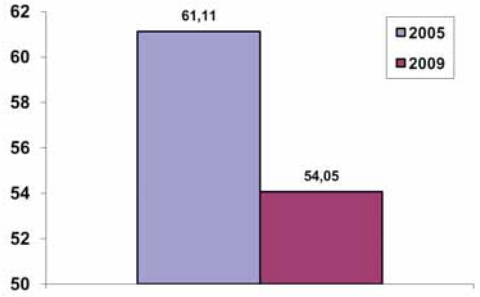
На следната слика е прикажана компарацијата на добиените врендости со оние добиени од предходните истражувања на Србиновски, М. (2005).



Сл. 2. Еколошката едуцираност по компоненти 2005/2009 (%).
Fig. 2. Environmental educations by components 2005/2009 (%).

Забележуваме дека сите испитувани варијабли имаат пониски вредности во споредба со оние добиени од предходното истражување. Најголем пад забележуваме кај вредносната и когнитивната компонента на еколошката едуцираност. Од друга страна пак, незначително пониски вредности добивме во поглед на афективната и конативната компонента.

На следната слика е прикажана просечната еколошка оспособеност на учениците во испитуваниот период (2005/2009).



Сл. 3. Општата еколошка едуцираност на учениците.
Fig. 3. General students' environmental education.

Забележуваме дека нивото на општата еколошка едуцираност на гимназијалците е пониско во однос на нивото од 2005 година.

Заклучоци

На тестот на знаење учениците средно освојија 34.71% од максималниот број можни поени. Според субјективна проценка на испитаниците, знаењата на учениците од областа на екологијата се на ниво "се сеќавам дека нив сум ги учел" и "имам чувство дека нив ги знам но не можам да ги искажам", односно истите ги усвојуваат до степен на препознавање.

Средното ниво на задоволство од квалитетот на животната средина изнесува 2.46. Учениците најмалку се задоволни од односот на надлежните органи и институции (аритметичка средина 2.23), чистотата на реките (воопшто не задоволни – 46.49%, главно незадоволни 29.96%, аритметичка средина 2.25) и од грижата на државата за природата во пракса (воопшто не задоволни – 36.78%, главно незадоволни 20.66%, аритметичка средина 2.28). Тие се најмногу задоволни од квалитетот на храната (воопшто незадоволни– 12.19%, главно незадоволни 22.52%, аритметичка средина 2.51) и од уреденоста на туристичките места (воопшто не задоволни – 15.91%, главно незадоволни 17.98%, аритметичка средина 2.88).

Поголемиот дел од учениците се подготвени активно да учествуваат во заштитата и унапредувањето на животната средина во која живеат. Повеќето од половината (56%) испитаници се подготвени колективно да се ангажираат во активностите за унапредување на нивната животна сердина. Процентот на ученици кои имаат индиферентан однос изнесува 12.85%.

Кај наште ученици најсилно се развиени вредносната и конативната компонента, а најслабо се развиени когнитивната и афективната компонента. Средно земено, еколошката едуцираност на гимназијалците од Република Македонија изнесува 44.18% од максималната вредност (100%).

Сите испитувани варијабли имаат пониски вредности во споредба со оние добиени од предходното истражување. Најголем пад забележуваме кај вредносната и когнитивната компонента на еколошката едуцираност. Од друга страна пак, незначително пониски вредности добивме во поглед на афективната и конативната компонента. Нивото на општата еколошка едуцираност на гимназијалците е пониско за 7,06% во однос на нивото од 2005 година.

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ЕКОЛОШКИ СОДРЖИНИ ВО УЧЕБНИЦИТЕ ЗА СРЕДНО ОБРАЗОВАНИЕ ВО РЕПУБЛИКА МАКЕДОНИЈА

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Извод

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Основата за секојдневната работа во училиштата се учебниците. Оттаму, квалитетот на еколошкото образование во значителна мера зависи од нивниот квалитет и другите дидактички материјали. Некои истражувања покажуваат дека улогата на учебниците е поголема дури и од онаа на наставниците.

Главната цел на истражувањето е да се определи квалитетот и квантитетот на еколошките содржини во учебниците за средните училишта во Република Македонија. Беа поставени следниве задачи: да се детерминираат еколошките содржини во учебниците по наставни предмети (i), класови (ii) и по аспекти од животната средина кои тие третираат (iii). Содржините во учебниците беа обработени со помош на метадата анализа на содржина. Беа анализирани скоро сите учебници за сите наставни предмети и класови од средното гимназиско образование во Република Македонија.

Не постои рамномерна дистрибуција на еколошките теми по предмети и класови. Најбогати со еколошки содржини се учебниците по биологија. Не постои хоризонтална и вертикална повзаност, исто така и дисхармонија во презентирањето на ширината на некои еколошки теми.

Поради недостиг од национални насоки и институционална кординација, не сме во можност да направиме квалитетен чекор. Со цел да придонесеме кон образованието ”about”, “in” и “for” животната средина потребен е холистички пристап.

Клучни зборови: еколошко образование, еколошки содржини, учебници, средно образование, Република Македонија.

Abstract

Srbinovski, M. (2013). Ecological Issues in the Secondary School Textbooks in the Republic of Macedonia. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

The bases for everyday work in schools are textbooks. So, the quality of environmental education will be significantly dependent on the quality of the schoolbooks and other didactic materials. Some investigations showed that the role of the school textbook is bigger than the teachers‘ one.

The main task of the examination is to determine quality and quantity of the environmental issues in didactic materials for secondary schools in Republic of Macedonia. We placed the following sub-tasks: to determine environmental issues in the didactic materials by subjects (i), by classes (ii), and by aspects of the environment they treat. The contents taking place in textbooks were subjected to content analysis. We analyzed almost all of the existing student‘s books for all subjects and grades from the secondary - gymnasium level in the Republic of Macedonia.

There is no equal distribution of the environmental issues by subjects and classes. The richest textbooks with environmental issues are biology ones. There is no vertical and horizontal linkage, as well as the disharmony in presenting the width of some environmental problems and issues.

Because of the lack of national guidelines and institutional coordination we are not able to make a qualitative leap, and we also need to seek a holistic approach to contribute to education about, in and for the environment.

Key words: environmental education, environmental issues, textbooks, secondary schools, Republic of Macedonia.

Вовед

Учебникот е неизоставно текстуално, наставно средство, основен извор на знаење наменет за учениците (Вилотијевиќ, 1999). Развојот на егзактната проблематизација на современиот учебник од една страна укажува на евидентната сложеност на проблематиката на современиот учебник, и од друга страна на неминовноста во методолошката преориентација од монодисциплинарна кон мултидисциплинарна основа и во елаборација и евалуација на учебникот (Продановиќ 1982 во: Србиновски 2003d).

Главна цел на реформите во образованието е осовременување на наставниот процес. Тоа подразбира, меѓу другото и осовременување на традиционално цврстата позиција на учебникот и другиот дидактички материјал. Дидактичкото оформување на современиот учебник се базира на интегралната современа дидактичка теорија. Ваквиот учебник треба да овозможи т.н. оперативно знаење и способност за самообразование.

Учебникот мораме и понатаму да го разгледуваме во согласност со промените кои настануваат од една страна во општеството... а од друга страна и во ученикот (субјектот), кој под влијание на секојдневните промени и дејствувањата од непосредната околина и самиот претставува изразито променлива варијабла (Erceg 1982).

За нас беше значајно да утврдиме колку денешните учебници придонесуваат на полето на еколошкото образование и воспитание. Истото беше извршено врз база на квалитативната и квантитативната проценка на еколошките содржини.

Методи

Главната цел на истражувањето е да се определи квалитетот и квантитетот на застапеноста на еколошките содржини во учебниците од средните училишта во Република Македонија. Конкретно, беа анализирани учебници од средното гимназиско образование. Од вака поставената цел, произлегоа следниве задачи на истражувањето: (I) да се детерминираат еколошките содржини во учебниците по наставни предмети, (II) да се утврди нивната застапеност по класови и (III) да се дефинира кои аспекти од животната средина се третираат. Содржините во учебниците беа обработени со помош на методата анализа на содржина.

Во истражувањето беа анализирани 43 учебници од скоро сите наставни предмети и класови од средното гимназиско образование во Република Македонија (Таб. 1).

Таб. 1. Анализирани учебници по наставни години.
Tab. 1. Analyzed textbooks by school years.

Наставна година School year	N	%
I	11	25.58
II	12	27.91
III	9	20.93
IV	11	25.58
Вкупно/Total	43	100.00

Забележуваме дека процентот на анализирани учебници по класови скоро е изедначен и се движи во границите од 20.93% до 27.91%.

Резултати и дискусија

Од вкупно 11 анализирани учебници за прва година, еколошки содржини пронајдовме само во учебниците по биологија и географија. Во следната табела се прикажани еколошките поими и содржини кои се обработуваат во овие учебници.

Еколошки содржини не пронајдовме во учебниците по следните наставни предмети: хе-

Таб. 2. Еколошки поими и содржини во учебниците за прва година.
Tab. 2. Environmental terms and contents into the textbooks for first school year.

Наставен предмет **Subject**	**Поими/Содржини** **Terms/Contents**
Биологија Biology	- екологијата како дисциплина; единство на природата; Земјата како отворен систем; животна средина; општи услови за живот; нивоа на еколошка интеграција; еколошка ниша; еколошки фактори ; еколошка валенца; ограничувачки фактори; животна средина; односи во екосистемот; антропогени фактори; нивоа на исхрана во екосистемите; синџири на исхрана; био-геохемиски циклуси; кисели дождови; ефект на стаклена градина; уништување на шумите; природни ресурси ; рециклирање на отпадоците.
Географија Geography	- еколошки фактори; користење на електричната енергија и обновливи извори на енергија.

мија, француски јазик, информатика, физика, англиски јазик, спорт и спортски активности, македонски јазик и литература, математика и историја,

Еколошки содржини пронајдовме во учебниците по следниве предмети за втора наставна година: географија, биологија, физика, хемија, социологија, англиски јазик, германски јазик (Таб. 3).

Во рамките на наставниот предмет Спорт и спортски активности се предвидени еколошки активности при престој во планина без нивно конкретизирање и детерминирање.

Не пронајдовме еколошки содржини во учебниците по следниве предмети: Ликовна уметност, Математика, Историја, Македонски јазик и литература.

Во следната табела се прикажани учебниците за трета наставна година во кои пронајдовме еколошки содржини.

Еколошки содржини не пронајдовме во учебниците по Македонски јазик и литература, Историја и Латински јазик за трета наставна година.

Во истражувањето анализиравме вкупно 11 учебници за четврта наставна година од средното гимназиско образование. Од аспект на застапеност на еколошките содржини би ги издвоиле следниве наставни предмети: биологија, физика и филозофија (Таб. 5). Кога сме кај биологија, сакаме да истакнеме дека содржините од овој наставен предмет се во основа повторување на оние од предходните години, со одредени измени и дополнувања. Оттаму, еколошките содржини во голема мера се исти со оние од прва наставна година.

Во учебниците по следниве наставни педмети не пронајдовме еколошки содржини: македонски јазик и литература, математика, логика, менаџмент, алгебра, математичка анализа, програмски јазици и економија.

Слични резултати за застапеноста на еколошките содржини, во одреден поглед, добиле и Abazi et al. (2008), Srbinovski & Palmer (2008), Србиновски (2002/03, 2003a, 2003b, 2003c, 2005, 2012), Srbinovski et al. (2007, 2009, 2010, 2012) итн.

Заклучоци

Од вкупно 43 анализирани учебници, еколошки содржини/елементи пронајдовме во 18 учебници или 41.86%. Не постои рамномерна дистрибуција на еколошките теми по предмети и класови, ниту хоризонтална и вертикална повзаност, како и дисхармонија во презентирањето на ширината на некои еколошки проблеми и теми.

Најголем број еколошки осмислени учебници има во втора (16.3%) и трета (13,25%) нас-

Таб. 3. Еколошки поими и содржини во учебниците за втора година.
Tab. 3. Environmental terms and contents into the textbooks for second year.

Наставен предмет **Subject**	**Поими/Содржини** **Terms/Contents**
Биологија Biology	- фотосинтезата и еколошките фактори; реакција на дразбите од животната средина.
Географија Geography	- загадување на воздухот (компоненти); сообраќај; последици врз здравјето; мерки на заштита; загадувањето на водите и мерки за заштита; загадување и заштита на почвата; рационално користење и заштита на растителниот и животинскиот свет; намалување на шумскиот фонд; значењето на пошумувањето ; заштита на шумите.
Физика Physics	- заштита од индустриска чад; енергетската криза; пораст на човековата популација и последиците од тоа; производство на енергија од фосилни горива; нуклеарната енергија и животната средина; алтернативни извори на енергија.
Хемија Chemistry	-значењето на фотосинтезата за живиот свет; ефект на стаклена градина; озонски слој и озонски дупки; мерки за заштита.
Социологија Sociology	демографска структура; развој на техниката и технологијата; експлоатација на природни ресурси; пренаселеност; човечка негрижа; нарушување на еколошките системи; хумана екологија; подигање на еколошката свест; загрозени видови; животна средина (природна и социјална); урбан живот; општествена организација итн.
Англиски јазик English	употреба на велосипед; сообраќајот и животната средина; ефектите од загадувањето врз климата и здравјето; озон; начини за подобрување на животната средина; преземи акција; контрола на туристичко подрачје.
Германски јазик German	шума; пожар; уништување; жив свет.

Таб. 4. Еколошки поими и содржини во учебниците за трета година.
Tab. 4. Environmental terms and contents into the textbooks for third school year.

Наставен предмет **Subject**	**Поими/ содржини** **Terms/contents**
Биологија Biology	-ефектот н загадувањето на воздухот врз здравјето; ефектот на бучавата.
Физика Physics	- дејството на бучавата врз човековиот организам и заштита на човековата околина од бучава; ултравиолетно зрачење; озон; "чиста енергија"; нуклеарен отпад; апсорбирана доза на зрачење и нејзино биолошко дејство; критериуми за заштита од изворите на јонизирачкото зрачење; гранични вредности на дозволени дози; доза на оправдан ризик; фон; организирање акција за собирање на пластичен отпад; ефектот на полимерите врз животната средина; енергетски ефикасна градба;
Хемија Chemistry	-предностите на земниот гас од еколошка гледна точка.
Педагогија Pedagogy	- техника и технологија; производство; односот кон природата; социјална средина и конфликти; катаклизма; екологија на социјалните односи; глобализација; еколошка педагогија; еколошко воспитание; дидактички концепти; еколошка свест и култура; еколошко знаење; насоки на однесување на човекот кон природата; патишта на реализација на еколошкото воспитание; екологија- основни еколошки поими; однесување; еколошко воспитание; еколошка свест; училишна средина; проекти; информациско преоптоварување и загаденост; кампови; национални паркови; работилници; вонинстуционално образование; еколошки здруженија; грижа за средината; озонска заштита; разубавување на општината; заштита на реките и езерата; исчезнување на животинските видови; велосипедот и автомобилот; хартија; загадување; екопроизводи; штедење вода за пиење; штедење електрична енергија и заштита од пожари.
Математика Mathematics	- веројатност од можна еколошка катастрофа од нуклеарен инцидент (нуклеарни катастрофи); последици врз луѓето и човештвото.
Германски јазик German	отпад; канти; јаглен; исцрпување; мочуриште; дрвја; трева; ливада.

Таб. 5. Еколошки поими и содржини во учебниците за четврта наставна година.
Tab. 5. Environmental terms and contents into the textbooks for the forth school year.

Наставен предмет **Subject**	**Поими/Содржини** **Terms/contents**
Биологија Biology	- фотосинтеза (значење); организација на Земјата; општи услови за живот; нивоа на еколошка интеграција; еколошки фактори (абиотички; биотички и антропогени); демографски карактеристики; разградување на дивите екосистеми; уништување на шумите; загадување на светскиот океан; засолување и ерозија на почвата; загрозување на атмосферта; климатски промени; карактеристики на екосистемите; биогеохемиски циклуси; кисели дождови; природни ресурси.
Филозофија Philosophy	судир со природата- нерационално користење на ресурсите; загадување; енергија; демографски прираст; сечење на шумите; сообраќај; ѓубре; пластика; нуклеарна енергија; генетски модифицирана храна; биодиверзитет; последици од загадувањето врз здравјето (психички растројства); свест; одговорност; (одговорно) однесување; етика на здравјето; етика на исхрана; етика на движење и спортување; етика на зависности; етика на заштита на животните; етика на дефектологија; етика на староста; етика на науката; бучава; генетски инжењеринг; клонирање; емпатија (чувствување); разбирање; загриженост и грижа; етика на грижа; екосфера (биосфера); хумана екологија; еколошка философија или екософија; норми на екоетика итн.
Физика Physics	животна средина; природна сфера (екосфера; геосфера); техносфера; биосфера; демографски прираст; индустриско и земјоделско производство; прекумерно користење на ресурси; деградација; рамнотежа во биосферата; сообраќај; загадување на животната средина; исчезнување на видовите; биодиверзитет; меѓузависности меѓу средината и живиот свет; отпадни материи; улога на физиката во екологијата (барање алтернативни извори на енергија; рационално користење на природните ресурси и енергијата; штетно зрачење и последици; заштита; јаглероден диоксид и други полутанти; примена на физичките законитости во екологијата (дифузија); радиоактивен отпад; свест; загадувачи; зрачење од ТВ; компјутерите; мобилни телефони; глобални климатски промени; аеросоли; кисели дождови; космолошки влијанија врз климата; стаклени гасови; меѓународна иницијатива; ефект на стаклена градина; озонска обвивка и последици од нејзино уништување; бучава; јонизирачко зрачење; радиоактивност; физички мерни методи и уреди во екологијата.

тавна година, а најмал во прва (4.65%) и четврта наставна година (6,98%).

Еколошките содржини се најзастапени во учебниците по природните науки. Најбогати со еколошки содржини се учебниците по биологија во прва и четврта година, како и учебниците по физика во четврта, трета и втора наставна година. Потоа следуваат учебниците по географија, педагогија, социологија и филозофија. Од природни науки, најмалку еколошки содржини пронајдовме во учебниците по хемија. Иако во мала количина, еколошки елементи пронајдовме и во учебниците по англиски и германски јазик.

Од аспект на сегментите на животната средина, доминираат содржини за природната животна средина, организацијата на живата материја, заемната поврзаност, влијанието на човекот, мерките на заштита итн. Самиот факт што животната средина се третира и во учебниците од групата општествени предмети (филозофија, педагогија и социологија), резултира со констатацијата дека во нив се проучува и општествениот аспект на животната средина.

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РУДНИЧКИ ДРЕНАЖИ И ПОСТАПКИ ЗА НИВНО ТРЕТИРАЊЕ

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Апстракт

Голомеова, М., Зенделска, А., Крстев, Б., Голомеов, Б. и Крстев А. (2013). Руднички дренажи и постапки за нивно третирање. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 28, Скопје.

Водите чие протекување е условено од рудниците со подземна експлоатација и површинските копови и содржат високи концентрации на растворени метали се наречени руднички дренажи. Рудничките дренажи според нивната алкалност и киселост може да се класифицираат во неколку основни типови. Киселите дренажи се јавуваат онаму каде што има карпест материјал богат со сулфидни, а сиромашен со карбонатни минерали, додека алкални услови на водите се создаваат од карпести материјали богати со алкалии и покрај значајните концентрации на сулфиди.

Рудничките дренажи се опасни бидејќи полутантите кои ги има во нив не се распаѓаат во медиумите на животната средина. Под одредени услови металите може да се концентрираат во животната средина, а под други може да се диспергираат.

Третманот на рудничките дренажи може да биде базиран на две технологии т.е. технологии за активен третман и технологии за пасивен третман. Кај активниот третман се користи алкални хемикалии за неутрализирање на киселата загадена вода. Овој третман е скап во поглед на хемикалиите, изградбата и одржувањето на постројката. Кај пасивниот третман се применуваат природни хемиски и биолошки реакции за третирање на рудничка дренажа и бара низок степен на одржување.

Во трудот се опишани постапки за третирање на руднички дренажи.

Клучни зборови: руднички дренажи, тешки метали, пасивен третман, активен третман

Abstract

Golomeova, M., Zendelska, A., Krstev, B., Golomeov, B. &, Krstev, A. (2013). Mine drainage treatment. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

Water flowing from underground and surface mines and containing high concentrations of dissolved metals is called mine drainage. Mine drainage can be categorized into several basic types by their alkalinity or acidity. Sulfide rich and carbonate poor materials are expected to produce acidic drainage, and alkaline rich materials, even with significant sulfide concentrations, often produce net alkaline water.

Mine drainages are dangerous because pollutants may decompose in the environment. In certain conditions metals can be concentrated in the environment, and in other conditions they can be dispersed.

Two methods can treat mine drainage to eliminate or reduce contamination by acidity and heavy metals. The active treatment method uses alkaline chemicals to neutralize acid-polluted water. However, the chemicals are expensive and the treatment facility is expensive to be construct and operated with. The passive treatment method uses a treatment system that employs naturally occurring chemical and biological reactions to treat mine drainage with little maintenance.

In this paper mine drainage treatments are presented.

Key words: mine drainage, heavy metals, passive treatment, active treatment

Вовед

Рудничката дренажа претставува вода со зголемена концентрација на метали која се формира како резултат на хемиска реакција помеѓу водата и карпите носители на минерали кои во својот состав содржат сулфур.

Рудничката дренажа, која најчесто е кисела, доаѓа од области каде што постојат или постоеле рударски активности или пак од карпести области богати со пирит (FeS_2). Како резултат на реакцијата помеѓу пиритот, водата и воздухот се добива сулфурна киселина и растворено железо. Ова железо, целосно или делумно, може да се исталожи и да формира црвени, портокалови или жолти седименти на дното од дренажните текови.

Киселата дренажа дополнително ги раствора тешките метали како што се: бакар, олово, цинк, жива, во подземните или површинските води.

Според Skousen and Ziemkiewicz рудничките дренажи може да се класифицираат во неколку основни типови според нивната алкалност и киселост:

- Тип 1 - Руднички дренажи со слаба или без алкалност, pH < 4,5, содржат високи концентрации на Fe, Al, Mn и други метали, киселост и кислород. Наречени се "кисели руднички дренажи" (Acid Mine Drainage - AMD). Во овој тип спаѓаат и водите со pH < 6,0 и содржина на нето киселост (киселоста е поголема од алкалноста);
- Тип 2 - Руднички дренажи со високи концентрации на вкупно растворени цврсти честички, со високи содржини на феро железо (Fe^{2+}) и Mn, без или со ниска содржина на кислород и pH > 6,0. После оксидацијата, вредноста на pH потенцијалот на овие води значително опаѓа и преминуваат во кисели руднички дренажи од Тип 1;
- Тип 3 – Алкални руднички дренажи кои имаат средни до високи концентрации на вкупно растворени цврсти честички, содржината на феро железо (Fe^{2+}) и Mn е ниска до средна, без или со ниска содржина на кислород, pH > 6,0 и алкалноста е повисока од киселоста. После оксидацијата, генерираната киселина се неутрализира од веќе присутната алкалност во водата.
- Тип 4 – Неутрализирани кисели рудници дренажи со pH > 6,0 и високи концентрации на вкупно суспендирани цврсти честички. Таложењето на металните хидроксиди во водата сеуште не е отпочнато. После одредено време на престој во таложникот, честичките се исталожуваат и се формираат води од Тип 5;
- Тип 5 – Неутрализирани кисели рудници дренажи со pH > 6,0 и високи концентрации на вкупно растворени цврсти честички. Откако повеќето метални хидроксиди ќе преципитираат во таложникот, главни катјони кои што остануваат во водата со високи концентрации вообичаено се растворени Ca и Mg. Растворените окси-анјони како што се бикарбонатите и сулфатите исто така остануваат во растворот. Доколку алкалноста или кислородот недостасуваат во процесот на неутрализација, водата нема да го достигне Типот 5;
- Инертни или неутрални води се појавуваат кај рудниците со минорни содржини на сулфиди и ниски до средни количини на карбонати. Вообичаено имаат неутрална вредност на pH потенцијалот, ниска специфична спроводливост (<100 uS/mm), а киселоста и алкалноста се речиси во рамнотежа.

Со мешање на наведените различни типови на води се образуваат преодни типови на води, а одредувањето на формираниот тип е со адекватно земање на примероци и анализа на pH вредноста, состојбата со кислородот и концентрацијата на металите и интензитетот на киселоста.

Комплексот на елементи во рудничката дренажа предизвикува различни ефекти на водениот свет. Вкупниот ефект зависи од концентрацијата на растворените метали, вкупната киселост, pH и количината на дренажата, како и од протокот, pH и алкалноста или пуферскиот капацитет на приемниот поток. Повисоката концентрација на бикарбонатни и карбонатни јони во приемниот поток и повисокиот пуферски капацитет овозможуваат поголема заштита на водениот свет од штетните влијанија на киселите руднички дренажи (Kimmel, 1983).

Алкалните руднички дренажи со ниска концентрација на метали имаат слабо забележителен ефект врз приемните текови, додека киселите руднички дренажи со зголемена концентрација на метали кои што се испуштаат во изворните текови или слабо пуферските текови може да имаат уништувачки ефект врз водениот свет.

Секундарните ефекти како што се зголемен јаглероден диоксид, намален кислород од оксидацијата на металите, зголемен осмозен притисок со висока концентрација на минерални соли и синергетски ефект на метални јони исто така допринесуваат за токсичноста. (Parsons, 1957). Покрај хемиските ефекти од рудничка-

та дренажа, се јавуваат и физички ефекти како што се: зголемување на заматеноста како резултат на ерозија на почвата, акумулација на јаглинова прашина и загушување на подлогата на потокот од наталожувањето на металните соединенија. (Parsons, 1968).

Технологии за третман на руднички дренажи

Третманот на рудничките дренажи може биде базиран на две основни технологии т.е. технологии за активен третман и технологии за пасивен третман. Основната разлика помеѓу овие технологии е тоа што системите за активен третман (како што кажува и самото име) бараат константно одржување на системот, додека системите за пасивен третман бараат понизок степен на одржување (или воопшто не се одржуваат).

Технологии за активен третман

Активниот третман е најраспространетиот метод за третирање на кисели рудници дренажи, кој вклучува додавање на хемикалии – неутрализирачки агенси (Coulton et al., 2003).

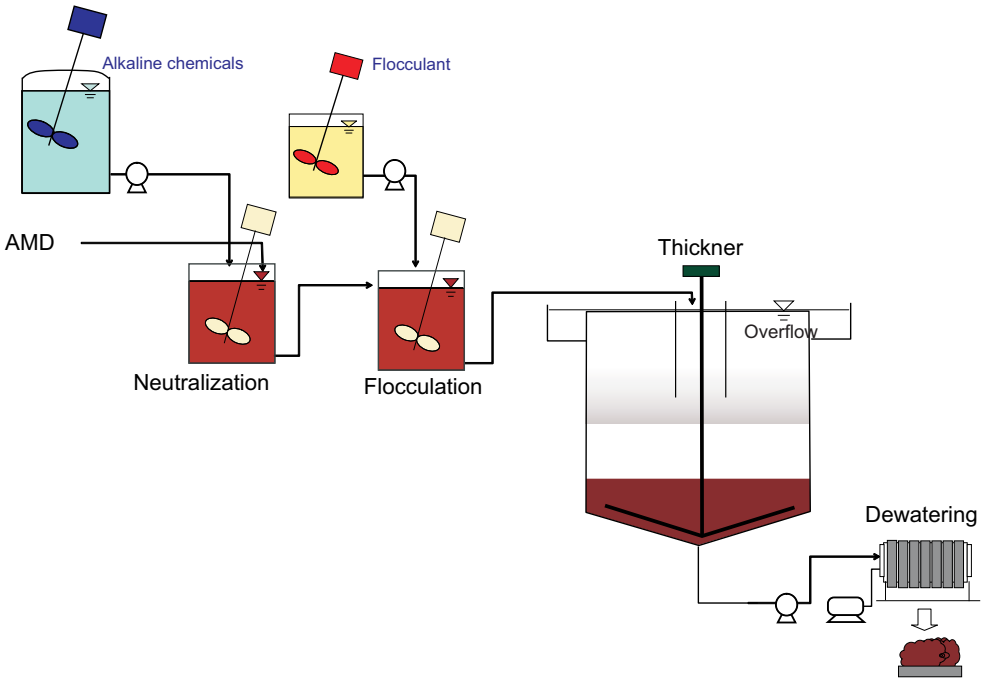
Типичниот активен третман вклучува оксидација на киселата рудничка дренажа, неутрализација (додавање на алкалии) и седиментација (додавање на коагуланти и флокуланти). Оксидацијата е важна бидејќи со неа се внесува кислород во дренажата, кој е неопходен за таложење на металите при ниска pH вредност. Неутрализацијата ја зголемува pH вредноста на киселата дренажа со што металите може да се исталожат од растворот како хидроксиди или карбонати, а со додавањето на флокулантите се формира густа тиња која побрзо се таложи во таложникот. Големата густина на тињата е поволна бидејќи се намалуваат трошоците поврзани со нејзиното одлагање и складирање поради намалениот обем (Coulton et al., 2003).

- Аерација / Оксидација

Аерацијата е процес на воведување на воздух во водата. Оксидацијата се јавува кога кислородот од воздухот реагира со металите во водата. Доколку водата е оксидирана, металите главно ќе преципитираат при пониски pH вредности. Сепак, само околу 10 mg/l O_2 може да се раствора во водата, така што се ограничени оксидационите ефекти на водата која што не е директно изложена на воздух. Поради оваа причина, аерацијата на водата може да ја помага оксидацијата во многу системи за третман на водите. Доколку аерацијата и оксидацијата се вклучени или усовршени во системите за третман на водите, ефикасноста на хемискиот третман би се зголемила, а трошоците би се намалиле.

- Неутрализација

За да се постигне неутрализација на киселоста и зголемување на pH на водата, до ниво каде



Сл. 1. Шема на активен третман
Fig. 1. Scheme of active treatment

Таб. 1. Хемикалии за оксидација, неутрализација и коагулација/флокулација
Tab. 1. Chemicals for oxidation, neutralization and coagulation/flocculation

Назив	Хемиска формула	Забелешки
Оксиданти		
Калциум хипохлорит	$Ca(ClO)_2$	Јак оксидант
Натриум хипохлорит	NaClO	Исто е јак оксидант
Калциум пероксид	CaO_2	Трапзен, неутрализатор на киселоста
Водороден пероксид	H_2O_2	Јак оксидант
Калиум перманганат	$KMnO_4$	Многу ефикасен, општо употребуван
Неутрализатори на киселоста		
Варовник (калциум карбонат) Варовнички канали	$CaCO_3$	Се користат кај безкислородните варовнички дренажи и кај отворените варовнички канали.
Хидратна вар (гасена вар) Вар	$Ca(OH)_2$	Рентабилен реагенс, но потребно е мешање.
Негасена вар (Калциум оксид) Валутоци од негасена вар	CaO	Многу реактивен, потребна мерна опрема.
Натриум карбонат Натриумова сол- брикети	Na_2CO_3	Систем за оддалечени локации, но е скап.
Натриум хидроксид Каустична сода	NaOH	Многу растоврлива, може да биде во цврста и течна форма. Поефтина е во течна форма.
Амонијак	NH_3 или NH_4OH	Многу реактивен и растворлив.
Летечка пепел	$CaCO_3$, $Ca(OH)_2$	Вредноста на неутрализацијата варира со секој производ.
Коауланти/Флокуланти		
Алуминиум сулфат	$Al_2(SO_4)_3$	Кисела материја, формира $Al(OH)_3$.
Феро сулфат	$FeSO_4$	Кисела материја, обично побавно реактивна во однос на алуминиум сулфат.
Фери сулфат	$Fe_2(SO_4)_3$	Фери продуктите реагираат побрзо отколку феро продуктите.
Натриум алуминат	$NaAlO_2$	Алкален коагулант.

(извор: Skousen et al., 1998)

што растворените метали во водата ќе образуваат нерастворливи метални хидроксиди и ќе преципитираат од водата потребно е додавање на доволно алкалност.

Најчесто користени неутрализатори за третман на киселите руднички дренажи се прикажани во Табела 1. Секоја хемикалија има одредени карактеристики кои ја прават повеќе или помалку соодветна за одредена ситуација.

- Флокуланти / коагуланти

Коагулантите и флокулантите се користат за зголемувањена ефикасноста на таложење на цврстите честички. Овие материјали обично се користат во ситуации кога соединенијата на металот бараат специјализиран систем за третман, или пак онаму каде што аерацијата и времето на престој во таложниците се недоволни за комплетна преципитација на металот. Коагулантите ги намалуваат нето електричните одбивни сили на површината на честичките, промовирајќи ја консолидацијата на малите честички во поголеми честички. Флокулацијата ги агрегира или комбинира честичките со премостување на просторот помеѓу честичките со хемикалии. Премостувањето се јавува кога сегменти од ланецот на полимери ги апсорбираат суспендираните честички, формирајќи поголеми честички.

- Технологии за пасивен третман

Моделирањето на пасивните системи е засновано според природните мочуришта и други природни процеси, применувајќи соодветна промена за да се исполнат специфичните цели на третманот.

Концептот на пасивниот третман ги користи предностите на природно настанатите хемиски и биолошки процеси за пречистување на рудничките води и овозможува реакциите за третирање да се извршуваат на контролирано место во сис-

темот за третирање, а не кај приемот на водата.

Основните пасивни технологии се поделени на: конструирани мочуришта (аеробни и анаеробни), системи со вертикален проток (системи за производство на сукцесивна алкалност и системи за редуцирање и производство на алкалност), безкислородни варовнички дренажи, варовнички базени и отворени варовнички канали.

- Конструирани мочуришта

Начинот на кој што се конструирани мочуриштата влијае на начинот на третман на водата. Доминираат два вида на конструкција: 1) "аеробни" мочуришта кои што содржат Typha (барски трски) и друга мочуришна вегетација засадена во плитките (<30cm), релативно непропустливи седименти кои што опфаќаат почви, глини или рудничка јаловина, и 2) "анаеробни" мочуришта кои што содржат Typha (барски трски) и друга мочуришна вегетација засадена во длабоките (>30cm), порозни седименти кои што опфаќаат почви, тресет, компост во кој што имало печурки, дрвени струготини, слама, ѓубриво, сено или други органски смеси, над подлога или измешани со варовникот.

Аеробните мочуришта се ограничени по однос на типовите на води кои што може ефикасно да ги третираат и се користат за третман на средно кисели или нето алкални води кои содржат зголемени концентрации на Fe. Примарната функција на овие системи е да се овозможи аерација на рудничките води кои течат низ вегетацијата, оксидација на растворено железо и да обезбедат време за задржување, каде што водата се забавува за да преципитираат железните оксиди. Бидејќи преципитацијата на Fe генерира H^+, водата која што излегува од аеробните мочуришта може да има пониска pH отколку водата што влегува во мочуриштата, дури и ако концентрациите на Fe се помали.

Модификацијата на дизајнот на аеробните мочуришта им овозможува на анаеробните мочуришта дополнителна алкалност, со цел ефикасен третман на нето киселите води и значителна преципитација на растворените метали. Ова вклучува додавање на подлога од варовник и органска материја која го поттикнува генерирањето на алкалноста како бикарбонат (HCO_3^-). Редукцијата на сулфатите е микробиолошки процес кој се јавува во безкислородни услови, кога се присутни сулфати и биоразградливи организми. Сулфато-редуцирачките бактерии го користат кислоро-

Сл. 2. Шематски дијаграми на системите за пасивен третман
Fig. 2. Schematic diagrams of passive treatment system

дот кој навлегол во безкислородната околина како компонента на сулфатот (SO_4^{2-}) за метаболичките процеси на биоразградливите огранизми, го трансформираат сулфурот или до гасна фаза (H_2S) или до сулфид во цврста фаза.

Анаеробните мочуришта се во состојба да ги отстранат металите кои што се растворливи во киселина (посебно Fe и Al), како и да генерираат алкалност. Нивната ефикасност е ограничена од бавното мешање на водите од алкалниот супстрат со киселите води близу површината. За овие системи често пати е потребна голема површина и долго време на задржување. Како и кај другите системи за пасивен третман нивната ефикасност за отстранувањето на Mn е ограничена, освен во случај кога се користат големи површини.

- Безкислородни варовнички дренажи

Безкислородните варовнички дренажи претставуваат потрупани ровови исполнети со варовник, конструирани да се спречи контактот на рудничките дренажи со атмосферскиот кислород. На тој начин е оневозможена оксидацијата на металите и образувањето на варовнички наслаги. Варовникот се раствора под влијание на рудничките води, со што генерира бикарбонатна алкалност.

Безкислородните варовнички дренажи се покриени со глина или збиени почви и PVC за да се заштитат од контакт со кислородот. PVC мембраната најчесто се поставува над варовникот за да го ограничи пристапот на кислородот и аерираната вода.. Целта на долниот дел на безкислородните варовнички дренажи е да обезбеди алкалитет и на тој начин киселата вода да ја трансформира во алкална. Задржувајќи го јаглеродниот диоксид во дренажите се подобрува растворливоста на варовникот и образувањето на алкалност. За да биде варовникот секогаш заситен со вода, истекот од безкислородните варовнички дренажи треба да биде поставен малку над горниот дел од варовникот, со што се избегнува пристап на воздух во системот. Пред да биде испуштен во природните водотеци, ефлуентот се задржува во таложник, за да се овозможи прилагодување на pH и преципитација на металите.

- Отворени варовнички канали

Кај овој тип на системи се прави канал од варовнички камен во кој се собира контаминираната вода од рудничките дренажи. Растворот од варовнички камен ја зголемува алкалноста на водата и го зголемува pH потенцијалот. Наслагите од варовнички камен со Fe $(CO)_3$ и Fe $(OH)_3$ образувани од неутрализацијата го намалуваат образувањето на алкалност, поради што е потребна поголема количина на варовнички камен. Големата брзина на протокот и образувањето на вртлози го зголемуваат ефектот намалувајќи ги наслагите од варовнички камен.

- Системи со вертикален проток

Системите за пасивен третман со вертикален проток ги комбинираат механизмите за третман на анаеробните мочуришта и безкислородните варовнички дренажи.

Основните елементи на овие системи се слични со анаеробните мочуришта, но овде е додаден и дренажен систем за да се обезбеди директен контакт на киселите руднички дренажи со супстратот кој произведува алкалност. Трите главни елементи на системот се дренажниот систем, варовничкиот слој и органскиот слој. Системот е конструиран во рамките на водопропусен басен, а во дренажниот систем е поставен хидрант за контрола на нивото на водата, за да се обезбеди поплавеност со вода на органскиот и варовничкиот слој. При текот на киселите руднички дренажи низ органскиот слој, се извршуваат следените основни функции: растворениот кислород се отстранува од страна на аеробните бактерии кои што ги користат биоразградливите органски соединенија како извори на енергија, а сулфато-редуцирачките бактерии генерираат алкалност и ги издвојуваат металите во облик на сулфиди. Органскиот слој кој е способен да ги намали концентрациите на DO до < 1 mg/l е од суштинско значење за заштита на варовникот од “армирање”, како и за редукција на сулфатите. Во варовничкиот слој, киселината го раствара $CaCO_3$ и безкислородните води движејќи се надолу низ дренажниот систем произведуваат дополнителна алкалност. Ефлуентот се испушта во таложник каде што се врши неутрализација на киселината и преципитација на металите, пред конечното испуштање во реципиентот. За руднички дренажи кои содржат значителни концентрации на Fe^{3+} и/или седименти, пред системите со вертикален проток треба да има други таложници или аеробни мочуришта, за да се ограничи акумулацијата на цврстите честички на површината на органскиот слој. За третман на дренажи со висока киселост, може да се постават неколку последователни прегради со вертикален проток, раздвоени со таложници.

Заклучок

Најдобриот избор помеѓу дадените опции зависи од техничкиот и од економскиот фактор. Техничкиот фактор го вклучува степенот на кисе-

лост, количината на проток, специфичните видови и концентрацијата на метали во водата, стапката и степенот на потребниот хемиски третман и посакуваниот финален квалитет на водата. Економскиот фактор ги вклучува цената на реагенсите, работната рака, механизацијата и опремата, потребниот период (години) за кој ќе биде неопходен третманот, отстранување и одложување на отпадниот талог, каматната стапка и факторите на ризик.

За да изврши селекција на систем за активен третман, операторот мора да го одреди протокот на отпадните води, pH, вкупно суспендираните цврсти честички (TSS), киселост/ алкалност во mg/l како $CaCO_3$, концентрациите на тешките метали, протокот на реципиентот, достапноста на електрична енергија, растојанието од местото на додавање на хемикалиите до местото каде што водата влегува во таложникот, како и волуменот и димензиите на таложникот. После евалуацијата на овие променливи за дадено време, операторот може да ги земе во предвид економските параметри на различните хемикалии и алтернативните системи за активен третман.

При дизајнирањето на пасивниот третман потребно е да се окарактеризираат водите кои ќе се третираат, односно треба да се направи мерење на протокот и квалитетот на водата во текот на подолг период, за да се утврди појавата на сезонски разлики. Примената на системи со пасивен третман го елиминира користењето на дополнителни хемикалии, ја намалува потрошувачката на енергија и потребата за одржување, што ги прави овие системи да имаат поголема предност во однос на активните системи.

Почетните трошоци кај пасивниот третман може да бидат повисоки отколку кај активниот, но бидејќи користат процеси кои не се оперативно интензивни, вкупните трошоците за нив се помали (Fripp et al., 2000). Активниот третман е поскап процес како резултат на трошоците за опрема, хемикалиите кои се применуваат и учеството на работната сила (Skousen et al. 1998). Освен тоа овој процес е долгорочен и претставува трајна обврска.

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НУТРИЕНТЕН РЕЖИМ ВО ВОДАТА ОД АКУМУЛАЦИЈАТА „СТРЕЖЕВО“

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Извод

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Акумулацијата „Стрежево“, сместена во југозападниот дел на Република Македонија, формирана во подножјето на Пелистерскиот масив, има повеќенаменска функција и тоа врши обезбедување на доволно количина вода за наводнување на 20200 ha обработлива површина во Пелагонија, водоснбдување на населението и индустријата, производство на електрична енергија итн. За извршување на овие функции, водата од акумулацијата треба да поседува соодветен квалитет. Како важен критериум за квалитет на водата претставува концентрацијата на нутриентите (азот и фосфор), кои претставуваат воедно и показатели за степенот на еутрофикација на акватичните екосистеми.

Целта на овој труд е да се добие целосна слика за нутриентниот режим во водата од акумулацијата „Стрежево“. Во таа насока за време на периодот од август 2009 год. до август 2011 год. извршено е сезонско колекционирање на површинска и длабинска вода (0, 8 и 20 m), на седум мерни места. Користени се стандардни лимнолошки методи. Истражувањата покажаа дека концентрацијата на азотните форми во акумулацијата „Стрежево“ во двегодишниот циклус значајно вариращ како резултат на различните концентрации на влезот во акумулацијата, ефектот на фотосинтетската активност, како и од разложувањето на белковинските материи од растително и животинско потекло. Констатирано е континуирано зголемување на средната просечна концентрација на вкупен фосфор за секоја сезона, како последица на антропогеното влијание. Зголемените количини на вкупен фосфор можат да доведат до влошување на квалитетот на водата во акумулацијата до ниво кое најчесто го загрозува користењето на водата за предвидените намени.

Клучни зборови: Акумулација „Стрежево“, нутриенти, еутрофикација, вкупен фосфор.

Abstract

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The “Strezevo” reservoir is located in the southwest of the Republic of Macedonia and it is formed on the bottom of Pelister massif. It is a multipurpose accumulation which provides water for irrigation 20200 ha arable land of Pelagonija, water supply of population and industry, electric power production etc. The water quality is very important for all these functions. One of the most important criteria for water quality is the nutrient concentration (nitrogen and phosphorus), which are important indicators for eutrophication level in aquatic ecosystems.

The aim of this paper is to provide a complete state of nutrient regime in the water of the Strezevo reservoir. The samples were taken seasonally from surface and profound water (0.8 and 20 m depth) from seven measuring points, during the period from August 2009 to August 2011. Analysis of the nutrient concentration has been performed using standard limnological methods.

The results obtained during these investigations show that nitrogen compounds of the water of the Strezevo reservoir have significant differences. These variables are the results of different concentration in the flow into accumulation, photosynthesis activity effect and decomposing processes of protein matter of animal and plant origin. Total phosphorus concentration has significantly increased. There was a continuous increase of the average total

phosphorus concentration in each season, as a consequence of increased anthropogenic impact. Increased amount of total phosphorus can lead to deterioration of water quality in the reservoir to a level which most threatens the use of water for the anticipated uses.

Key words: Strezevo reservoir, nutrients, eutrophication, total phosphorus.

Вовед

Процесите на еутрофикација на водата во акумулациите, посебно на оние наменети за водоснабдување, долго се центар на интересирњето на голем број на истражувачи на широките простори. Секоја акумулација има одредени специфичности за која се потребни одредени испитувања со што би се добиле подетални информации за состојбата и квалитетот на водата, како би се превземале мерки за предупредување од негативните последици.

Соджината на нутриентите, азотните и фосфорните материи во акумулациите и површинските води, е важен лимитирачки фактор за појава на еутрофикацијата. Основен чекор со цел намалување на емисијата на нутриенти е познавање на нивната количина, извор и дистрибуција, што е условено како од геолошките карактеристики, така и од антропогеното дејствување. Затоа, познавањето на моменталната состојба, како и сезонските варијации во количеството на азотните и фосфорните материи, се основен предуслов за правилно и успешно управување со повеќенаменските акумулации.

Секундарен извор на вода за водоснабдување на градот Битола е акумулацијата Стрежево, формирана на реката Шемница. Изградбата на браната со висина 76 m, започнала во 1978 година, а завршила во 1983 година. Градот почна да користи вода од акумулацијата во 1985 година. Вкупниот волумен на акумулацијата изнесува 119,23 $\cdot 10^6$ m^3 вода, а нејзиниот корисен волумен 108,87 $\cdot 10^6$ m^3. Сливното подрачје на акумулацијата „Стрежево“ изнесува 715 km^2. Тоа опфаќа повеќе водотеци кои по својот тек минуваат низ подрачја со комунални отпадни води, рурални подрачја кои се оптеретени со современи средства за заштита на растенијата. Дел од тие отпадни контаминенти дотекуваат со речната вода во крајната цел – акумулацијата.

Материјали и методи

Колекционирањето и складирањето на материјалот е извршено со стандардни лимнолошки методи (Standards methods for the examination of water and wastewater, 1998). Примероците се земани со Ruttner-црпец за длабинско земање на проби од 2 l со сезонска динамика од седум мерни места од три профили; влив на р. Шемница, централен дел и дел во близина на кула зафат.

Вкупниот фосфор е одредуван како ортофосфат (Strickland & Parsons, 1972), после киселa дигестија со персулфат и третман со амониум молибдат и антимонил-калиум тартарат, пришто се создава комплекс антимон-фосфат-молибдат, кој се редуцира со аскорбинска киселина до син молибденски комплекс чиј интензитет е во функција на количеството на фосфор. Ослободените ортофосфати се отчитуваат спектрофотометриски на 885 nm бранова должина. При тоа е користен спектрофотометар марка Specord, модел S – 10, на фирмата Carl Zeiss Jena.

Вкупниот азот е одредуван со Kjeldahl дигестија (Solarzano, 1969) до амонијак, а потоа како амонијак се одредува спектрофотометриски на 640 nm бранова должина (Strickland & Parsons,1972). Резултатите се отчитувани на спектрофотометар марка Perkin-Elmer, модел

Сл. 1. Акумулација „Стрежево“
Fig. 1. Reservoir “Strezevo”

Colleman. Вкупниот азот всушност претставува збир од редуцирачки форми (органски + амонијачен) и оксидирачки форми (нитритни + нитратни). При тоа органскиот и амонијачниот азот се одредуваат со спомнатата Kjeldahl метода, а нитритниот азот со сулфанил амид и нафтил етилен диамин дихидрохлорид, пришто се добива обоен комплекс чиј интензитет (во зависност од концентрацијата) се отчитува спектрофотометриски на веќе спомнатиот спектрофотометар. Овој нитратен азот прво се редуцира преку Cd-колона до нитритен, а потоа се одредува како нитритна форма.

Резултати и дискусија

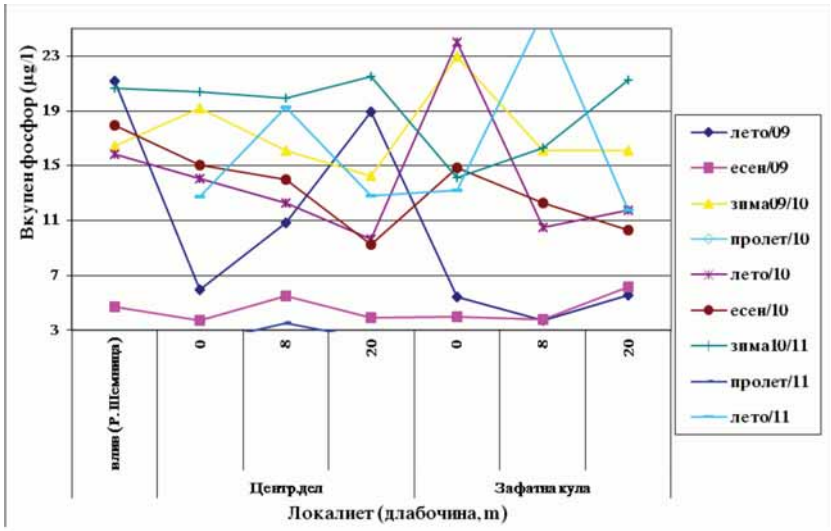
Голем број хемиски елементи ги потпомагаат или потиснуваат, а некои пак и ги менуваат биохемиските реакции било тие да се одвиваат во клетките или во медиумите во кои опстануваат. Еден таков незаменлив хемиски елемент кој често е ограничувачки во одвивањето на примарната продукција на акватичните екосистеми е фосфорот. Зависно од степенот на загадување, фосфатите можат да бидат присутни во значително високи концентрации кои потекнуваат од употребените средства за перење, детергенти или ѓубрива кои се применуваат во земјоделството. Не е ништо невообичаено да притоките кои минуваат низ неколку населби да донесуваат толкаво количество на органски материи собрано од шталските ѓубришта, септичките јами, полските клозети и други извори на загадување од селските домаќинства кои во одредени градежни работи можат да се намалат. Постои и секундарен внес на големи количини на органски материи во акумулациите од спортските риболовци. „За примарните продуценти, фосфорот е достапен во облик на ортофосфати кои се растворливи и кој е важен во контрола на примарната продукција" (Wetzel, 1990).

Содржините на вкупниот фосфор во Стрежевската акумулација покажуваат одредена сезонска динамика. Добиените резултати за содржината на вкупниот фосфор се прикажани на Слика 2. Анализирајќи го графичкиот приказ на содржината на вкупниот фосфор, може да се заклучи дека постојат големи флуктуации во динамиката на вкупниот фосфор во водата од Стрежевската акумулација. Најниската концентрација на вкупен фосфор во текот на целиот истражувачки период, е измерена во пролет 2011 година и изнесува 3,43 µg/l (површинската вода кај зафатна кула). Највисоката концентрација на вкупен фосфор е регистрирана во летниот период 2011 година и изнесува 26,16 µg/l во истиот дел на длабочина од 8 m.

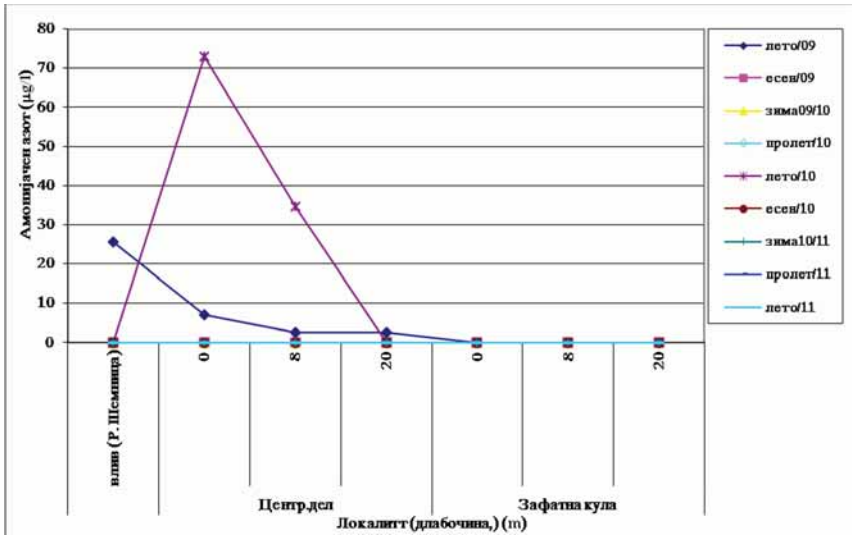
Споредувајќи ги летните концентрации на вкупен фосфор од 2009, 2010 и 2011 година, се констатира дека за разлика од 2009 година кога концентрациите на вкупен фосфор се релативно ниски, има значајно зголемување на истите во 2010 и 2011 година.

Во есенскиот период со нарушувањето на стратификацијата, се зголемуваат концентрациите на фосфорот во горните слоеви на трофогената зона и се намалуваат во слоевите до кои мешањето се извршило.

Споредувајќи ги концентрациите на вкупен фосфор сезонски, може да се констатира дека тие се значително повисоки во зимскиот период, што најверојатно резултира со процесот на миксија, т.е. мешање на водната маса, при што доаѓа до збогатување и на погорните слоеви со нутриенти



Сл. 2. Содржина на вкупен фосфор во водата од акумулацијата „Стрежево" (2009-2011)
Fig. 2. Total phosphorus content in the water of "Strezevo" reservoir (2009-2011)



Сл. 3. Содржина на амонијачен азот во водата од акумулацијата „Стрежево“ (2009-2011)
Fig. 3. Ammonia-nitrogen content in the water of “Strezevo” reservoir (2009-2011)

од подлабоките слоеви на хиполимнионот.

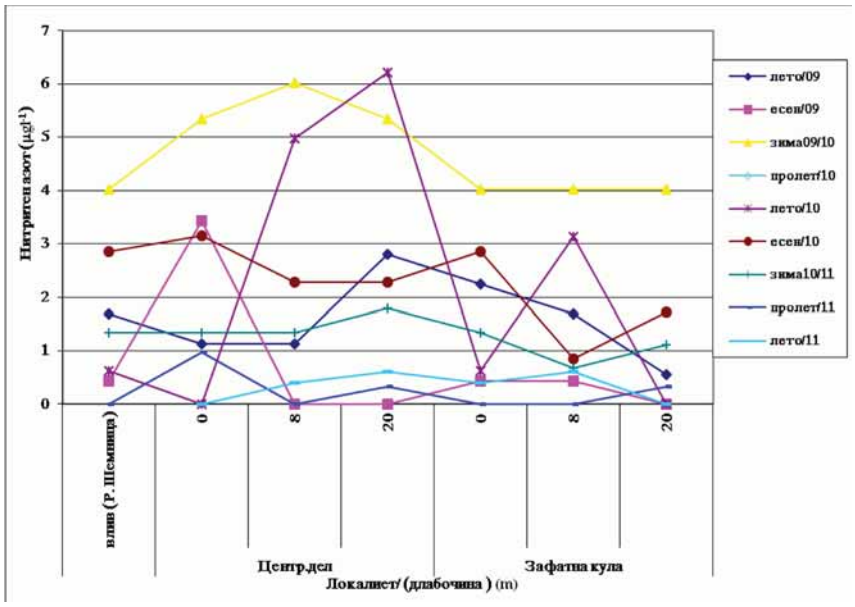
Сите овие вредности укажуваат на фактот дека одејќи од година во година, концентрацијата на вкупен фосфор се зголемува континуирано без оглед на годишното време и сезона, што е резултат на засилено антропогено влијание и нарушување на квалитетот на водата во Стрежевската акумулација.

„Азотот е ограничувачки фактор за растителна продукција после фосфорот, а според Lind (1985), во водата општиот аналитички интерес ги содржи раствореният и партикуларниот азот, кои се во различни редуцирани форми рангирани од обични амино киселини до комплексни протеини, и во живите и во мртвите ткива и продуктите на ткивата; амонијакот кој е најмногу во редуцирана форма и е продукт на органското распаѓање, па нитратите и нитритите кои се оксидирана форма, резултат од нитрификацијата (бактериската оксидација на амонијакот)”. Изворите на азот се многубројни. Во сировата вода неговиот состав е варијабилен во облик на вкупен N, NH_4, NO_3, NO_2 и органски азот. Со разградувањето на органските материи во водниот столб на езерото, се ослободуваат значајни количини на азотни соли. Од сето ова, може да се констатира дека содржините на сите азотни форми ни во еден циклус не биле во доменот во кој би го лимитирале развојот на алгалната биомаса.

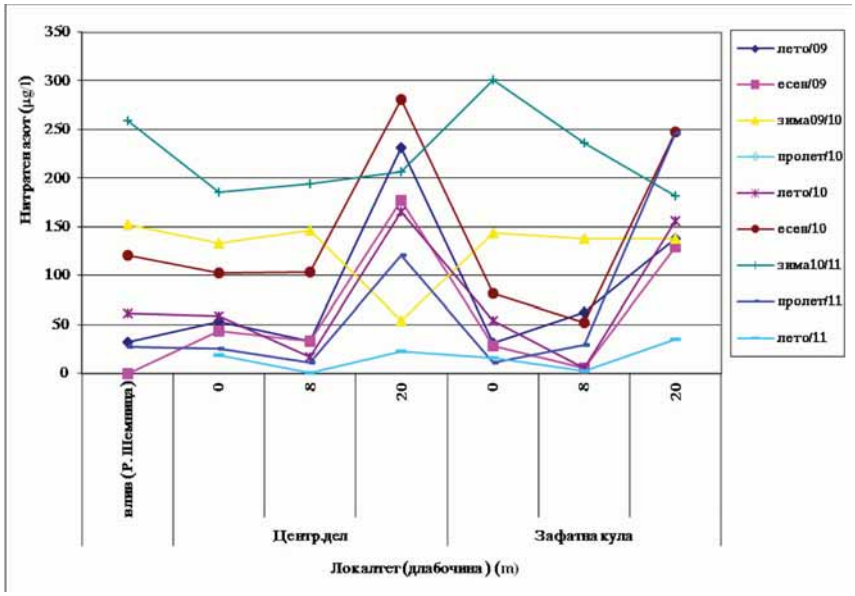
Азотните форми во акумулацијата „Стрежево” значајно вариираат во годишниот циклус како резултат на различните концентрации на влезот во акумулацијата (содржината на речната вода) и ефектот на фотосинтетската активност во акумулацијата. Најголеми концентрации на азотни нутриенти во акватичните средини имаат нитратите и амонијакот, и нивното однесување е важно за „азотниот метаболизам во водата” (Yasushi et al., 1990). И Goldman (1993), истакнува дека во акватичните системи, главните форми на азот достапни за бактериите, фунгите и растителниот свет се амонијакот и нитратот.

Добиените резултати за концентрацијата на амонијачен азот во водата од Стрежевската акумулација во периодот 2009-2011 година се претставени на Слика 3. Од сликата може да се забележи дека амонијачниот азот е констатиран во мал број примероци и тоа само во летниот период во 2009 и 2010 година. Значително голема концентрација е измерена во површинската вода во близина на вливот на река Шемница во акумулацијата (лето 2010 година; 25,54 µg/l). Тоа е разбирливо со оглед на големиот внес на алохтони материи во акумулацијата од краварските фарми што се наоѓаат во непосредна близина на вливот. Но ваквото големо количество на амонијачен азот значително се намалува одејќи кон следниот профил, површинската вода во централниот дел кога количеството на амонијак се редуцира на 7,044 µg/l (во лето 2009 година), за да на 8 m и 20 m се намали на 2,642 µg/l. Меѓутоа, во лето 2010 година се издвојува голем пик во концентрацијата на амонијачен азот (73,09 µg/l) во површинска вода во централниот дел. Сето ова е резултат на минерализацијата на органските материи во летниот период при високи температури како на водата, така и на воздухот.

Како помалку застапени форми на неоргански азотни соединенија, нитритите, како нитритен азот во акумулацијата „Стрежево“ се претставени на Слика 4. Нитрити воопшто не се евидентирани и во голем број примероци во различни сезони. Најголема содржина NO_2 - N е измерена во лето 2010 година (6,222 µg/l на 20 m длабо-



Сл . 4. Содржина на нитритен азот во водата од акумулацијата "Стрежево" (2009-2011)
Fig. 4. Nitrite-nitrogen cocntent in the water of "Strezevo" reservoir (2009-2011)

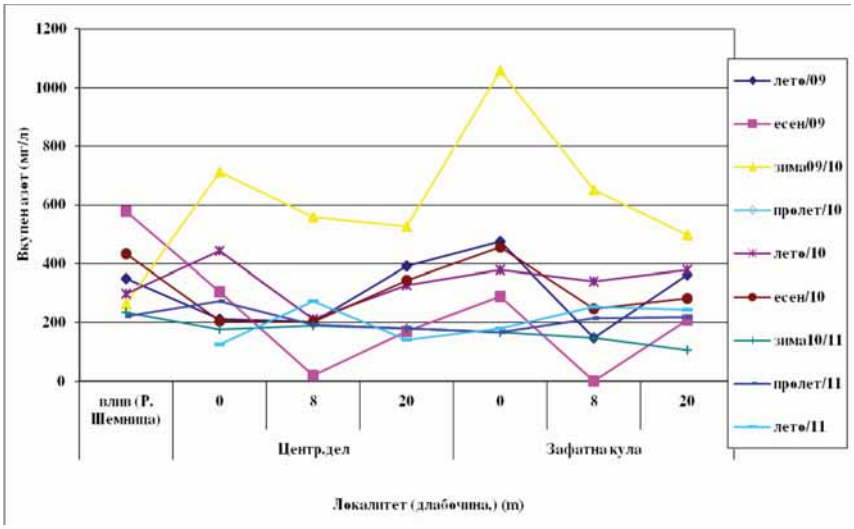


Сл. 5. Содржина на нитратен азот во водата од акумулацијата „Стрежево" (2009-2011)
Fig. 5. Nitrate-nitrogen content in the water of "Strezevo" reservoir (2009-2011)

чина, централен дел). Контрадикторно е тоа што на истата длабочина од 20 m при истите земања на примероци во делот кај зафатната кула, не беше констатиран нитритниот азот. Исто така голем пик се јавува во зима 2009/10 година, кога содржината на нитритите достигна вредност од 6,02 µg/l (8 m длабочина, централен дел).

Нитратите - крајните оксидациони продукти на азотните соединенија, се претставени како примарна форма на неорганski азот. Графичкиот приказ на содржината на нитратен азот е даден на Слика 5.

Концентрациите на нитратниот азот во водата од акумулацијата „Стрежево" се во ранг од 0,58 µg/l (8 m, централен дел, лето 2011 година) до 301,126 µg/l (површинска вода, зафатна кула, зима 2010/11 година). Карактеристично е тоа што во зоната на термоклината се измерени најниските концентрации на нитратен азот (освен зима 2010/11 година со мал број исклучоци). Ова се објаснува со фактот што вредностите за нитратниот азот во трофогениот слој и во термоклината се помали поради неговото искористување од страна на фитопланктонот, како резултат



Сл. 6. Содржина на вкупен азот во водата од акумулацијата „Стрежево“ (2009-2011)
Fig. 6. Total nitrogen content in the water of “Strezevo” reservoir (2009-2011)

на што се и високите кислородни концентрации, а во трофолитичкиот слој е максимумот поради процесите на интензивна минерализација во водата и седиментите.

Вкупниот азот во водата од Стрежевската акумулација е претставен на Слика 6. Најниска вредност за вкупен азот во целиот истражувачки период (19,57 µg/l) е измерена на длабочина од 8 m (есен 2009 година) во централниот дел од акумулацијата (Слика 6).

Највисоката концентрација на вкупен азот во целиот истражувачки период е измерена во зима 2009/10 година, и изнесува 1057,13 µg/l во површинската вода кај зафатната кула. Забележливо повисоки вредности на вкупен азот се измерени во зима 2009/10 година, за разлика од зима 2010/11 година. Пролетните содржини на вкупен азот укажуваат на рамномерно распределување на вкупниот азот низ цел воден столб. Летните концентрации се повисоки во лето 2009 година и лето 2010 година, за разлика од лето 2011 година.

Солите на фосфорот и азотот имаат најважна улога во метаболизмот на организмите во водените средини. Тие претставуваат и главни лимитирачки фактори за примарната продукција. Меѓутоа, големите количини фосфор кои доаѓаат во слатководните екосистеми како последица на антропогеното загадување, доведуваат до „збогатување на езерата со фосфор, а неговото одредување може да послужи во дефинирање на степенот на трофија и еутрофикација“ (Martinović - Vitanović, 1996).

Заклучок

Анализата на параметрите за оценка на нутриентниот режим во водата од акумулацијата „Стрежево“ во двегодишниот период на истражување, укажува на сезонска и просторна динамика на нутриентите азот и фосфор. Евидентна е значајна редукција на вкупниот азот во езерската вода, во однос на влезните количини. Содржината на нитритите е во рамките на дозволените количини пропишани за водите за пиење. Нитратите се јавуваат во поголеми количини, но исто така се далеку под дозволените граници. Присуството на амонијак е констатирано само во летниот период и тоа само на две мерни места. Главно квалитетот на водата во Стрежевската акумулација во периодот август 2009 – август 2011 година, ги задоволува критериумите за бараниот квалитет на водата за повеќенаменските акумулации, со акцент кон тенденција на континуирано зголемување на средната просечна концентрација на вкупен фосфор за секоја сезона. Тоа укажува на зголеменото влијание на антропогениот фактор. Зголемените количини на вкупен фосфор можат да доведат до влошување на квалитетот на водата во акумулацијата до ниво кое најчесто го нарушува користењето на водата за предвидените намени. Затоа неопходно е континуирано следење на квалитетот на водата, како и спроведување на соодветни мерки на заштита на овој акватичен екосистем.

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Summary

The analysis of parameters for assesment the nutrient regime in the water of the reservoir "Strezevo" in the a two-year period of investigation, indicating the seasonal and spatial dynamics of nutrients nitrogen and phosphorus. Considerable reduction of total nitrogen was noticed towards the reservoir in terms of the input quantities. Content of nitrite-nitrogen was in the admissible range of drinking water. Nitrate-nitrogen appeared in a larger amount, but it was under admissible limits. Ammonia-nitrogen content was noticed only in summer period on two measuring points.

Main water quality in Strezevo reservoir in the period August 2009 - August 2011, meets the required quality criteria for multipurpose water reservoirs, with emphasis on the tendency of continuous increase of the average concentration of total phosphorus for every season.This indicates the increasing influence of anthropogenic factor. Increasing amounts of total phosphorus can lead to deterioration of water quality in the reservoir to a level which often disturbs the water use for the planned purposes.

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Ohrid, 12-15 October 2012
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PERIPHYTON IN DIFFERENT MICROHABITATS ON TUFA BARRIER IN NATIONAL PARK PLITVICE LAKES

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Abstract

Gulin, V., Matoničkin Kepčija, R. (2013). Periphyton in different microhabitats on tufa barrier in National Park Plitvice Lakes. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

Tufa, freshwater carbonate deposit, develops under specific physicochemical conditions. In Plitvice Lakes tufa creates barriers between succeeding lakes. On a microscale, tufa formation increases the habitat complexity, supporting heterogeneous periphytic communities. With the aim to test the differences in community composition of periphyton in different microhabitats, we performed *in situ* experiment using artificial substrates (glass slides) between May and November 2010. Four microhabitats on the barrier between last two lakes in the hydro-system differed with respect to current velocity and vertical position. Tufa deposition was more intense on upside microhabitats compared to underside. Ciliates dominated among heterotrophs with the share in abundance between 64% and 76%. Among 133 determined species, 73 were ciliates. Endemic species of heterotrichids *Lagotia dinaridica* was determined. Periphyton on the underside had on the average 16 times lower abundance and 8 times lower taxa number, compared to the upside communities on the same current velocity, probably due to deprived food resources. Microhabitat conditions structured ciliate communities, for instance Peritrichia and Hypotrichia were significantly more abundant in slow current. Our results highlight the heterogeneity of periphyton with tufa deposition possibly even increasing habitat complexity. Sampling designs for periphyton in such habitats should consider possible high within-habitat variability.

Keywords: microhabitats, ciliates, current velocity, artificial substrate

Introduction

Periphyton can be defined as a complex community of organisms developing on a natural or artificial substrate completely or partially exposed to water (Palmer and White 1997). The periphyton layer development begins with bacteria that form a coating consisting of mucopolysaccharides and continues with diatoms followed by protozoa (Battin et al. 2003). Periphyton growth is a complex phenomenon under the influence of many environmental factors and therefore cannot be defined only as a type of succession. Some of the environmental factors that influence periphyton growth are: physical and chemical parameters (water temperature, pH, nutrients, dissolved oxygen, isolation and conductivity), mechanical processes as sloughing, current velocity, uptake and genetic factors (Wimpenny et al. 2000).

Current velocity is considered to be one of the key factors that determine the dynamic of periphyton community and its structure (Saravia et al. 2001). Through most of the boundary layer water current is turbulent with exception of the part closest to the substrate called the laminar layer. Its thickness decreases with higher current velocity which enhances sloughing but also diffusion of food particles and therefore the productivity (Saravia et al. 2001). The positive effect of higher current velocity ends reaching the critical point at 50 cm/s (Horner and Welch 1981) or 60 cm/s according to Horner et al. 1990). Studies that tried to associate biomass with current velocity have had, so far, contradictory results. According to Habdija et al. (2000) biomass decreases significantly with higher current velocity, yet Pitios et al. (2001) indicate the opposite.

Recent studies show a connection between periphyton development and tufa deposition in karst streams (Pitois et all. 2001). Tufa is described as an ambient temperature freshwater carbonate deposit in which biological remains (like macrophyte stands)

may comprise significant parts of deposited frameworks (Pedley 2000). Sites of active tufa deposition provide rough surface, that is suitable for periphyton growth, but tufa also becomes part of the structure of the matrix (Matoničkin Kepčija et al. 2011).

The aim of this study was to test the differences in community composition of periphyton, with a focus on ciliates, in different microhabitats depending on current velocity and vertical position, as well as to analyse the differences in primary production between microhabitats.

Material and Methods

We performed an *in situ* experiment using glass slides 26 x 76 mm (Menzel-Gläser) as artificial substrate. The exposed surface was 15.2 cm^2. Before the experiment was set, each glass slide was carefully cleaned, washed with distilled water, dried, marked and in the end covered with aluminium foil to additionally protect it. Eight slide holders were placed on four microhabitats on tufa barrier. Each slide holder consisted of Plexiglas frame fixed on a brick and was carrying 7 glass slides. Microhabitats differed with respect to current velocity (slow current: 0.13-0.42 m/s and medium current 0.25-0.64 m/s) and vertical position (Gs – upside in slow current; Gm – upside in medium current, Ds – underside in slow current, Dm – underside in medium current).

The artificial substrates were placed on the barrier in January 2010 and were sampled from May to November 2010. Design of the experiment was set in order to collect glass slides exposed approximately 4 to 5 months. In total 58 glass slides were collected and examined in laboratory using 125x, 250x and 400x magnification (Jeneval binocular microscope). For determination of protozoa and micrometazoa, we used determination keys (Kahl 1930–1935, Koste 1978, Foissner et al. 1991, 1992, 1994, 1995, Page 1991). The content of chlorophyll *a* (as mg cm^{-2}) was also analysed according to the ethanol extraction procedure of Nusch (1980). Chlorophyll *a* was used as a measure of primary production.

Hydrological, physical and chemical factors were measured, some *in situ*, and some in the laboratory. Field multi-parameter probe Multi340i (WTW) was used to measure temperature, dissolved oxygen, conductivity and pH. Flow velocity was measured with the flow-velocity meter SWOFFER 3000 (Swoffer Instruments). Alkalinity, total hardness, chemical oxygen demand and nutrient concentrations were determined in the laboratory (according to APHA 1985).

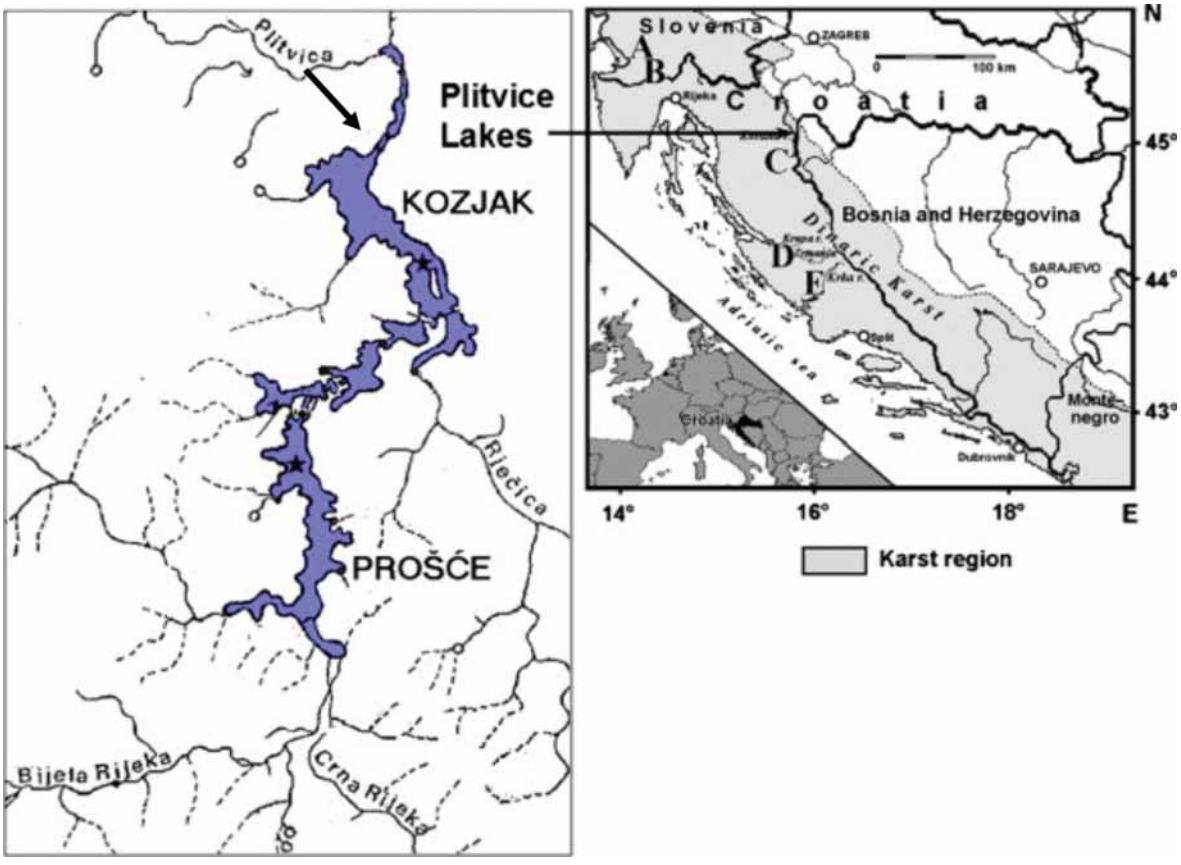

Fig.1. Geographical position of investigated Plitvice Lakes with an arrow pointing to experimental site, barrier between lakes Novakovića brod and Kaluđerovac

Tab. 1. Environmental parameters of water during sampling in 2010

Parameter	May	June	October	November
Temperature (°C)	16.4	24.0	16.2	10.1
Dissolved Oxygen (mgO_2/L)	8.3	8.2	11.0	17.1
Oxygen saturation (%)	86	101	119	152
pH	8.10	8.20	8.33	8.35
Conductivity (µS/cm)	383	392	388	381
Alkalinity (mg $CaCO_3/L$)	210.0	202.5	220.0	201.0
Total hardness (mg $CaCO_3/L$)	215.4	227.8	218.9	213.6
COD_{KMnO4} (mg O_2/L)	1.58	1.46	0.50	0.39
Orthophosphates (mg P/L)	0.119	0.011	0.0025	0.007
Total phosphorus (mg P/L)	0.246	0.018	0.019	0.017
Nitrites (mg N/L)	0.0030	0.0000	0.0025	0.0025
Nitrates (mg N/L)	0.57	0.78	0.39	0.43

In order to analyse community composition we used Bray Curtis similarity index, followed by cluster analysis, and one-way ANOVA was used to compare number of taxa and abundance between microhabitats.

Investigated area

The Plitvice Lakes are located in the central part of Croatia in the region of the contact of two bio-geographical regions: flat Pannonian and elevated karsted Dinaric (Fig. 1.). The lakes lay on the very spring of River Korana on the hillside of mountains Mala Kapela and Plješivica (480 to 636 meters above sea level) (Božićević 1994). The whole area of the national park lays on Mezozoic limestone and dolomite base which specific hydrological characteristics resulted in lake creation. The 12 upper lakes have dolomite base and 4 lower lakes a limestone base.

The experiment was set on the barrier between the two last lakes of the system Kaluđerovac and Novakovića brod, both lower lakes with strong tufa deposition. The macrophyte vegetation consisted mainly of *Phragmites australis*, *Cladium mariscus*, *Salix* spp., while dominant bryophyte was *Cratoneurum commutatum*.

Results

Physical and chemical water parameters showed seasonal differences (Table 1). May and June were characterised with higher values of COD and nutrients, compared to October and November.

Chlorophyll *a* concentration was between 0 to 0.439 mg/dm^2, with the lowest values being measured on Ds microhabitat and highest on Gs microhabitat (Fig. 2.). Differences between months were not consistent among microhabitats, for instance there was a strong maximum in May on Gs, while

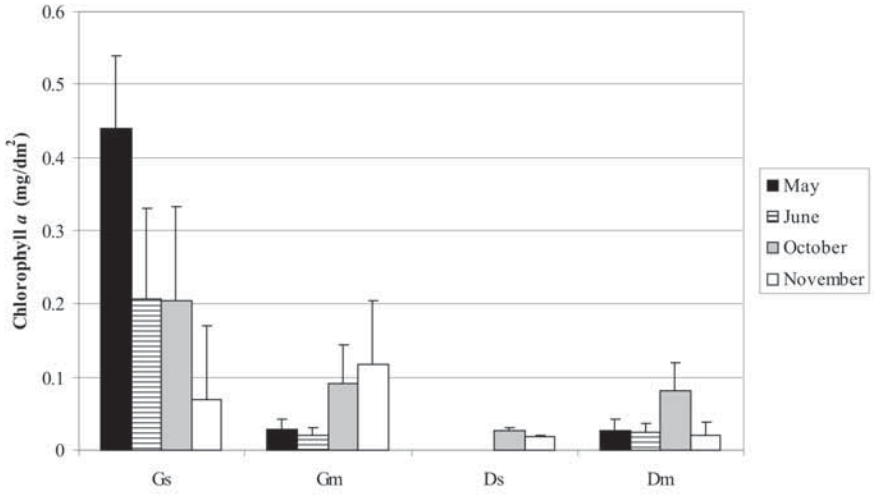

Fig. 2. Chlorophyll a concentrations on different microhabitats through months of sampling

other microhabitats had peak values in October or November. Tufa deposition was recorded on all microhabitats with the highest amount on Gs microhabitat in May and June. Generally, G microhabitats were more intensively incrusted compared to D microhabitats.

In total we recorded and identified 113 taxa of protozoans and micro-metazoans. Ciliates dominated in number of taxa (73 taxa) and abundance. In G microhabitates, ciliates contributed with an average of 65% in total abundance, rotifers with 25.3%, and nematods with 10.9%. In D microhabitates ciliates contributed with 62.5% in total abundance followed by rotifers (15,8%) and nematods (8.7%). Diptera, Gymnoamoebae and Heliozoa were also abundant while Testacea, Turbellaria, Nematoda, Oligochaeta, Tardigrada, Ostracoda, Copepoda, Plecoptera, Trichoptera and Bryozoa were represented with less than 1% in total abundance.

Ciliate taxa belonged to these groups (genus): Colpodea (*Platyophrya*), Cyrtophorida (*Chilodonella*, *Chlamydonellopsis, Dysteria*, *Odontochlamys*, *Pseudochilodonopsis*, *Trithigmostoma*, *Trochilia*), Gymnostomatida (*Dileptus*, *Lacrymaria*, *Lagynophrya),* Nassulida *(Leptopharynx),* Protostomatida *(Placus),* Suctoria *(Heliophrya*, *Metacineta, Acineta),* Hymenostomata *(Cyclidium*, *Frontonia*, *Glaucoma*, *Paramecium*), Peritrichia (*Carchesium, Vaginicola*, *Vorticella, Platycolla),* Pleurostomatida *(Acineria*, *Litonotus*), Prostomatida (*Urotricha*), Oligotrichida (*Halteria*), Heterotrichida (*Stentor, Lagotia*), Hypotrichia (*Aspidisca*, *Balladyna*, *Diaxonella, Euplotes*, *Holosticha, Oxytricha*, *Stylonychia*, *Uroleptus*, *Urostyla, Tachystoma*).

In general, higher abundance and number of taxa were observed in G microhabitats. Among 66 identified taxa, 17 were recorded only in slow current, 12 only in medium current, whereas remaining 37 were recorded in both. Abundances on G microhabitats were between 43.4 ind./cm^2 and 410.1 ind./cm^2, while on D microhabitats values were between 6.6 ind./cm^2 and 258.8 ind./cm^2. D microhabitats sustained only 38 taxa, with Ds having only 8 taxa (mainly Heterotrichida and Peritrichia), and Dm 37 taxa. Periphyton on D microhabitats had on the average 16 times lower abundance and 8 times lower taxa number, compared to the upside communities on the same current velocity. Although upside microhabitats dominated in terms of abundance and taxa number, downside microhabitats were more specific according to the structure of periphyton community. The 8 taxa that occurred only in these microhabitats were: *Stylonychia* sp., *Euplotes* sp., *Platycolla decumbens, Carchesium* sp., *Heliophyra rotunda, Lagynophyra acuminata*, *Urotricha* sp. and *Lagotia dinaridica*. The last one is a rare endemic ciliate, belonging to Folliculinidae that lives fixed to the substrate.

There were significant differences in number of taxa among different microhabitats (ANOVA $F_{3, 60} = 25.975$, $p<0.001$). *Post hoc* unequal HSD test showed statistically significant differences among all microhabitats ($p<0.05$), with the exception of Ds and Dm that showed no significant difference in taxa number ($p>0.05$). In terms of abundance there was statistically significant difference between microhabitats (ANOVA, $F_{3, 60} = 39.915$, $p<0.001$). *Post-hoc* unequal HSD test showed that there was no significant difference between Gs and Gm (($p>0.05$) and Ds and Dm ($p>0.05$), while other combinations differed ($p<0.05$).

According to cluster analysis there was clear segregation between D and G microhabitats with the exception of D2 microhabitat. Communities on

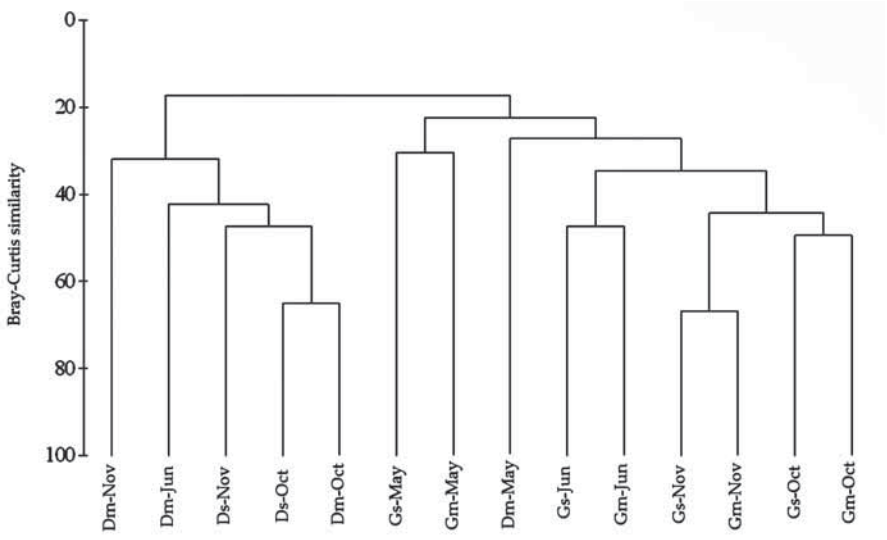

Fig. 3. A dendogram showing periphyton through months of exposition (Gs – upside in slow current; Gm – upside in medium current, Ds – underside in slow current, Dm – underside in medium current)

G microhabitats also showed clustering according to month of sampling, indicating stronger influence of that factor compared to vertical position (Fig.3.).

Discussion

We registered expected seasonal temperature trend based upon 4 experimental series of samples and physicochemical parameter. Physicochemical water parameters show difference depending on the current season. Results of these parameters match with those of Iveković (1958), Srdoč et al. (1985) and Matoničkin Kepčija (2006).

Highest COD values were registered in May which indicate high amount of organic compounds with lower values in June, October and minimum in November. This type of distribution shows possible isothermy and two mixing periods in spring and autumn as in dimictic lakes. Highest chlorophyll *a* concentration was measured in spring, which corresponds to the previously mentioned.

We recorded intensive tufa deposition on glass slides collected during spring and summer and thus a positive correlation of tufa deposition and temperature in accordance with Matoničkin Kepčija (2006). Calcite precipitation increased with longer exposition time and was more intense in G microhabitats in slower water current. These results are in concordance with Matoničkin Kepčija (2006) although some other authors recorded an opposite trend (Primc-Habdija et al.2001).

We established a negative correlation of current velocity with abundance and number of taxa in G microhabitat, but the opposite trend in D microhabitats. G microhabitats had higher primary production, as a result of better insulation. Higher number and abundance of taxa on G microhabitats can be explained by higher quantities of organic matter. Tufa barriers of Plitvice Lakes are also places of lake outlet, and there is considerable sedimentation of detrital particles in places of slow and medium current (Habdija et al. 2004, Matoničkin Kepčija 2006). Ds microhabitat sustained lower number of taxa, possibly due to low food resources, for instance chlorophyll *a* values had minima on that microhabitat. There is a possibility that slow current resulted in low diffusion of nutrients and low detrital particle transport in Ds microhabitat, thus impeding periphyton community. Our results points to different effects of current on periphytic communities, depending on the vertical position. In different seasons different genera were dominant, showing strong influence of the season in accordance with Matoničkin Kepčija (2006).

Clustering pointed out vertical position as the most important factor in community structuring followed by months of sampling and current velocity as last. These results indicate large changes that occur in the periphyton community during the year, which is one of the main ecological features of protozoan. (Finley and Esteban 1998, Matoničkin Kepčija 2006).

Conclusion

Periphyton on tufa barriers is highly heterogeneous with vertical position having the highest influence on its community structure. Upside microhabitats sustained more diverse and abundant community of protozoa and micrometazoa due to higher primary productivity and probably richer food resources. Current velocity plays different roles in upside compared to underside, thus it can enhance or impede periphyton development.

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Summary

During a four months period (May-November 2010.) artificial substrates have been placed on the barrier between lakes Kaluđerovac and Novakovića brod, Plitvice Lakes. The Plitvice Lakes are located in the central part of Croatia in the region of the contact of two bio-geographical regions: flat Pannonian and elevated karsted Dinaric. Substrates were positioned on four different microhabitats: on the upside in slow current (Gs) and in medium current (Gm), and on the underside in slow (Ds) and in medium current (Dm). Glass slides were used as a substrate with the time of exposition of four to five months. The aim of this study was to test the differences in community composition of periphyton, with a focus on ciliates, in different microhabitats depending on current velocity and vertical position, as well as to analyse the differences in primary production between microhabitats.

Periphytic communities developed on glass slides and tufa deposition was observed. Primary production, measured as chlorophyll *a* concentration, was the highest during spring. The highest chlorophyll *a* concentrations were recorded on G1 microhabitat, while other microhabitats did not significantly differ. During the experiment 133 species have been determined, including 73 ciliates. A taxonomic interesting species *Lagotia dinaridica* was determined on the underside community in medium water current velocity. This taxon is an endemic species in the freshwaters of the Dinaric karst region. Ciliates dominated in communities developed in all four investigated microhabitats. They comprised about 65% of community on the upside, and about 75% on the underside followed by Rotatoria and Gymnoamoebae with regard to abundance and taxa number. The highest taxa number and abundance were observed in upside community in slow current. The underside communities had on the average 16 times less abundance and 8 times less taxa in comparison with the upside communities of the same rheotope, probably caused by a smaller amount of food resources. Ciliate composition depended on the microhabitat conditions. Higher share of Peritrichia and Hypotrichia, groups which prefer low-velocity conditions. Current velocity plays different roles in upside compared to underside, thus it can enhance or impede periphyton development.

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COMPOSITION AND SEASONAL VARIATION OF PHYTOPLANKTON COMMUNITY UPSTREAM OF THE OSUMI RIVER (EASTERN ALBANIA)

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Abstract

Xhulaj, S. (2013). Composition and seasonal variation of phytoplankton community upstream of the Osumi River (Eastern Albania). Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 21, Skopje.

Phytoplankton composition and abundance at three selected stations upstream of the Osumi River, Eastern Albania, were investigated seasonally during 2011. A total of 118 taxa were recorded, of which 35 species were common at all stations. Diatoms (Bacillariophyceae) were the dominant group with 75%, followed by green algae (Chlorophyceae) with 16%, blue-green algae (Cyanophyceae) with 6% and euglenoids (Euglenophyceae) with 3%. More than 40% of the identified species belong to the five genera *Navicula*, *Nitzschia*, *Cymbella*, *Pediastrum* and *Scenedesmus*. There were a few species which showed high cell numbers and found at all stations investigated, such as *Achnanthidium minutissimum* (Kützing) Czarnecki, *Cyclotella meneghiniana* Kützing, *Fragilaria crotonensis* Kitton, *Synedra ulna* (Nitzsch) Ehrenberg, *Chlorella vulgaris* Beyerinck and *Pediastrum boryanum* (Turpin) Meneghini. Highest species numbers were found at the second station. Cell counts were dominated by diatoms with two peaks during summer and autumn.

Keywords: Phytoplankton,composition, seasonal variation, Osumi River

Introduction

Osumi River is one of the main rivers of Albania. It is of interest for agriculture, energy, hydrogeology, ecology and urban planning. Osumi River (length 161 km) has a catchment area of 2,150 km^2, average height 828 m and multi-annual average flow rate 32.5 m^3/s (Kabo 1990, 1991). In recent times details have been published on water quality and human impact (Çullaj et al. 2003, 2005) and on environmental state of some Albanian rivers (Miho et al. 2005), including sections of the Osumi River. These publications were focused on the assessment of water quality in diatom-based monitoring. The seasonal variations of phytoplankton composition have never been published for the Osumi River. The present work deals for the first time with the quantitative and qualitative seasonal variation of phytoplankton species upstream of the Osumi River.

Material and methods

Water samples were taken seasonally from three selected stations upstream of the Osumi River during 2011, using Hydro-Bios plankton net of 25 µm in pore diameter. The material was fixed with formaldehyde with final concentration of 4%. For the quantitative analyses, subsurface water samples (2 liters) were collected from each station. Each sample was mixed with Lugol's iodine solution (as a preservative), allowed to sediment for a week, after that was concentrated to 100 ml. Phytoplankton organisms were counted using inverted microscope Carl Zeiss, Axiovert 40C at high magnification 40x and 100x (objectives) according to Utermöhl (1958) and EU Guidance Standard (EN 15204:2006). Abundance is expressed as number of cells per liter. The references used for identification and classification of phytoplankton organisms were based on Hustedt (1945), Huber-Pestalozzi (1955, 1961, 1968, 1982 and 1983), Bourrelly (1966, 1968, 1970), Prescott

Tab. 1. List of phytoplankton species recorded at three stations upstream of the Osumi River ('+' indicates the presence of species)

Name of Species	Station		
	1	2	3
Cyanophyceae			
Anabaena sp.	+	+	
Chroococcus sp.		+	+
Merismopedia glauca (Ehrenberg) Kützing	+	+	
Microcystis sp.			+
Oscillatoria limosa C. Agardh	+	+	
Oscillatoria sp.	+		+
Spirulina major Kützing		+	+
Bacillariophyceae: Centrales			
Aulacoseira italica (Grunow) Simonsen		+	+
Cyclotella cyclopuncta Håkansson		+	+
Cyclotella commensis Hustedt	+		+
Cyclotella meneghiniana Kützing	+	+	+
Cyclotella radiosa (Grunow) Lemmermann		+	
Melosira varians Agardh	+		+
Stephanodiscus medius Håkansson	+	+	
Bacillariophyceae: Pennales			
Achnanthidium minutissimum (Kützing) Czarnecki	+	+	+
Achnanthes lanceolata (Brebisson) Grunow		+	+
Amphora coffeaeformis (C.Agardh) Kützing	+	+	
Amphora pediculus (Kützing) Grunow	+	+	
Amphora ovalis (Kützing) Kützing		+	+
Brachysira neoexilis Lange-Bertalot	+	+	
Brachysira vitrea (Grunow) Ross		+	+
Caloneis bacillum (Grunow) Cleve	+		
Cocconeis pediculus Ehrenberg		+	+
Cocconeis placentula Ehrenberg var. *placentula*	+		+
Cocconeis placentula var. *lineata* (Ehrenberg) Van Heurck		+	+
Craticula cuspidata (Kützing) D.G. Mann		+	
Cymatopleura solea (Brebisson) W. Smith	+		+
Cymbella affinis Kützing		+	+
Cymbella caespitosa (Kützing) Brun		+	+
Cymbella cistula (Ehrenberg) Kirchner		+	
Cymbella helvetica Kützing	+	+	
Cymbella microcephala Grunow	+		+
Cymbella lanceolata (Ehrenberg) Van Heurck	+	+	
Cymbella prostrata (Berk.) Cleve	+	+	
Cymbella silesiaca Bleisch		+	+
Diatoma ehrenbergii Kützing	+		+
Diatoma vulgaris Bory	+	+	
Diploneis elliptica (Kützing) Cleve	+		
Diploneis marginestriata Hustedt	+		+
Fallacia lenzii (Hustedt) Lange-Bertalot		+	+
Fragilaria construens (Ehrenberg) Gunow		+	+
Fragilaria capucina var. *vaucheriae* (Kützing) Lange-Bertalot		+	
Fragilaria crotonensis Kitton	+	+	
Geissleria acceptata (Hustedt) Lange-Bertalot & Metzeltin		+	+
Geissleria decussis (Østrup) Lange-Bertalot & Metzeltin		+	
Gomphonema minutum (Agardh) Agardh		+	+
Gomphonema olivaceum (Hornemann) Brebisson	+	+	+
Gomphonema parvulum Kützing	+		
Gomphonema tergestinum Fricke	+	+	
Gomphonema truncatum Ehrenberg	+		+
Gyrosigma scalproides (Rabenhorst) Cleve			+
Hantzschia amphyoxys (Ehrenberg) Grunow		+	+
Luticula kotschyi (Grunow) Mann	+		
Luticola mutica (Kützing) Mann	+		+
Mastogloia smithii Thwaites		+	+
Meridion circulaire (Grewille) Agardh			+
Navicula capitatoradiata Germain			+
Navicula cryptocephala Kützing		+	

Name of Species	Station		
	1	2	3
Navicula cryptotenella Lange-Bertalot	+	+	
Navicula cryptotenelloides Lange-Bertalot	+	+	
Navicula digitoradiata	+		+
Navicula gregaria Donkin		+	
Navicula halophila (Grunow) Cleve	+		+
Navicula leistikowii Lange-Bertalot		+	
Navicula menisculus Schumann			+
Navicula oligotraphenta Lange-Bertalot & Hofmann	+	+	
Navicula radiosa Kützing	+	+	
Navicula reichardtiana Lange-Bertalot			+
Navicula rostellata Kützing			+
Navicula saprophila Lange-Bertalot	+		+
Navicula tripunctata (O. F. Müller) Bory		+	+
Nitzschia acicularis W. Smith	+	+	
Nitzschia amphibia Grunow		+	+
Nitzschia angustata (W. Smith.) Grunow		+	
Nitzschia brunoii Lange-Bertalot	+	+	
Nitzschia constricta (Kützing) Ralfs		+	+
Nitzschia dissipata (Kützing) Grunow	+	+	
Nitzschia hungarica Grunow		+	+
Nitzschia fonticola Grunow		+	
Nitzschia incospicua Grunow		+	
Nitzschia lacuum Lange-Bertalot	+		
Nitzschia longissima (Baun) Ralfs	+		+
Nitzschia linearis (Agarth) W. Smith var. *linearis*	+		+
Nitzschia palea (Kützing) W. Smith		+	
Nitzschia recta Hantzsch		+	
Nitzschia sigmoidea (Nitzsch) W. Smith	+		
Nitzschia sinuata var. *tabellaria* (Grunow) Grunow		+	
Nitzschia vermicularis (Kützing) Hantzsch			+
Pinnularia microstauron var. *brebissonii* (Kützing) Mayer	+		+
Rhoicosphenia abbreviata (Agardh) Lange-Bertalot	+	+	+
Rhopalodia gibba (Ehrenberg) O. Müller	+		+
Sellaphora bacillum (Ehrenberg) D.G.Mann	+		+
Sellaphora pupula (Kützing) Mereschkovsky			+
Surirella brebissoni Krammer & Lange-Bertalot		+	
Synedra ulna (Nitzsch) Ehrenberg	+	+	+
Euglenophyceae			
Euglena sp.	+	+	
Peranema sp.			+
Phacus sp.	+	+	
Trachelomonas sp.			+
Chlorophyceae			
Actinastrum hantzschii Lagerheim		+	+
Ankistrodesmus falcatus (Corda) Ralfs	+		+
Chlamydomonas sp.	+	+	+
Chlorella vulgaris Beyerinck	+	+	+
Closterium sp.		+	
Cosmarium hammeri Reinsch		+	
Dictyosphaerium pulchellum H.C.Wood			+
Golenkinia paucispina W. & G.S. West	+		+
Mougeotia sp.	+	+	+
Oocystis sp.		+	+
Pediastrum boryanum (Turpin) Meneghini	+	+	
Pediastrum duplex Meyen		+	
Pediastrum simplex Meyen		+	
Pediastrum tetras (Ehrenberg) Ralfs		+	+
Scenedesmus acutus Meyen	+		+
Scenedesmus longus var. *carpetana* P.González	+		+
Scenedesmus quadricauda (Turpin) Brébisson	+	+	
Scenedesmus subspicatus Chodat			+
Scenedesmus sp.		+	

Tab. 2. Number of identified species and genera of the different algal classes in the investigated stations upstream of the Osumi River.

Class	Station 1		2		3		Total	
	Genera	Species	Genera	Species	Genera	Species	Species	%
Cyanophyceae	3	4	5	5	4	4	7	6
Bacillariophyceae								
Centrales	3	4	3	5	3	5	7	6
Pennales	19	41	19	52	25	45	81	69
Euglenophyceae	2	2	2	2	2	2	4	3
Chlorophyceae	7	9	9	13	10	12	19	16
Total	34	60	38	77	44	68	118	100

(1973), Compere (1974), Patrick & Reimer (1966, 1975), Findlay & Kling (1979), Krammer & Lange-Bertalot (1986, 1988, 1991a, 1991b) and Van den Hoek et al. (1995).

Investigated area

The upstream of Osumi River in Vithkuqi area had narrow riverbed, clear water and moderate flow over boulder and gravel bottom. Much of the reach is heavily shaded by right side riparian vegetation dominated by *Alnus glutinosa* and *Salix alba*. Aquatic plants are well represented, in small open parts, by some algae and aquatic mosses growing on submerged or partially submerged bedrock and boulders. Areas of bank erosion are present at the left bank of the channel do to dynamic of the river and the scarce tree vegetation. The access of livestock on the left side has contributed significantly to this event. The site at the river cross location is almost natural habitat. Perroi i Qafes, is a creek situated nearby Qafa village. It is one of the tributaries of Osumi River in this area, collecting waters from surroundings and flows over a stony and clay base. During dry season it has little running waters, while during fall it turns into a torrent. The slopes are covered by vegetatin consisted mainly of European hop hornbeam (*Ostrya carpinifolia*) and Turkey oak (*Quercus cerris*). Due to hydrological conditions there are not aquatic macrophytes present at this habitat.

Results

A total of 118 taxa of phytoplankton were identified in the three stations investigated (Table 1). Diatoms were the dominant group (75%), most of them belonged to pennatae diatoms (69%), and 6% to the centrics (Table 2). The green algae (Chlorophyceae) contributed with 16% to the total taxa identi-

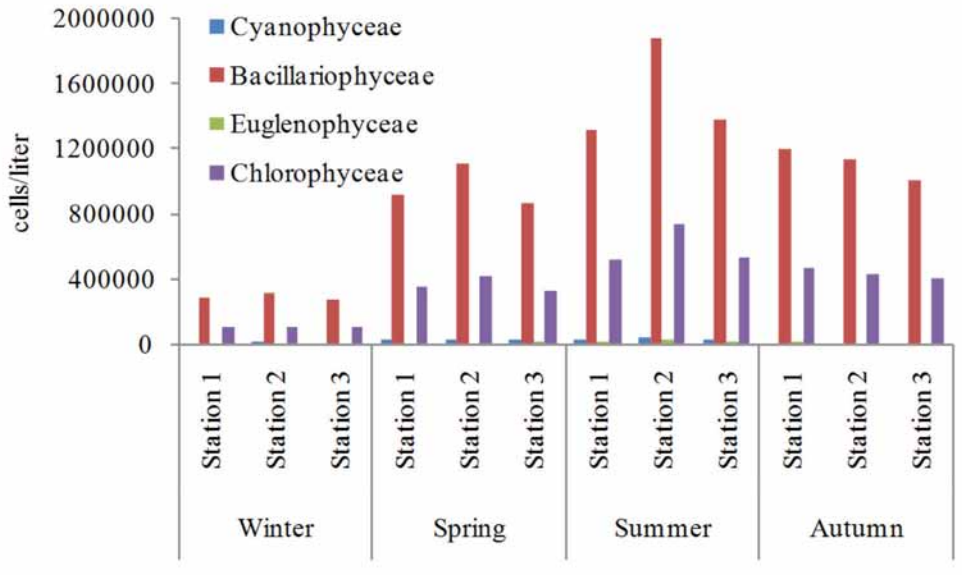

Fig. 1. Seasonal values of phytoplankton groups (cells/liter) for each station upstream of the Osumi River.

fied, followed by the blu-green algae (Cyanophyceae) with 6% and the euglenoids (Euglenophyceae) with 3%. The total cell numbers at the investigated stations varied from 394.000 to 2.690.000 cells/1. Diatoms dominated also in the cell numbers (70%) at all stations (Figure 1) and showed a clear increase during spring and autumn seasons. The green algae were with 15 % the next most abundant group at all stations, followed by the blu-green algae with 5%. There were a few species which appeared at markedly high cell numbers, such as *Chlorella vulgaris* which was found at high cell densities at all stations studied. *Chlamydomonas* sp. was also found in all stations with 0.6% (station 3) to 11.3% (station 1) of the total number of cells. It appeared at slight higher numbers during autumn season. *Achnanthidium minutissimum* was also identified at all stations with a range from 1.7% in station 1 to 48.6% in station 2, and showed higher densities during spring time. *Synedra ulna* was recorded at all stations and ranged from 7% in station 2 to 22.8% in station 1, with a higher density during the summer season. There was a clear increase in its cell numbers from spring to summer at station 1. *Cyclotella meneghiniana* varied from 0.7% in station 1 to 16.5% in station 2, and was present in all stations, with a higher density during spring and summer. *Cyclotella commensis* was observed in station 1 and 3. It ranged from 0.4% in station 3 to 21.6% in station 1, and showed a higher density during spring.

Discussion

Apart from limited number of true planktonic species, most of the identified species in the Osumi River were at benthic origin. More than 40% of the species identified totally in the investigated area belong to the genera *Nitzschia* (17 species), *Navicula* sensu lato (15 species), *Cymbella* sensu lato (8 species), *Scenedesmus* (5 species) and *Pediastrum* (4 species) (Table 1). The importance of the genera *Nitzschia*, *Navicula* and *Cymbella* in some Albanian rivers and inland waters was given by Miho et al. (2005). They recorded among others 45 species belonging to *Navicula*, 31 species belonging to *Nitzschia* and 29 species to *Cymbella*. *Achnanthidium minutissimum* (Kützing) Czarnecki, *Cyclotella commensis* Hustedt, *Cyclotella meneghiniana* Kützing, *Fragilaria crotonensis* Kitton, *Gomphonema olivaceum* (Hornemann) Brebisson, *Rhoicosphenia abbreviata* (Agardh) Lange-Bertalot and *Synedra ulna* (Nitzsch) Ehrenberg which were found at all studied stations and in relatively high cell densities, are known to be common in the Albanian waters.

In comparison to the other stations investigated, higher densities were recorded in station 2 during winter, spring and summer (438.105, 1.573.650 and 2.690.100 cells/liter, respectively). During autumn, the highest population density was observed in station 1 (1.694.600 cells/liter), due to the contribution of Bacillariophyceae (1.200.000 cells/liter) and Chlorophyceae (470.000 cells/liter). These were the highest values of the season comparing to the other two stations. The lack of such studies, not only upstream but also in other parts of the Osumi River makes it difficult to interpret and compare the data obtained. However, a range of factors naturally can be expected to affect phytoplankton development in this area. It may include dispersal and variations in important abiotic parameters and nutrients not measured in this investigation.

Conclusions

Evidently, further studies on phytoplankton communities are required to give a better view and to increase the accuracy of predictions. Without a sufficient base of historical information from which to draw confident comparisons, the 118 phytoplankton taxa recorded here (some of them for the first time for this region, excluding diatoms) should be attributed to the recent increase in monitoring activity, rather than to any occasional survey. These present findings contribute essential base-line information that should help similar studies in the future.

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ELECTRON MICROSCOPIC ANALYSIS OF DEGENERATIVE CHANGES OF SERTOLI CELLS AS SOMATIC COMPONENT OF SEMINIFEROUS LOBULES OF SALMONIDE FROM OHRID LAKE DURING THE REPRODUCTION

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Abstract

Tavchiovska-Vasileva, I., Rebok, K. & Jordanova, M. (2013). Electron microscopic analysis of degenerative changes of Sertoli cells as somatic component of seminiferous lobules of Salmonide from Ohrid Lake during the reproduction. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

Elektron microscopic analysis of degenerated Sertoli cells of Salmonidae from Ohrid Lake during reproduction have been made. Sertoli cells being an integral part of the seminiferous lobules underwent considerable changes, which influenced their cytomorphological features. The degenerative changes of Sertoli cells were manifested by an extreme vacuolization, mitochondria in degeneration with widened crusts and thickened matrix, desorganised ER, autophagosomes, "myelin like" structures and lysed cytoplasmatic regions. The above mentioned changes were followed by karyopycnosis, complete degeneration and delamination of cells from the wall of the seminiferous lobules, lysis and Sertoli cell detritus in the lumen of the lobules.

Key words: Sertoli cells, Salmonidae, Ohrid Lake, degenerative changes, electron microscopic analysis.

Извод

Тавчиовска-Василева, И., Ребок, К. и Јорданова, М. Електрон микроскопска анализа на дегенеративните промени на Sertoli клетките како соматична компонента на семените лобули кај Salmonidae од Охридското Езеро во тек на репродукцијата. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 28, Скопје.

Направена е електрон микроскопска анализа на дегенерираните Sertoli клетки кај Salmonidae од Охридското Езеро во тек на репродукцијата. Sertoli клетките како интегрален дел на семените лобули претрпуваат значајни промени, што влијаат на нивните цитоморфолошки карактеристики. Дегенеративните промени на Sertoli клетките се манифестираат со екстремна вакуолизација, митохондрии во дегенерација со проширени кристи и густ матрикс, дезорганизиран ЕР, "myelin like" структури и лизирани цитоплазматични региони. Горе споменатите промени се проследени со кариопикноза, комплетна дегенерација и деламинација на клетките од ѕидот на семените лобули, лизис и детритус од Sertoli клетките во луменот на лобулите.

Клучни зборови: Sertoli клетки, Salmonidae, Охридско Езеро, дегенеративни промени, елецтрон микроскопска анализа.

Introduction

The structural and functional characteristics of Sertoli cells in different Teleostei species is noticeable (Billard 1970; Nicols & Graham 1972; Gresik et al. 1973; Lahnsteiner & Patzner,1990; McClusky 2005; Petersen & Söder 2006; Prisco et al. 2003; Sharpe et al. 2003; Van Vurey & Soley 1990). However, literature data about the changes in the postspawning period in different species of Teleostei are less (Billard 1970; Billard & Takashima 1983; Tavciovska-Vasileva 1992). The lack of literature data concern-

ing the testes, especially the Sertoli cells as somatic components of the seminiferous lobules of testes of two species of Salmonidae from Ohrid Lake (Rebok & Tavchiovska-Vasileva 2010; Tavciovska-Vasileva 1999, 2000, 2003; Tavciovska-Vasileva & Dimovska 1997; Tavciovska-Vasileva & Rebok 2003, 2004, 2005, 2010) has motivated this research. On the other hand, the two species of Salmonidae from Ohrid Lake were chosen as an object to research because of their big economic significance for the lake and due to the fact that they represent a relic and endemic species of this lake.

Material and methods

Testes of sexually mature Salmonidae males caught in Ohrid Lake have been analysed. Analyses have been done with electronic microscope. Smal parts of testes 1-2 mm big have been used for electronic microscopy. The material has been fixed according to following procedure: Immediately after the tissue sections have been taken, they are fixed in 3% glutaraldehyde and then conserved in 0.1 M phosphate buffer. After adequate fixation the material has been subunitted to postfixation in 1% osmium tetraoxid (OsO_4). In the further treatment the material has been washed in phosphate buffer, dehydrated in series of acetone and uranil acetate. The tissue parts have been infiltrated with Durcopan ACM mixture, mixture of acetone-Durcopan, Durcopan No.1, Durcopan No. 2, fit in Durcopan No. 2 and polymerised. For the ultrastructural analysis, ultrathin sections of 40-60 ηm tickness have been prepared, with the help of glass knives, on Reichert-Yung "Ultracut" ultramicrotome, installed on copper nets, contrasted with uranil acetate and lead cytrate. The sections have been observed on Tesla BS 500 and OPTON (Zeis) EM 109 electronic microscope. The microphotographs for electronic microscope were obtained on Agfa Scientia EM Film 23056/6,5 x 9 cm, ORWO NP 20 panchromatic 120, Kodak 120 and made on Agfa papirtone Paper P1-3.

Results

In the postspawning period the most important changes in testes of Salmonidae occurred on the level of Sertoli cells, being in the structure of seminiferous lobules as their somatic components. In the postspawning period they gradually lost the squamous form, increased their dimensions and acquired polymorphic nuclei. The presence of lipid vacuoles of different sizes was evident in their cytoplasm, especially well seen on ultrathin sections (Fig. 1). Also, at an ultrastructural level, lysosomes could be observed (Fig. 2), as well as interdigitations between the Sertoli cells were clearly noticed (Fig. 3). One of the functions of Sertoli cells is phagocytosis of the sperm residues. The presence of transfersal cut fragments of flagellumes of sperm residues in the cytoplasm of Sertoli cells (Fig. 4) or phagolysosomes with already digested material of sperm origin (Fig. 5) supported this fact. In the later phase of the life cycle of Sertoli cells a more distinct vacuolisation of their cytoplasm could be observed, which caused a degeneration of these somatic cells, characterised by karyopycnosis. The final phases of Sertoli cells` life cycle were followed by exfoliation from the wall of the seminiferous lobules, disintegration and complete destruction of the cells, presence of detritus in the lumen of the lobules, as well as lysis. Desintegration and destruction of some Sertoli cells which are manifested with torn cell borders, presence of vesicular nucleus or nucleolus in pycnosis with emphasized hyperchromatic characteristic, undifferentiated nucleolus were evident on ultrathin sections (Fig. 6). The degeneration of the Sertoli cells was followed by detachment of the nuclear membrane, a process which was well distinguished at an ultrastructural level (Fig. 7). In the cytoplasm of Sertoli cells in degeneration, excluding the presence of pycnotic nucleus, digestive vacuoles, i. e. autophagosomes were noticed, indicative for autophagia occurring on the level of these cells (Fig. 8). On ultrathin sections the degeneration of Sertoli cells was demonstrated by a presence of lysosomes with "myelin like" figures in their cytoplasm, endoplasmic reticulum in desorganisation, mitochondria with initial signs of degeneration, with widened crusts and thickened matrix, chyaloplasm with granular structure and lysed cytoplasmic regions (Fig. 9). All these changes occurring on the level of Sertoli cells showed their degeneration in the postspawning period.

Discussion

The ultrastructural analysis of testes of Salmonidae from Ohrid Lake during the reproduction showed certain features which provided a characteristic histological picture of testes in this period. In postspawning period visible changes on the level of seminiferous lobules, especially in the Sertoli cells were observed. All these changes occurred successively. In the initial phase of the postspawning period sperm residues were still present in the lumen of seminiferous lobules. As changes progressed, degeneration of Sertoli cells took place. The mentioned changes, especially those which happened in the final phase of postspawning period, at a sufficient extent, changed the histoarchitectonic of the testes, in coprarison with the prespawning period. On the basis of consequent characteristic changes which happened on the level of the testes in the postspawning period in Salmonidae from Ohrid Lake, we can concluded that this was a period of regeneration of the testes. The seminiferous lobules underwent im-

Microphotographs

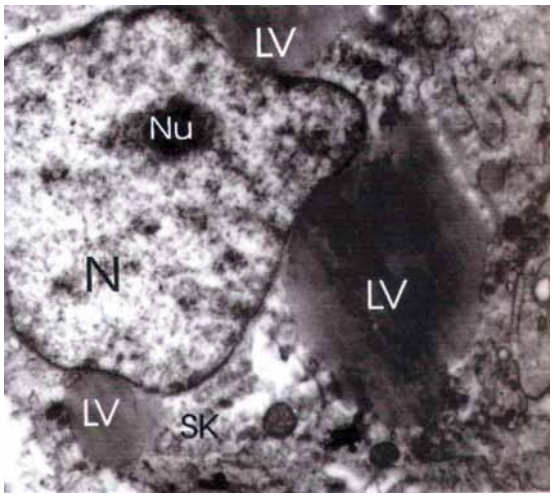

Fig. 1 Part of Sertoli cell (SK) with well seen nucleus (N) and nucleolus (Nu), presence of big lipid vacuoles (LV). Ultrathin section, 7.000x.

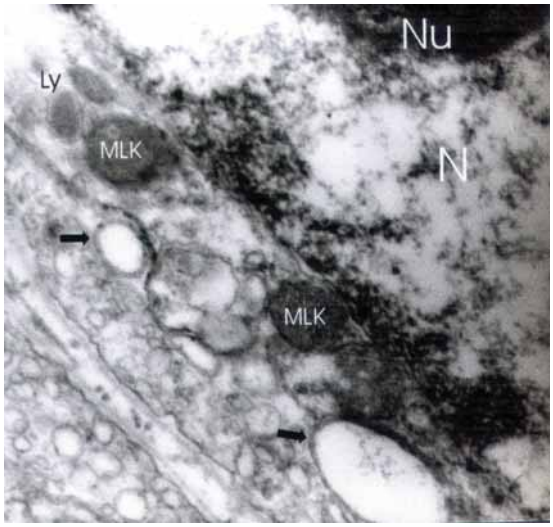

Fig. 2 Part of Sertoli cell with well visible nucleus (N), prominent nucleolus (Nu), mitochondria with lamellar crusts (MLK), vesicles of SER (black arrows) and lysosomes (Ly). Ultrathin section, 20.000x.

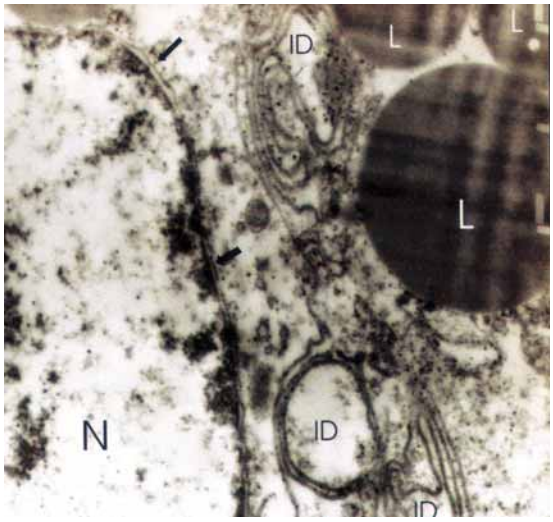

Fig. 3 Interdigitations (ID) between two adjacent Sertoli cells, lipids (L) in the cytoplasm and prominent nucleus (N) with well seen nuclear membrane (black arrows). Ultrathin section, 12.000x.

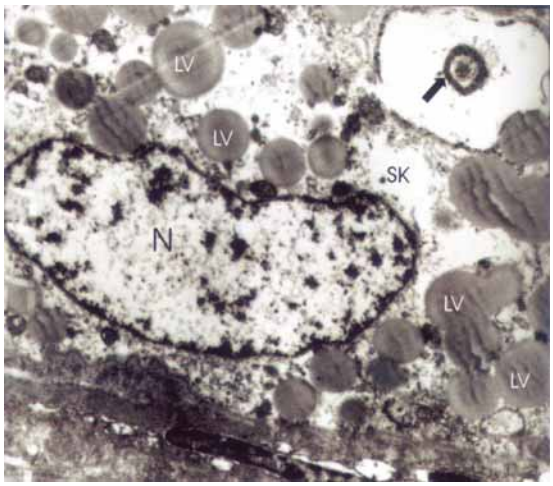

Fig. 4 Part of cytoplasm of Sertoli cell (SK) with well seen nucleus (N) and lipid vacuoles (LV) of different size. Presence of transfersally cut fragments of flagellumes of sperm residues (black arrow). Ultrathin section, 4.400x.

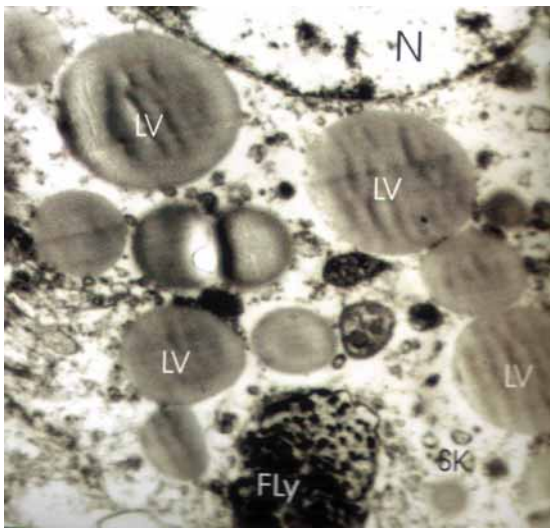

Fig. 5 Part of Sertoli cell cytoplasm (SK) with phagolysosomes (Fly) with sperm residual material. Presence of lipid vacuoles (LV) of dofferent size and a part of nucleus (N) of the Sertoli cell are also visible. Ultrathin section, 12.000x.

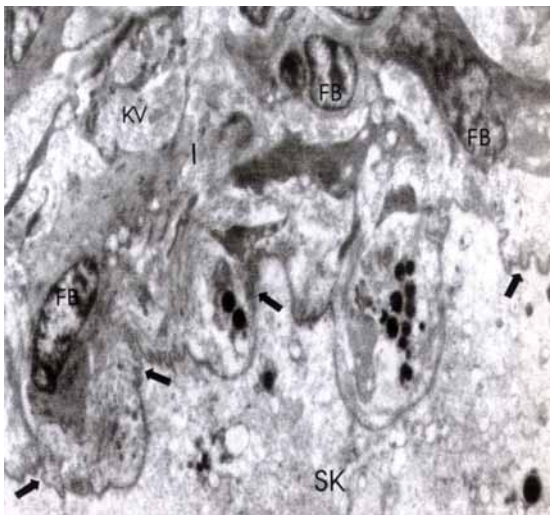

Fig. 6 Well distinguished interstitium (I) with fibroblast (FB) and colagenous fibers (KV). A part of Sertoli cell (SK) cytoplasm in degeneration is seen, as well as the basal lamina (black arrow) of the lobule. Ultrathin section, 3.000x.

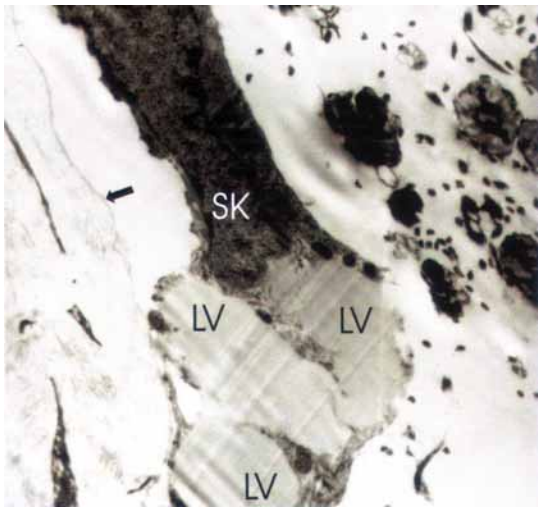

Fig. 7 Sertoli cell (SK) in degeneration. Presence of lipid vacuoles (LV) in the cytoplasm and separation of cytoplasm from basal membrane (black arrow) are visible. Ultrathin section, 4.400x.

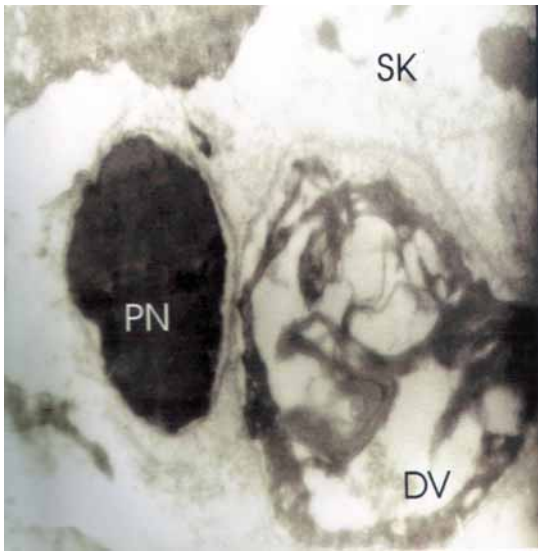

Fig. 8 Part of cytoplasm of Sertoli cell (SK) in degeneration with a pycnotic nucleus (PN) and a digestive vacuole (DV). Ultrathin section, 12.000x.

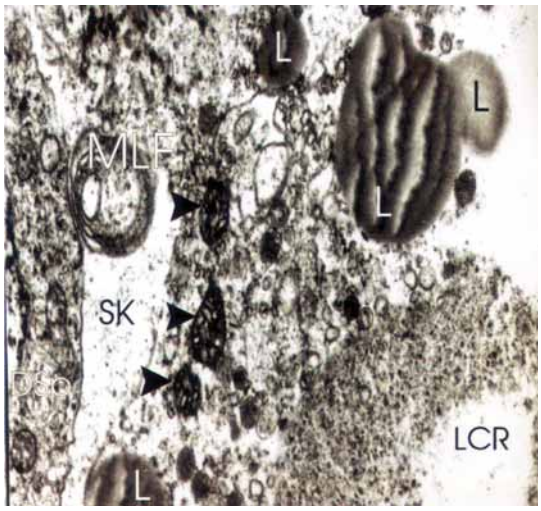

Fig. 9 Part of cytoplasm of Sertoli cell (SK) in degeneration, with lysosomes with "myelin like" figures (MLF), lysed cytoplasmic regions (LCR), mitochondria in degeneration (black arrows), lipid droplets (L) with different size. A part of one spermatogonium in degeneration (DSp) is shown. Ultrathin section, 8.000x.

portant transformations in the postspawning period. As a somatic component of the seminiferous lobules Sertoli cells suffered significant degenerative changes which caused their involution, i. e. involution of seminiferous lobules themselves. This process in Salmonidae is repeating every year. The seminiferous lobules and the Sertoli cells themselves, in Salmonidae, are not constant elements of testes, but temporary formations which are formed every year after the spawning. The findings of this study confirmed our preliminary investigations (Rebok & Tavchiovks-Vasileva 2010; Tavciovska-Vasileva 1999, 2000, 2003; Tavciovska-Vasileva & Dimovska 1997; Tavciovska-Vasileva & Rebok 2003, 2004, 2005, 2010) on changes which happen on the level of testes of Salmonidae from Ohrid Lake, i. e. collapsing and disintegration of the lobules, degeneration, i. e. involution of the Sertoli cells, ect. This process was also noted in other Teleostei (Tavciovska-Vasileva 1992). Therefore, our results support the difference between mentioned species and mammals, where seminiferous lobules or tubules are constant elements of the testes. There are literature data for different Teleostei species which point out the presence of degenetative changes of Sertoli cells during the postspawning period. After phagocytosis of the residual bodies by Sertoli cells, the later suffer lipid degeneration. Similar statements were given about the fate of the Sertoli cells after the finished sexual cycle with *Perca fluviatilis macedonica* Kar. By Tavciovska-Vasileva (1992). After the expulsion of sperm cells in the lumen of tubules, in several species of Teleostei, Sertoli cells suffer lipid degeneration, and probably, finaly are resorbed (Nagahama et al., 1978). The degeneration of Sertoli cells in some species of Atheriniformes, as *Poecilia reticulata* was also described (Billard 1970). Recently the phenomenon of the life cycle of Sertoli cells has been noted by other authors, not only with Teleostei (Billard 1970; Nicols & Graham 1972; Gresik et al. 1973; Lahnsteiner & Patzner 1990; McClusky 2005; Petersen & Söder 2006; Prisco et al. 2003; Sharpe et al. 2003; Van Vurey & Soley 1990), but in other low Vertebrata as well (Lofts, 1972a). However, the fact is that a small number of authors have dealt with this problem. Relatively few authors have treated the changes which happen immediately after the spawning, and later (Billard, 1970; Billard & Takashima, 1983; Tavciovska-Vasileva 1992; Tavciovska-Vasileva & Dimovska 1997). Our investigation in Salmonidae from Ohrid Lake pointed out that derectly after the spawning, similarly to other examined Teleostei, an intensive phagocytosis of sperm residues by Sertoli cells took place. The phagocytic activity of these somatic elements of seminiferous lobules was accompanied at the same time by numerous changes which reflected upon their cytomorphological appearance. Namely, in the prespawning period Setoli cells are characterised with squamous appearance, whereas in the postspawning period they gradually lost the squamous form and increased their dimensions. The presence of increased number of vacuoles of different size was evident in their cytoplasm. Close to or in contact with these Sertoli cells, as in their cytoplasm numerous sperm residues were evident. In favoir of this fact was the presence of transversally and longitudinally cut fragments of flagelumes of sperm residues in the cytoplasm of these cells, later its lysis, which indicated the phagocytotic role of these somatic elements of the seminiferous lobules during this period of the year. Gresik et al. (1973) noticed presence of philopodia and residual bodies on the level of Sertoli cells in the postspawning period in *Oryzias latipes*. The presence of philopodia in Sertoli cells of different species of Teleostei in the period after the spawning was reported in *Cyclostoma nigrofasciatum* (Nicholls & Graham 1972). In Salmonidae as *Oncorhynchus kisutch* and *Oncorhynchus gorbuscha* the presence of philopodia on a level of Sertoli cells was determined by Nagahama et al. (1978). The phagocytotic activity of Sertoli cells in Salmonidae from Ohrid Lake is characterised by subsequent considerable cytological changes, manifested by intensive vacuolisation of the cytoplasm, lipid degeneration, karyopycnosis, total destruction and delamination, presence of their residues in the lumen of the seminiferous lobules, as well as its lysis, mitochondria with disintegrated crusts, autophagosomes, “myelin like” structures. All these structutal changes point out the degeneration of these somatic cells, i. e. these changes couse their involution and with that the involution of the seminiferous lobules themselves.

Conclusions

The successive ultrastructural changes of Sertoli cells of Salmonidae from Ohrid Lake during the reproduction can be defined like this:

1. Sertoli cels as an integral part of seminiferous lobules suffered considerable changes, changing their cytomorphological aspect. Namelly, out of cells with squamous appearance characteristic for the prespawning period, they gradually increased their dimensions. Lipid vacuoles of different size can be noticed in their cytoplasm while the nuclei acquired a polymorphic form.

2. The close contact of Sertoli cells with the sperm residues, as well as the presence of fragments of their flagellumes in the cytoplasm of Sertoli cells, showed their phagocytic activity.

3. The degenerative changes of Sertoli cells were manifested by extreme vacuolisation, mitochondria in degeneration with widened crysts and thickned matrix, desorganised ER, digestive vacuoles (autophagosomes), “myelin like” structures and

lysed cytoplasmic regions. The above mentioned changes were followed by karyopycnosis, complete degeneration and delamination of the cells from the wall of the seminiferous lobules, their detritus in the lumen of the lobules and its lysis.

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LAND USE CHANGES ON GALICICA MOUNTAIN

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Abstract

Despodovska, A., Arsovska, B., Melovski, Lj., Hristovski, S.. (2013). Land use changes on Galicica Mountain. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

This paper presents the changes of land use of Galicica Mountain (including the National Park „Galicica"), in the last 60 years. Topographic maps from the 1950s and 1970s of the 20th century were used as models, as well as Google maps from 2007. The analyses were made by using GIS (Geographic Information System) software. The maps that were used were in scale 1:50000. The goal of this research is to determine the direction of the transformation of the land, including: the reason why the changes occurred and appeared which factors affects them etc. The results determined the difference in the areas of the identified territories i.e. the direction of the transformation of the land of Galicica Mountain in three comparative periods. The area under forests increased due to the reduction of the areas under pastures and shrubs.

Key words: Galicica, land use, land transformation.

Апстракт

Десподовска, А., Арсовска, Б., Меловски, Љ., Христовски, С. (2013). Промени во искористувањето на земјиштето на планината Галичица. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 28, Скопје.

Во овој труд се прикажани промените во искористувањето на земјиштето на планината Галичица (вклучувајќи го и Националниот парк „Галичица") во последните 60 години. За таа цел, беа искористени топографски карти од 1950тите и 1970тите години на XX век, како и Google сателитски снимки од 2007 година. Анализата беше направена со помош на GIS софтвер (географски информациски систем). Картирањето беше извршено во размер 1:50000. Главна цел на истражувањето беше да се утврди насоката во трансформацијата на земјиштето, вклучувајќи и анализа на причините и факторите на промените. Резултатите ги покажаа разликите во површината на идентификуваните подрачја т.е. насоката на трансформацијата на земјиштето на планината Галичица во трите периоди. Главната промена е зголемување на површината на шумско земјиште и намалување на површините под пасишта и грмушеста вегетација.

Клучни зборови: Галичица, искористување на земјиште, трансформација на земјиште.

Introduction

Growth rates of any type of land are shown through the exploitation of the land, it`s structure and morphology, i.e. the transformation of the land that occurs during a certain period of time. This proves the necessity to research the evolution of the soil, which is the most important component for sustainable development of the region. (Ratnadeb & Ami, 2003). The changes and the transformation of the land are result of complex interaction of many factors including politics, economy, culture, human behavior and environment (Dale et al., 1993).

The models of exploitation of the land and the changes of the land cover are powerful tool that can be used in the understanding and the analysis of the important connections between the socio-economic processes that are in relation with the agricultur-

al activities, the evolution of the land and the strategy for management of the natural resources as well as the ways these changes influence the structure and the function of the eco-systems. (Turner and Mayer, 1991).

The transformation of the land can also influence the local and regional economies (Burchel, 1996).

Understanding the changes in the transformation of the land and how they occur is crucial since the anthropogenic activities have great impact on the environment, on the change of the hydrological cycle (Steiner F., Osterman D.A., Hicks T.L., Ledgerwood R., 1988), on the dynamics of the biogeochemical cycles (Flintrop et all., 1996), on the size and the arrangement of the natural habitats such as forests (Dale et al., 1993) and the species varieties (Costanza R. and Patten B.C., 1995).

The exploitation of the land is defined as human activity over the land (Turner et all, 1995).

Natural factors such as: relief (terrain) characteristics, geological composition, climate, hydrological conditions, pedological composition of the terrain etc. influenced the development of various vegetation where areas with forests and pastures on the Galicica Mountain prevail.

Small portion of the land on Galicica Mountain, man has adopted for cultivation of agricultural areas. Therefore, the growth of the vegetation cover is influenced by a number of social, economic-geographic, as well as socio-geographic factors.

Activities related to the exploitation of the land result in destruction of the vegetation cover (Lambin 1997). Therefore, the satellite shots very often can be used for detection of the changes in the exploitation of the land through the records of the biophysical characteristics of the terrain.

The aim of this study is to determine the direction of the transformation of the land on Galicica Mountain through comparison of the condition of the land in the1950s, 1970s of the 20th century as well as in 2007.

Method of work

Galicica Mountain is located in the southwest part of the Republic of Macedonia, between the Ohrid and Prespa Lake and it covers an area of 317 km^2. Review of the changes of the land on Galicica Mountain has been made in 1950, 1970 and 2007. For the conditions in the 1950s and 1970s, topographic maps were used in scale of 1:50000, prepared by the Military Geographic Office (VGI) of the Yugoslav National Army (YNA). For the condition in 2007, pictures from Google Maps were used in scale of 1:5000. Forests landscapes, short bole vegetation-shrubs, arable land, pastures, stone fields, glade fields in forests, populated areas, swamps were identified.

All maps are referenced on the basis of the topographic maps in scale of 1:25000 in geographic projection UTM/VGS 84 zone 34 North. The topographic basis for the terrain is prepared by the Military Geographic Office of YNA on topographic maps. ArcGIS 9.3 software is used for the processing of the data, developed by ESRI which provides recognition of colors of the identified territories on the maps. For the calculation of the surface covered with the identified territories, plan projection review was used and the obtained surfaces are calculated in hectares.

Discussion

Transformations in the nature, in general, as well as the changes in the vegetation cover on the Galicica Mountain are strongly correlated with the natural and with the social factors as well.

Mainly, the natural factors are related to the characteristics of the terrain, geological composition, climate, hydrological conditions, pedological composition of the terrain etc. The individual characteristics of the natural factors, as well as the mutual influences, determine the development of the particular floristic systems in a certain area. According to the relatively big inclinations (large slope) of the surface and the altitude, the areas with forests and pastures prevail. Parts of these areas are used for growing cultivated vegetation and this illustrates the impact of the social factors on the vegetation cover.

In the last few decades, 23 located areas on the Galicica Mountain have been populated with 10000 habitants. Out of 38000 hectares in their function, 6000 hectares are adopted as arable areas where fields and orchards prevail.

The social factors are: physical planning, declaration of Galicica as national park, processes of social planning, emerging urbanization, emerging industrialization, late infrastructural installation and arrangement of settlements, inadequate agricultural politics, motorization and use of agricultural mechanization, cultural and educational level of population, historically illogical factors for localization and development of settlements, functionally inadequate organization of the settlements territories, migration of the population in the cities, reorientation of the population from the primary towards secondary business activities, changes in the exploitation of the energy potentials, changes in the farming practices and traditional engagements etc.

Because of these reasons, great part of these arable territories is abandoned and therefore the transformation of the land from cultivated to uncultivated begins. Due to the functional transformations of parts of the settlements dealing with agriculture (farming, orcharding, stockbreeding) into catering, tourism, trade and other service activities, part of the arable land is transformed into unproductive areas

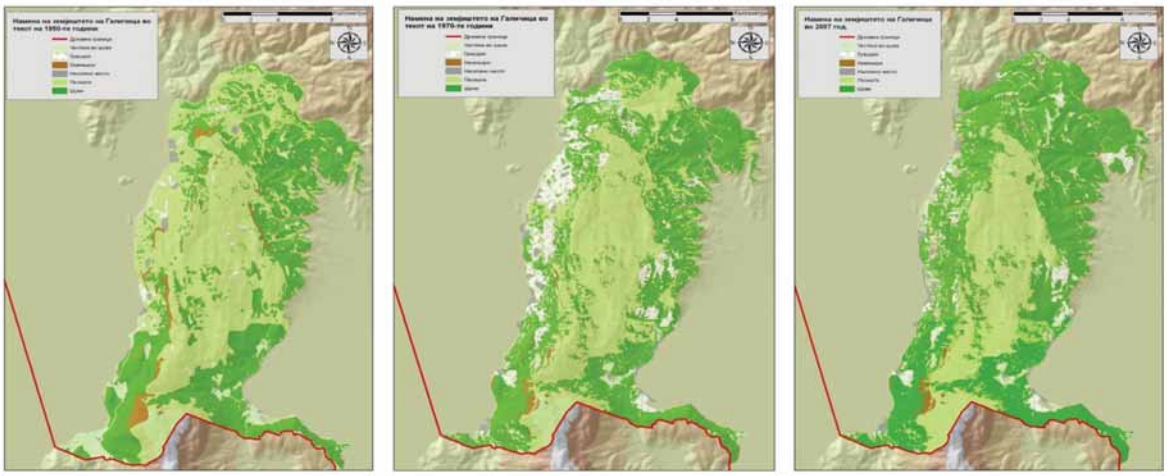

Fig. 1. Land condition of Galichica mountain in 1950's,1970's and 2007

Results

Fig. 2. Land use of Galichica mountain in 1950's (in %)

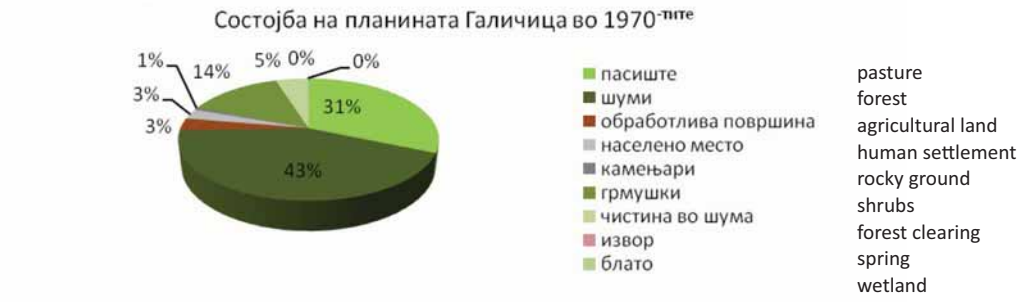

Fig. 3. Land use of Galichica mountain in 1970's (in %)

Fig. 4. Land use of Galichica mountain in 2007 (in %)

(houses, buildings, yards, religious objects, graveyards etc.). Examples for this are the settlements in the coastal region of Lake Ohrid, such as Konjsko, Peshtani, Trpejca and Ljubanishta which today are oriented towards tourism, trade and other service activities. In these settlements even though the number of population is increasing, still the arable areas are transforming into unproductive. The situation in the Prespa Region is different than the Ohrid Region. The population number in Oteshevo, Leskoec, Petrino, Preljublje, Stipona etc., is drastically decreasing because of the migration of the population towards cities and abroad. In these settlements the transformation of the cultivated areas into unproductive is result of the migration and the abandonment of the arable fields.

From this information it can be concluded that the impact of human on the transformation of the land on Galicica Mountain is expressed through the increased pressure in the coastal area of Ohrid and Prespa Lake, and the pressure of the population inside the mountains is significantly reduced and mainly concerns the tourist recreational visits of individuals and small groups.

The obvious differences in the changes of the land on Galicica Mountain in the compared three periods can be noticed in Figure 1. Furthermore, the percentages of presence of the identified areas are shown in Figure 2, 3 and 4.

It was noticed on Galicica Mountain that the areas of pastures are decreasing from 50% in 1950s, to 24% in 2007. This is a result of the abandonment of the cattle breeding as a basic activity and reorientation towards catering and tourism, as well as the migrations of people from rural settlements to the cities. The land under forests is increased from 40% in the 1950s to 58% in 2007. This is mostly as a result of the succession of the land itself, more specific as a result of the growing of the shrubs into forest. The area under shrubs decreased from 14% in 1970s to 5% in 2007 due to the succession. Royatos et al. (2003) brought similar conclusions for the Pyrenees in Spain where the fields under forests increased due to the ingrowth of tree species on the abandoned arable areas. Specific problem arises from the organized pressure within the National Park Galicica where under the plan for protection and management of the park in many occasions (perhaps due to irregular cut, but certainly with alleged spacing or cleaning the fields) an exploitation of the forests is made (Маркоски, 2011). As a result, it is possible the percentage of land under forest to be variable, but the most important thing is that this percentage increases successively in the three comparative periods.

During the preparation of this research, we faced inclarities of the topographic maps from 1950s of the 20th century. Throughout the marking of the maps difficulties were faced in the recognition and marking the areas, part of this research. While at Google Earth maps the shadow that appears on the photos can be noticed as a downside, depending on the angle of the satellite shoots.

Conclusion

According to the results from the researched area, it can be concluded that the land cover of Galicica Mountain from the 1950s until 2007 has significant changes. The areas under forests are increased whilst the areas under short bole vegetation – shrubs and areas under pastures are reduced. The reasons why these changes occurs are the succession of the land itself, the migration of the population from the countryside to the cities, the abandonment of the cattle breeding and reorientation towards catering and tourism, but also the climate factors all around the globe should not be forgotten.

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IMPACT OF THE MUNICIPAL SOLID WASTE (MSW) DISPOSAL SITE "DUPLJA" NOVI VINODOLSKI (CROATIA): HEAVY METALS CASE STUDY

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Abstract

Bistričić, I., Strmić Palinkaš, S. (2013). Geochemical impact of the municipal solid waste (MSW) disposal site "Duplja" Novi Vinodolski (Croatia): heavy metals case study. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

Municipal solid waste disposal site "Duplja" is situated close to the city of Novi Vinodolski (Primorsko-goranska County, Croatia) and water source "Novljanska Žrnovnica", which represents the major source of drinking water in the Croatian coastal region. The MSW disposal site is located in karst terrain and on it mixed municipal waste has been disposed since 1968 without any coverage or isolation of the landfill. In 2007, during the first phase of the landfill remediation a bottom liner with drainage system and leachate lagoon were constructed. This paper in a form of preliminary research investigates the possible past and present influence of the landfill on water source "Novljanska Žrnovnica" using selected heavy metals as indicators.

Key words: landfill, leachate, Novljanska Žrnovnica, Gacka, seawater

Апстракт

Бистричиќ, И., Стрмиќ Палинкаш, С. (2013). Геохемиското влијание на комуналната депонија за цврст отпад „Дупља" Нови Винодолски (Хрватска): студија на тешките метали. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 28, Скопје.

Комуналната депонија за цврст отпад „Дупља" се наоѓа во близина на градот Нови Винодолски (Приморско-горанска област, Хрватска) и во близина на изворишето „Новљанска Жрновница" кој претставува основен извор на вода за пиење во хрватското приморје. Депонијата е изградена врз карстен терен и во неа мешан комунален отпад се одлага од 1969 години без затрупување или било каква изолација. Во 2007 година, за време на првата фаза од ремедијацијата на депонијата беше поставена геомембрана и дренажен систем со лагуна за собирање на исцедокот. Во овој труд се прикажани прелиминарните резултати од истражувањето на минатото и сегашното влијание на депонијата врз изворот Новљанска Жрновница користејќи избрани тешки метали како индикатори.

Клучни зборови: депонија, исцедок, Новљанска Жрновница, Гацка, морска вода

Introduction

Municipal solid waste disposal site „Duplja" is situated in a karst terrain close to the city of Novi Vinodolski (Primorsko-goranska County, Croatia) and there is only 4,9 km air distance between disposal site and water source "Novljanska Žrnovnica", which represents the major source of drinking water in the Croatian coastal region. To be more precise, the MSW "Duplja" is located on the border of the third water source protection zone of "Novljanska Žrnovnica" (Biondić et al. 2009), which is established according to the Croatian legislation (NN 66/11). The possible connection between these two sites, and therefore a risk of groundwater contamination is the main objective of this research.

Fig. 1. Municipal solid waste disposal site "Duplja" before (left) and after the first phase of remediation (right) (photo: Novi list, Kristian Stipeč)

The unsanitary landfill has been operational since 1968 and there were recorded several big and small fires over the years (Fig. 1) since the waste was just dumped in this karst sinkhole without any compression or soil covering. According to IPZ Uniprojekt MCF (2002) analysis, the remaining waste was mostly composed of ashes and incombustible residue. Therefore it has been suggested that those materials have in a way isolated the bottom side of the disposal site by filling in the voids in the karst terrain.

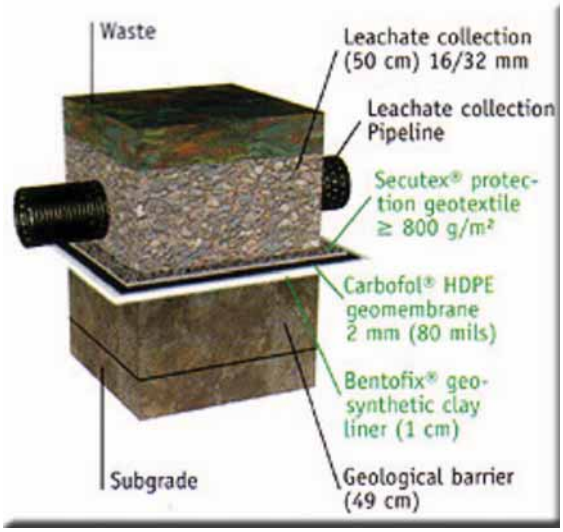

Fig. 2. Scheme of a bottom landfill liner (GT-Trade 2006).

In 2007 the first phase of landfill remediation was carried out, during which a bottom liner with drainage system and leachate lagoon were constructed (Fig. 1). The structure of the bottom liner is presented in the Figure 2. During the remediation most of the ashes and incombustible residue were disposed, but some quantity has been left on the bottom of karst sinkhole, below the bottom liner of the landfill due to inaccessible terrain.

The landfill remediation provided the capacity for the disposal of municipal and non-hazardous industrial waste until 2013. Simultaneously with the development and filling of the landfill, a passive degassing system is built (Budiša et al. 2010). Disposal of waste is planned until the opening of County Waste Management Centre "Marišćina" and then the landfill will be fully remediated and converted to the waste transfer station.

Investigated area

Investigated area corresponds to the drainage basin of "Novljanska Žrnovnica", which covers a vast area in the North Adriatic Coast region and in the mountain region of Gorski kotar, and as well in Lika, more precisely from Lič polje in the northwest to the mountain range Velika Kapela in the north and northeast, including also Gacka and Lika River basins (Fig. 3). In short, the water from water source "Novljanska Žrnovnica" originates from two main locations, on one side from Lič polje and on the other side from rivers Gacka and Lika. The water source includes three smaller water sources and it has been suggested that water from water sources "Nova kaptaža" and "Stara kaptaža" derives from Lič polje and water source "Čardak" from Lika and Gacka (Biondić 2001).

Material and methods

The research was carried out as a preliminary research. Therefore only one sampling was conducted on 16th of April 2011. The weather conditions were changeable and water level was medium. In order to cover the vast research area, 6 representative sampling sites were chosen. The locations and short descriptions of the sampling sites are presented in the Table 1. IB-1 location was chosen according to known occurrences of submarine springs that are

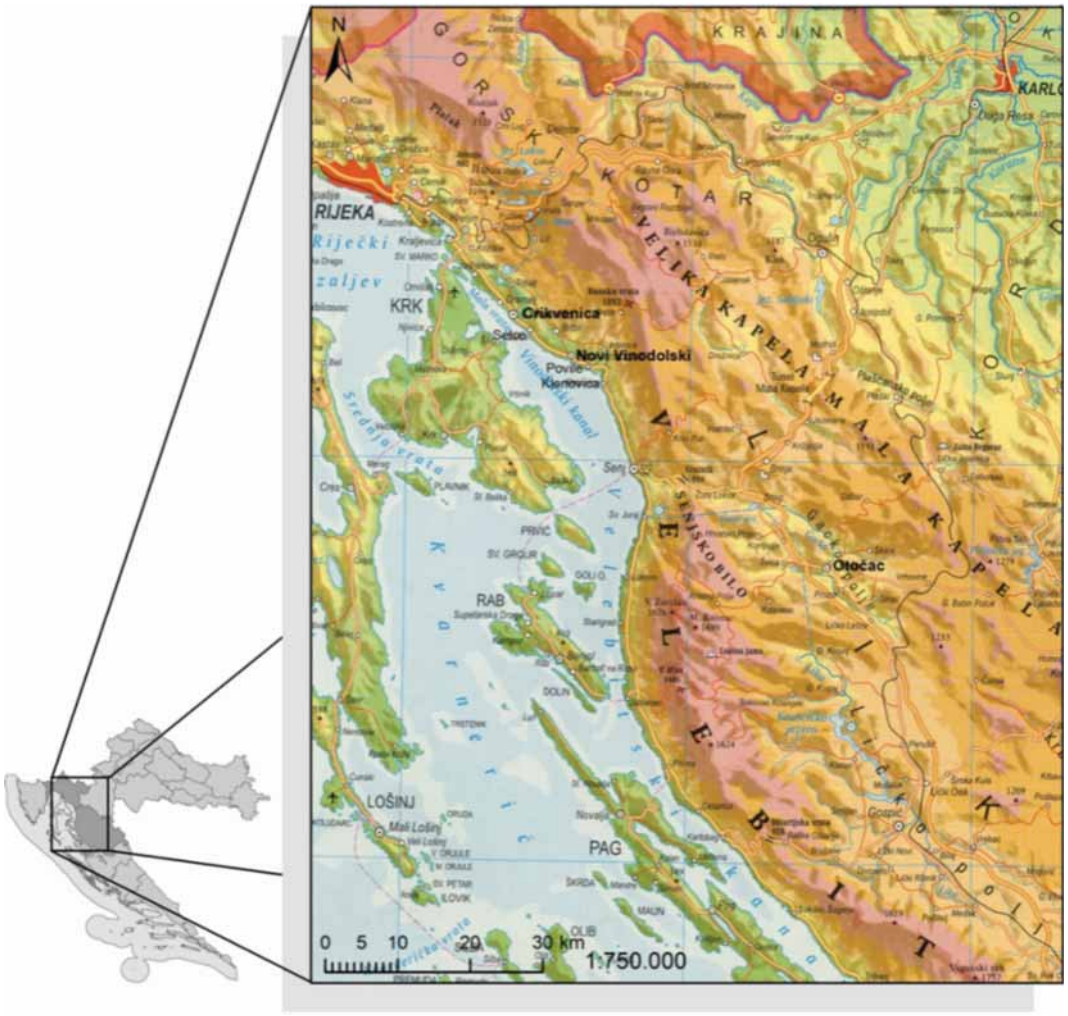

Fig. 3. Geographic position of the investigated area (adapted from Haiman 2007).

not in direct influence of water source "Novljanska Žrnovnica" and IB-7 was chosen as another possible input of pollution into a drainage basin of "Novljanska Žrnovnica".

Directly on the sampling sites basic indicators were measured: temperature (t), pH, dissolved oxygen (DO), redox potential (Eh) and conductivity (CND). For these measurements Hach Lange HQ40D portable meter was used. The meter is operational with four exchangeable electrodes and it is suitable for different types of fluid samples, e.g. wastewater, seawater or fresh water (Hach Lange 2006).

In the laboratory environment concentrations of six heavy metals (Cd, Cr, Cu, Pb, Ni, Zn) were measured. Water samples were collected in 0,5 litre PET bottles. Before usage, bottles were rinsed with nitric acid solution (HNO_3), volume ratio 3:1. After sampling, in laboratory of Department of Mineralogy and Petrology (Faculty of Science, University of Zagreb), to each sample was added nitric acid (HNO_3) to lower the pH of samples below 2. This method was used to ensure mobility of heavy metals, due to the fact that they are often absorbed or precipitated at higher pH. During next few days samples were microfiltrated on a microfilter with 0,45 μm pore size. After the microfiltration samples were stored in 50 ml HDPE bottles and analysed with method 2C on an ICP-MS in AcmeLabs™ in Canada.

In the landfill leachate sample (IB-2) HNO_3 was added more than once, because of high concentration of organic matter which resulted in subsequent increase in pH. The same sample had to be prefiltrated on three different filters (pore sizes 12-25 μm, 4-12 μm and 2 μm), due to high concentrations of organic matter that was blocking the microfilter to fast.

Results

The results of field measurements of temperature (t), pH, dissolved oxygen (DO), redox potential (Eh) and conductivity (CND) and as well measurements of heavy metals, conducted in AcmeLabs™ (Canada) are presented in Table 2.

Tab. 1. List of samples and sampling sites.

Sample	Gaus-Krüger coordinates		Type of sample	Sampling site
	x	y		
IB-1	5478126	5001048	seawater	gravel beach in Selce
IB-2	5484908	5000337	landfill leachate	leachate lagoon at MSW disposal site "Duplja"
IB-4	5488366	4996867	fresh water	water source "Nova kaptaža"
IB-5	5488364	4996893	fresh water	water source "Stara kaptaža"
IB-6	5488387	4996775	fresh water	water source "Čardak"
IB-7	5518688	4969171	fresh water	river Gacka

Tab. 2. Results of field measurements of temperature (t), pH, dissolved oxygen (DO), redox potential (Eh) and conductivity (CND) with laboratory measurements of heavy metals.

parameter	**t**	**pH**	**Eh**	**DO**	**CND**	**Cd**	**Zn**	**Cr**	**Cu**	**Pb**	**Ni**
units of measurement	°C		mV	mg/l	mS/cm	ppb	ppb	ppb	ppb	ppb	ppb
SAMPLES											
IB-1	13,0	8,39	255,8	10,78	58,5	<5	79	<50	16	<10	<20
IB-2	11,2	8,64	-144,5	0,24	15,98	3	770	561	202	45	345
IB-4	8,6	7,83	238,4	11,33	0,242	0,07	8,4	0,6	6	0,6	<0,2
IB-5	9,4	7,86	219,4	11,44	0,243	<0,05	15,8	<0,5	1,3	0,3	<0,2
IB-6	8,6	7,95	248,2	11,84	0,242	<0,05	15,2	<0,5	1,3	0,2	<0,2
IB-7	10,4	7,59	157,9	10,09	0,465	<0,05	16,3	<0,5	1,5	0,2	<0,2

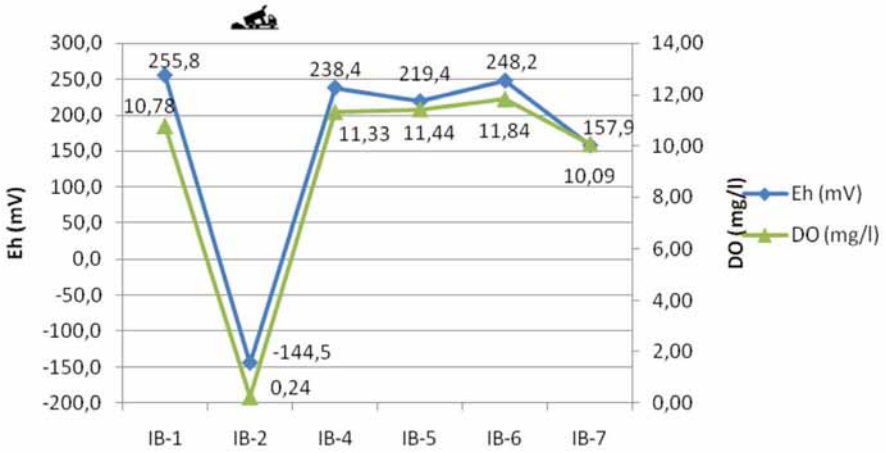

Fig. 4. Chart of the measured redox potential (Eh) and dissolved oxygen concentrations (DO) in the samples. The waste handling vehicle represents the landfill leachate sample.

Temperature is highest for the seawater sample IB-1, and the lowest temperature values are for samples from water sources of "Novljanska Žrnovnica" (IB-4,5,6). All samples are mildly alkaline with the pH range from 7,59 for the river sample (IB-7) to 8,64 for the landfill leachate sample (IB-2). Redox potential is positive for all samples apart from the leachate sample (IB-2), which is characterized by oxidative environment as opposed to reductive environment in other samples. The concentration of dissolved oxygen (DO) is directly related to the redox potential (Fig. 4) and has the lowest value in the lea-

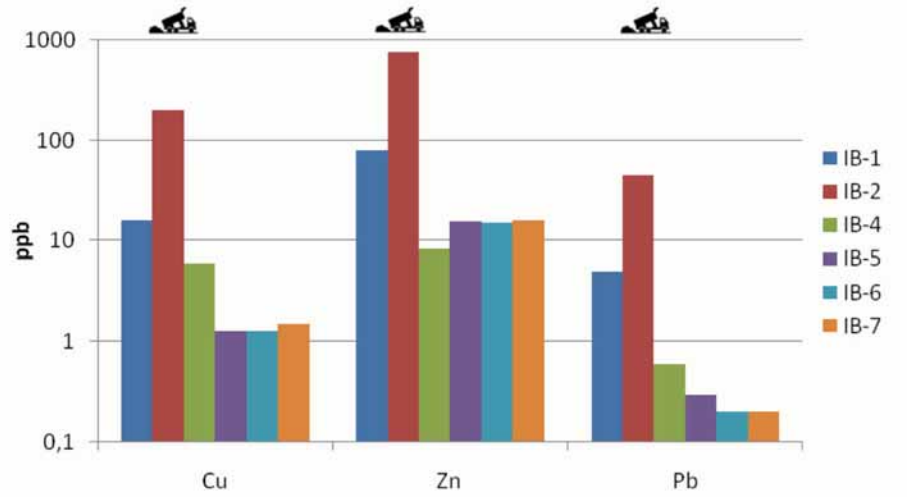

Fig. 5. Concentration of Cu, Zn and Pb in samples. The waste handling vehicles represent the landfill leachate samples.

chate sample (IB-2) which is characterized by nearly anaerobic environment. DO values are in the remaining samples quite uniform, with the highest value in the sample from water source of "Novljanska Žrnovnica" (IB-6). Conductivity (CND) is very low in the samples from water sources of "Novljanska Žrnovnica" (IB-4, 5.6) and Gacka River (IB-7). As expected the maximum CND value is recorded in the seawater sample (IB-1), due to high ion species concentration.

Figure 5 represents a logarithmic distribution of cooper (Cu), zinc (Zn) and lead (Pb) in all samples. Concentrations of other three heavy metals (Cd, Cr, Ni) are not represented graphically due to really low values in most samples, usually below the detection limit. Maximum concentrations of all heavy metals were recorded in the landfill leachate sample (IB-2).

Discussion

During this research concentrations of two sets of indicators were measured. Basic indicators (t, pH, DO, Eh, CND) have been used as indicators of possible connections between sites, but also as indicators that provide general information of the environment and according to that expected heavy metal behaviour.

Temperature values of water from water sources of “Novljanska Žrnovnica” are much lower than annual average air temperature of that location, which corresponds with the origin of water from mountain hinterland (Biondić 2001). pH is for all samples alkaline as expected in karst environment. pH of landfill leachate sample (IB-2) is alkaline as a result of anaerobic methane phase that is dominant in this landfill and as well as a result of large quantities of ashes that remained after waste combustion. Concentrations of dissolved oxygen are typical for natural fresh water and seawater at specified temperatures. DO levels in IB-2 sample are as anticipated very small, since the oxygen is consumed in large quantities by bacterial decomposition of organic matter. As seen on Figure 4 redox potential (Eh) is in direct relation to DO. It’s positive for all samples, apart from IB-2 because of anaerobic conditions of the landfill leachate. Reduced conditions determine the low mobility of the large number of potentially toxic heavy metals. Conductivity (CND) is a relevant indicator of pollution and salination of natural aquifers. Chapman (1996) states that CND value for fresh water greater than 1 mS/cm corresponds to pollution, while the maximum contaminant level (MCL) established by Croatian legislation is 2,5 mS/cm (NN 47/08). Even if we take into account the more stringent criteria, all values measured in samples of fresh water (IB-4,5,6,7) are far below mentioned limit.

Heavy metals were chosen as indicators of possible influence and connection between MSW disposal site and water source “Novljanska Žrnovnica”, due to the fact that their concentration is much higher in landfill leachates then in natural waters and also because they are stable in the environment for relatively long time. Six heavy metals (Cd, Cr, Cu, Pb, Ni, Zn) were selected as crucial for this research according to average landfill leachate concentrations (Christensen et al. 2001). Due to the alkaline pH, which was recorded in all samples, most heavy metals have really low mobility, therefore samples were acidified to maximize their mobility to accurately determine their content in the sample. Also, the standard procedure is to filter the fraction below 0,45 μm, which removes the larger organic component and all the heavy metal content connected to it. Apart from organic complexes very important are

inorganic complexes as well. Complexes with a carbonate ion often create zinc and nickel, and to a lesser percentage cadmium, copper and lead. Complex formation increases the solubility and mobility of the metals, but it seems that the sorption and precipitation are very significant for most metals, and therefore have a considerable impact on reducing the migration of metals leaching from landfills (Christensen et al. 2001).

From all the heavy metals cadmium concentrations were the lowest. Low values were recorded in the landfill leachate sample (IB-2) and even lower in water source "Nova kaptaža" sample, while in the other samples values were below the threshold of detection. Only in the sample IB-4 was recorded concentration slightly above the detection threshold, but this concentration is far below the MCL values for drinking water. Nevertheless, during seven years long monitoring of "Novljanska Žrnovnica" Biondić et al. (2009) stated that all the cadmium concentrations were below the detection threshold, i.e. less than 0,003 mg/l. As cadmium in groundwater under natural conditions is usually associated with ore deposits of zinc, lead or copper when they are in contact with a soft, slightly acidic water (Biondić et al. 2009), which are not recorded in the study area (Grimani et al. 1973), the question arises whether the observed concentration of cadmium in the IB-4 sample is of anthropogenic origin. Anthropogenic sources of cadmium are usually from leaching of industrial waste water and landfills or from artificial fertilizers. Cadmium is highly toxic due to chemical similarity to zinc, which is an essential element. As a result cadmium is easily incorporated into enzymes and inhibits the metabolism of zinc. Since replacing zinc, these two elements significantly negatively correlate. Zinc concentrations in the samples are opposite to concentrations of cadmium, and as a result of significantly higher solubility of zinc in most natural waters (Hem 1985), its concentrations are the highest in all samples of the observed heavy metals.

Lead and copper concentrations were measureable in most samples. The highest concentrations were recorded for the landfill leachate sample (IB-2) and seawater (IB-1). The concentrations from samples of water source "Novljanska Žrnovnica" (IB-4,5,6) and Gacka (IB-7) are small, below the MCL. The concentrations of lead and copper in samples from "Novljanska Žrnovnica" are far below the MCL, but the focus is on the highest concentration from this three samples, recorded at "Nova kaptaža" (IB-4). In IB-4 sample concentration of Cu was 6 ppb and Pb 0,6 ppb. The concentration in that sample is consistent with the previous research data (Biondić et al. 2009). Then the concentration of lead in the majority of samples from "Novljanska Žrnovnica" was below the limit of detection (<1 ppb), and the maximum recorded concentration was 1,4 mg/l. However, there is a pattern for "Nova kaptaža" (IB-4) and as mentioned above for zinc and cadmium, this specific water source stands out again from the other two. Increase in lead and copper in IB-4 sample is possible of anthropogenic origin. Anthropogenic sources can be landfills, copper and lead pipes, for copper specifically pesticides and for lead gasoline, discarded batteries, tin cans and paint (Hem 1985). The concentrations of chromium and nickel are very large in the leachate sample and mostly below the limit of detection in all other samples.

Conclusions

According to the heavy metal analysis there is no present connection between disposal site "Duplja" and water source "Novljanska Žrnovnica" which corresponds with well-done remediation of the landfill. In comparison of the indicators with the legislation there is established that all of the measured values from water samples of "Novljanska Žrnovnica" and Gacka are within the MCL limits (NN 47/08, NN 137/08). In samples from "Novljanska Žrnovnica"" and Gacka were found very low concentrations of heavy metals, in most cases below the detection limit. According to the comparison of heavy metal content between individual water sources of "Novljanska Žrnovnica", water source "Nova kaptaža" (IB-4) stands out from the rest.. For that sample there are reported higher concentrations of several heavy metals (Cd, Cr, Cu, Pb), but these concentrations are still far below the MCL. There is a possibility that slightly increased concentrations of heavy metals in the sample IB-4 are result of the contamination from the landfill prior to its remediation and it may be that the residue below bottom liner has been slowly rinsing, but it is necessary to carry out further research in order to determine the real situation.

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NN 137/08: Uredba o opasnim tvarima u vodama.

NN 47/08: Pravilnik o zdravstvenoj ispravnosti vode za piće.

NN 66/11: Pravilnik o uvjetima za utvrđivanje zona sanitarne zaštite izvorišta.

Summary

Solid municipal waste disposal site "Duplja" is situated close to the city of Novi Vinodolski and only 4,9 km air distance from water source „Novljanska Žrnovnica", which represents the major source of drinking water in the Croatian coastal region. Drainage basin of "Novljanska Žrnovnica" covers a vast area from Lič polje in Gorski kotar, in the northwest to the mountain range Velika Kapela in the north and northeast, including also Gacka and Lika river basins. The solid municipal waste disposal site is located in karst terrain and on it mixed municipal waste has been disposed since 1968. Considering its location on the border of third water protection zone of „Novljanska Žrnovnica", it was necessary to carry out landfill remediation, whose first phase was completed in 2007. This research was concentrated on several heavy metals as indicators of possible influence of the disposal site on the water source, alongside with the set of basic indicators. Using these parameters there hasn't been a present day connection revealed, but also that doesn't excludes the possibility that one was possible in the past or in the different underground water conditions.

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DETERMINING THE EFFECTIVENESS OF REMOVING HEAVY METALS FROM MODIFIED WASTEWATER BY COPRECIPITATION AND ADSORPTION WITH $CaCO_3$

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Abstract

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This paper presents the results of the research which was based on leachate from landfill of municipal waste and on modified wastewater. Water was modified by the Method of Standard Addition of the following metals: Ba, Cu, Cd, Fe, Hg, Mn, Ni, Pb, Sn and Zn. Metals have been removed from the modified wastewater by method of coprecipitation with calcium carbonate and by adsorption to calcium carbonate. The goal of the study was to explain and compare mechanisms of the most common processes for purification of wastewater by using low cost materials. Effectiveness of the processes was determined after the statistical analysis of the gathered data.

Keywords: leachate, landfill, calcium carbonate

Introduction

Heavy metals are elements having relative atomic mass between 63.5 and 200.6, and a specific density greater than 5.0. With the rapid development of industries such as metal plating facilities, mining operations, fertilizer industries, tanneries, batteries, paper industries and pesticides, etc., heavy metals wastewaters are directly or indirectly discharged into the environment increasingly, especially in developing countries. Unlike organic contaminants, heavy metals are not biodegradable and tend to accumulate in living organisms and many heavy metal ions are known to be toxic or carcinogenic. Toxic heavy metals of particular concern in treatment of industrial wastewaters include zinc, copper, nickel, mercury, cadmium, lead and chromium (Fu et al., 2011).

Zinc is a trace element that is essential for human health. It is important for the physiological functions of living tissue and regulates many biochemical processes. However, too much zinc can cause eminent health problems, such as stomach cramps, skin irritations, vomiting, nausea and anemia (Oyaro et al., 2007). Copper does essential work in animal metabolism. But the excessive ingestion of copper brings about serious toxicological concerns, such as vomiting, cramps, convulsions, or even death (Paulino et al., 2006). Nickel exceeding and its critical level might bring about serious lung and kidney problems aside from gastrointestinal distress, pulmonary fibrosis and skin dermatitis (Borba et al., 2006). Furthermore it is known that nickel is human carcinogen. Mercury is a neurotoxin that can cause damage to the central nervous system. High concentrations of mercury cause impairment of pulmonary and kidney function, chest pain and dyspnoea (Namasivayam and Kadirvelu, 1999). The classic example of mercury poisoning is Minamata Bay. Cadmium has been classified by U.S. Environmental Protection Agency as a probable human carcinogen. Cadmium exposes human health to severe risks. Chronic exposure of cadmium results in kidney dysfunction and high levels of exposure will result in death. Lead can cause central nervous system damage. Lead can also damage the kidney, liver and reproductive system, basic cellular

processes and brain functions. The toxic symptoms are anemia, insomnia, headache, dizziness, irritability, weakness of muscles, hallucination and renal damages (Naseem and Tahir, 2001). Chromium exits in the aquatic environment mainly in two states: Cr(III) and Cr(VI). In general, Cr(VI) is more toxic than Cr(III). Cr(VI) affects human physiology, accumulates in the food chain and causes severe health problems ranging from simple skin irritation to lung carcinoma (Khezami and Capart, 2005).

Faced with more and more stringent regulations, nowadays heavy metals are the environmental priority pollutants and are becoming one of the most serious environmental problems. Therefore these toxic heavy metals should be removed from the wastewater to protect the people and the environment.

Materials and methods

Water samples were collected from landfill of municipal waste. Directly on the sampling site temperature, pH, dissolved oxygen, redox potential and conductivity were measured with different types of electrodes (Table 1).

Tab. 1. Results of field measurements of temperatute, pH, dissolved oxygen, redox potential and conductivity

t (°C)	pH	Eh (mV)	CND (mS/cm)	DO (mg/l)
23,4	8,26	-228,4	15,08	0,22

There have been 7 solutions prepared in laboratory, mixed in different ratios with collected leachate water (Table 2). Heavy metals have been removed from modified wastewater by method of co-precipitation with calcium carbonate and by method of adsorption to calcium carbonate.

Tab. 2. Solutions used in the study

Name of the sample	Composition of the sample
AG-1	Jak.O.
AG-2	1:1
AG-3	1:9
AG-4	Ot.m.
AG-5	Ot.m.1:9
AG-6	1:1 Ot.m.1:9, Jak.O.
AG-7	1:9 Ot.m.1:9, Jak.O.

Previously prepared solutions (AG-1, AG-2, AG-3, AG-4, AG-5, AG-6 and AG-7) were transferred to volumetric flasks from 100 mL. 2.7722g of $CaCl_2$ and 3.4521g of K_2CO_3 was added to each one for co-precipitation, which is equivalent to 2.5g of $CaCO_3$ and 2.5g of $CaCO_3$ was added to each one for adsorption. Samples were left in the digestor for a few days to balance concentrations. Then samples were centrifuged in a Centric 322A centrifuge at 3500 rpm for 20 minutes to separate the sediment from the filtrate. Precipitates were dried in plastic cuvettes in an oven at 50 °C. After drying they were crushed in the mortar and stored in paper bags.

Reaction of precipitation of $CaCO_3$:

$$CaCl_{2(s)} + K_2CO_{3(s)} \Leftrightarrow CaCO_{3(s)} + 2Cl^-_{(aq)} + 2K^+_{(aq)}$$

Sediments obtained after co-precipitation and adsorption have been analyzed by method of Energy Disperzive X-ray Fluorescence (EDXRF). Measurements were done with a W anode and Mo secondary target in orthogonal geometry, with measurement parameters of 40 kV and 35 mA. The irradiation time was 1000 s. X-ray spectra were collected with a Si(Li) detector (FWHM=170 eV at 5.9 keV) and were analyzed using QXAS program package – direct comparison method. IAEA "Lake Sediment" was used as a reference material.

Results and discussion

It can be seen from the results from Table 3 that concentrations of heavy metals in a sample of wastewater from landfill of municipal waste (AG-1) are low. They are low because of controlled chemical treatment of leachate water and for maintaining conditions of high pH in leachate water. In those conditions heavy metals are immobilized. Because of that made ideal has been solution in laboratory conditions which has high concentrations of heavy metals and is without organic matter - AG-4 (Table 4).

Tab. 3. Concentrations of metals in the wastewater sample (AG-1)

Metals	AG-1 (ppb)
K	23,36
Ca	50,92
Ti	18,28
V	6,88
Mn	3,64
Fe	2290
Co	37,12
Ni	21,48
Cu	4,44
Zn	9,96
As	3,24
Zr	56,88

Mixing those two solutions (AG-1 and AG-4) in different ratios has obtained solution with high heavy metals concentrations and also with high concentration of organic matter. The results from the co-

precipitation and adsorption can be seen in Figure 1 and Table 5 for ideal solution and in Figure 2 and Table 6 for realistic solution.

Tab. 4. Ideal solution prepared in laboratory (AG-4)

Metals	c (mol/L)	γ (g/L)
Cu	1,574 x 10^{-3}	0,1
Ni	1,704 x 10^{-3}	0,1
Pb	4,815 x 10^{-4}	0,1
Hg	4,985 x 10^{-4}	0,1
Mn	1,820 x 10^{-3}	0,1
Fe	1,791 x 10^{-3}	0,1
Zn	1,529 x 10^{-3}	0,1

Co-precipitation with $CaCO_3$ for removing heavy metals has shown itself as a more effective method, except for lead. It has not been effective for lead because pH conditions in solution were about 11 (because of hydrolysis of K_2CO_3) and in those conditions lead is mobile (Figure 3). Method sholud be effective for lead in conditions of pH 7-9 (Figure 3).

Method of adsorption to $CaCO_3$ also proved effective because pH of water in carbonates is about 8,4 and in those conditions most of the heavy metals are immobile (Figure 4). What can also be seen from the results is a great impact of organic matter on the efficiency of removing heavy metals, especially for mercury that forms organometallic complexes.

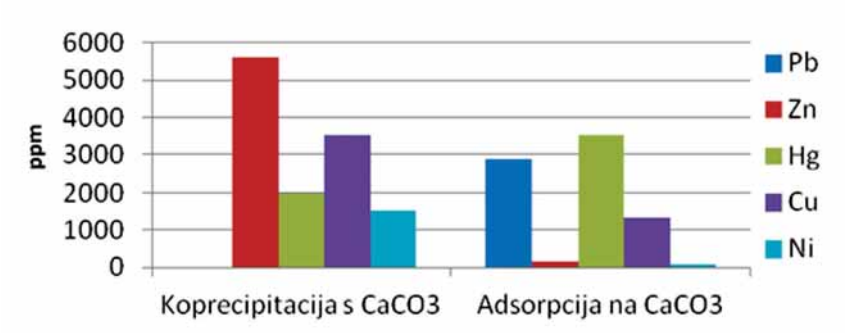

Fig. 1. Concentrations of heavy metals in sediments of solution AG-4.

Tab. 5. Concentrations of heavy metals in sediments of ideal solution AG-4.

AG-4	Ni (ppm)	Cu (ppm)	Zn (ppm)	Hg (ppm)	Pb (ppm)
Co-precipitation with $CaCO_3$	1526	3516	5626	1974	0
Adsorption to $CaCO_3$	89.7	1319	154	35251	2870

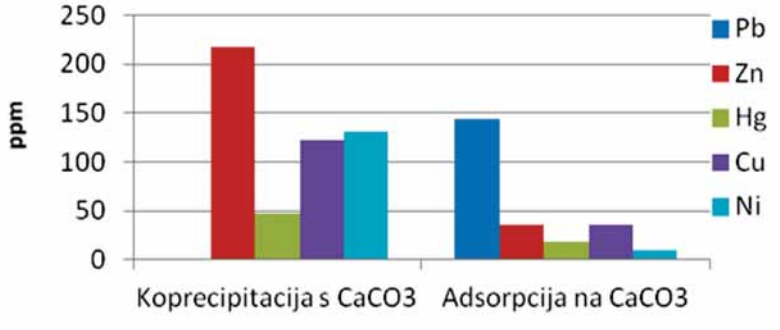

Fig. 2. Concentrations of heavy metals in sediments of solution AG-6.

Tab. 6. Concentrations of heavy metals in sediments of realistic solution AG-6.

AG-6	Ni (ppm)	Cu (ppm)	Zn (ppm)	Hg (ppm)	Pb (ppm)
Co-precipitation with $CaCO_3$	131.14	121.68	217.70	46.65	0
Adsorption to $CaCO_3$	9.39	35.26	35.10	17.71	143.80

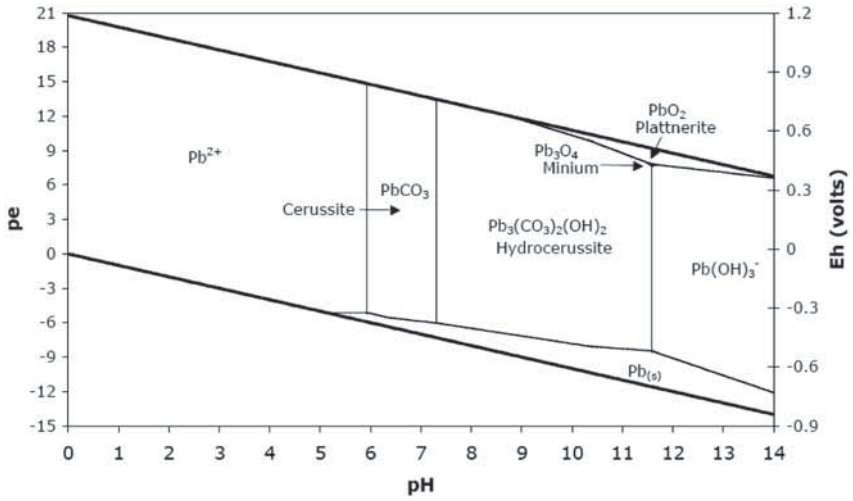

Fig. 3. Eh-pH diagram for Pb-CO_3-H_2O system at 25° C (Scheetz, 2004).

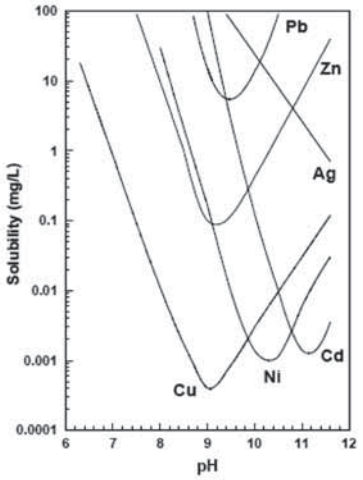

Fig. 4. Solubility of metal hydroxides as a function of pH (EPA, 1982.).

Conclusions

From the results we see that the co-precipitation with $CaCO_3$ is a better method for removing all heavy metals, except lead. For the co-precipitation with $CaCO_3$ to be effective for lead the pH must be lowered to 7-9, as we have already determined, but the problem is that the ideal pH for one metal may put another metal back into solution. The method of adsorption on $CaCO_3$ has also proved itself. This is because the typical pH of water in carbonate terrains is 8,4 and in that pH conditions metals are immobile so they accumulate.

If the wastewater contains compounds that create complexes (organic matter, chloride, carbonate and bicarbonate ions, nitrates, nitrites, amonium complexes) they will mobilize metals and inhibit their precipitation as seen in the case of mercury which is prone to form organometallic complexes. Therefore it is necessary first to remove such compounds so the process of removing heavy metals can be as effective as possible. From all our results we can conclude that the best solution is to combine the methods.

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Summary

Nowadays heavy metals are the environmental priority pollutants and they are becoming one of the most serious environmental problems. Heavy metals should be removed from the wastewater to protect the people and the environment. Many methods are being used to remove heavy metal ions. The most common ones are chemical precipitation and adsorption. This research was based on leachate water from landfill of municipal waste and on modified wastewater. The goal of the research was to explain and compare mechanisms of the most common processes for purification of wastewater by using calcium carbonate. Results showed that co-precipitation with $CaCO_3$ is more effective method for removing heavy metals than method of adsorption to $CaCO_3$, but the best results are achieved by combining both methods.

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INFLUENCE OF INCREASED SALINITY ON PROTOZOA IN ACTIVATED SLUDGE

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Abstract

Jelavić, E., Jaćimovska, M., Matoničkin Kepčija, R. (2013). Influence of increased salinity on protozoa in activated sludge. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

Activated sludge is a biomass of organisms used in biological treatment of wastewater. Various industrial plant wastewaters can be laden with salts and seawater intrusions into wastewater treatment plants is also a possibility. We set up an experiment in order to study the effects of sodium chloride (NaCl) on heterotrophic microorganisms in activated sludge. Different quantities of NaCl were added to samples in order to attain concentrations of 5, 7 and 10 ‰. Experiment lasted for two weeks and the activated sludge used was taken from the Central Wastewater Treatment Plant for the city of Zagreb. In all treatments, NaCl had an effect on both composition and structure of the communities. With increasing concentrations of NaCl, a decrease of the number and density of species in activated sludge microfauna was observed. This implies possible unfavourable effects on the efficiency of activated sludge. Species that proved resistant to sodium chloride were the holo-euryhaline species of ciliates, namely *Cyclidium glaucoma* and *Acineria incurvata*. These species were also dominant in samples containing NaCl. Most sensitive species proved to be the oligo-stenohaline species of ciliates (*Coleps hirtus*, *Aspidisca cicada*, *Drepanomonas revoluta*) as well as all the species belonging to the groups Suctoria and Rotifera.

Keywords: wastewater, protozoa, ciliates, salinity tolerance, activated sludge

Introduction

Activated sludge is a biomass of organisms composed of bacteria, fungi, protozoa and small metazoa used in biological treatment of wastewater. Protozoa are an important part of activated sludge with ciliates as dominant group. They play a role in regulation of bacterial biomass, removal of pathogenic and faecal bacteria and clarification of the effluent (Madoni 2003). Protozoa assemblage changes with operational conditions of the wastewater plant, therefore their community structure can be used as an indicator of the biological reactor performance (Madoni, 1994).

Various industrial plant wastewaters can be laden with salts and seawater intrusions into wastewater treatment plants is also a possibility. Negative effects of salt on eukaryotic heterotrophs can limit performance of activated sludge. Organisms of protozoa in activated sludge show different resistance and tolerance to salinity (Salvadó et al. 2001).

An experiment was carried out in order to study the effects of sodium chloride (NaCl) on heterotrophs in activated sludge with the aims to determine concentration that has significant effect on composition of protozoa and micro-metazoa and to determine the most sensitive and the most tolerant species. One of the aims was to find out the recovery patterns of heterotrophs after salinity stress.

Materials and methods

Laboratory cultures with different NaCl concentrations were prepared in Erlenmeyer flasks using activated sludge from the Central Wastewater Treatment Plant for the city of Zagreb. Activated sludge was diluted with municipal wastewater (1:9) with subsequent addition of different quanti-

ties of NaCl to attain concentrations of 5, 7 and 10 ‰. Three replicate samples were prepared for each concentration. Experiment lasted for two weeks and all samples were aerated (6 L/min) in order to simulate the conditions occurring in an aeration tank. Each flask was covered with aluminium foil to prevent any autotrophic organisms from appearing.

Subsamples (100 μL) of micro-fauna were taken on days 0, 2, 5, 7, 9 and 12. Taxa were identified and enumerated at various magnifications (100, 250, 400X) using literature (Kahl 1930− 1935, Koste 1978, Foissner et al. 1991, 1992, 1994, 1995, Page 1991). Ciliates were additionally analyzed with respect to life form (free-swimming, attached, crawling and swimming-crawling) and salinity tolerance according to Foissner et al. (1996).

Statistical analysis was done using analysis of covariance (ANCOVA) and unequal N HSD *post-hoc* test. Shapiro-Wilk W test was used to test for normality of data. When needed, data were subjected to transformations in order square root-fourth root-logarithm to achieve normal distribution. Analysis was done using Statistica 9.1 (StatSoft Inc 2010).

Results

Overall, 55 taxa of protozoa and micro-metazoa were identified. Ciliates dominated with 41 taxa, followed by Gymnoamoebae (5) and Rotifera (3). Only one taxon was found for Choanoflagellata, Euglenozoa, Testacea, Rhizaria, Nematoda and Tardigrada. We identified 45 taxa in control treatment, while treatments with NaCl showed clear pattern of decrease in taxa number with increase in salinity (31 taxa in 5 ‰, 27 taxa in 7 ‰ and 24 taxa in 10 ‰). Time was not statistically significant covariable ($p>0.05$), while there was statistically significant difference between treatments ($p<0.001$). According to *post-hoc* test (unequal N HSD) control treatment had significantly higher number of taxa compared to all three concentrations ($p<0.001$). There was also statistically significant difference in taxa number between 5 ‰ and 10 ‰ ($p<0.001$) and between 7 ‰ and 10 ‰ ($p<0.05$). This pattern remained almost constant throughout an experiment (Fig. 1).

Ciliates dominated in abundance, having share of 47 % to 94% in total abundance of heterotrophs. Testate amoebae followed with the share of 6 % to 53 %, while other groups contributed at most 2 % to total abundance. NaCl also showed an effect on abundance of taxa in activated sludge (Fig. 2). Recovery of community in terms of both taxa numbers and abundance was evident for cultures at 5 ‰ of NaCl (Figs. 1 and 2). Concentration of 7 ‰ of NaCl already led to irreversible changes in community structure, within time span covered by our experiment. Time was statistically significant covariable, and abundance statistically differed between treatments ($p<0.001$). According to *post-hoc* test (unequal N HSD) difference was significant between 5‰ and 7‰ ($p<0.01$), between 5 ‰ and 10 ‰ ($p<0.001$) and between control and 10 ‰ ($p<0.01$).

Species with highest abundance were ciliate *Cyclidium glaucoma,* being dominant in treatment with 5 ‰ of NaCl. Testate amoeba *Euglypha* sp. followed with high share in abundance in all treatments. Other taxa having high abundance were: *Acineria* sp., *Litonotus* sp. and *Coleps hirtus*, with the first two being salinity tolerant and *C. hirtus* was being completely absent from all treatments with NaCl. *Amphileptus punctatus*, *Litonotus crystallinus*, *Litonotus lamella, Opercularia coarctata*, Peritricha-swarmer and *Tetrahymena pyriformis* were found in all doses, except in the initial samples. The dynamics of total abun-

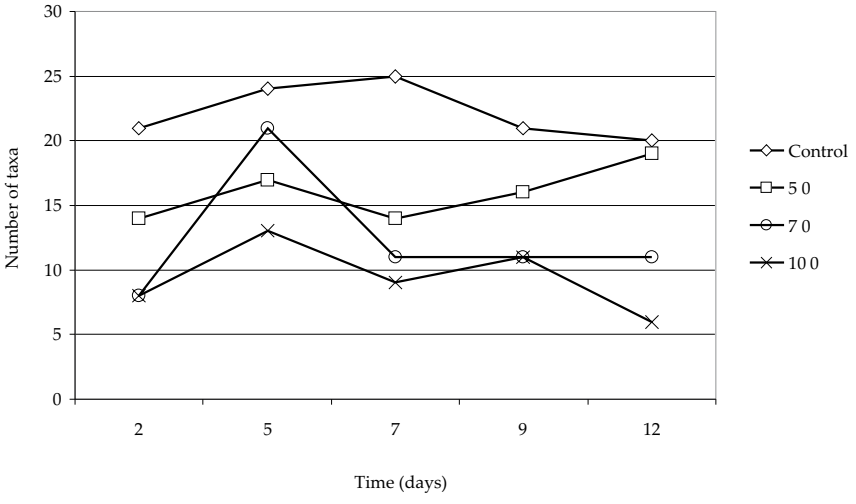

Fig. 1. Dynamics of taxa number of microfauna in activated sludge

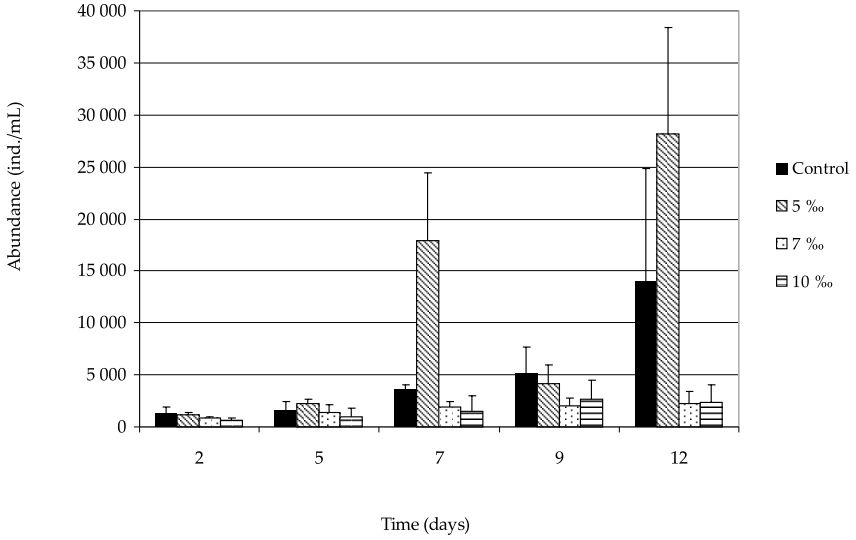

Fig. 2. Dynamics of microfauna abundance in activated sludge

dance (Fig. 2) was highly determined by dominant species, especially in treatments containing NaCl.

Increased salt concentrations influenced life forms of ciliates (Fig. 3). Attached ciliates decreased in all experimental samples, while crawling and free-swimming ciliates dominated in treatments with NaCl. This pattern was also under the influence of the most dominant species, for instance free-swimming ciliates dominated in 5 ‰ treatment due to *C. glaucoma* dynamics, while crawling ciliate *Acineria* sp. and swimming-crawling *Litonotus* sp. dominated in 7 ‰ and 10 ‰ treatment.

Expectedly, the share of holo-euryhaline ciliates greatly increased at all treatment with NaCl (Fig. 4). More tolerant species, namely holo-euryhaline species *C. glaucoma* and *Acineria* sp. developed dense populations. Most sensitive species in our experiment proved to be the oligo-stenohaline species of ciliates (*Coleps hirtus*, *Aspidisca cicada*, *Drepanomonas revoluta*) as well as all rotifers.

Discussion

Different concentrations of NaCl affected activated sludge microfauna by causing changes in abundance and number of species. The biggest number of taxa appeared in the control while taxa number decreases with higher concentration of NaCl. Abun-

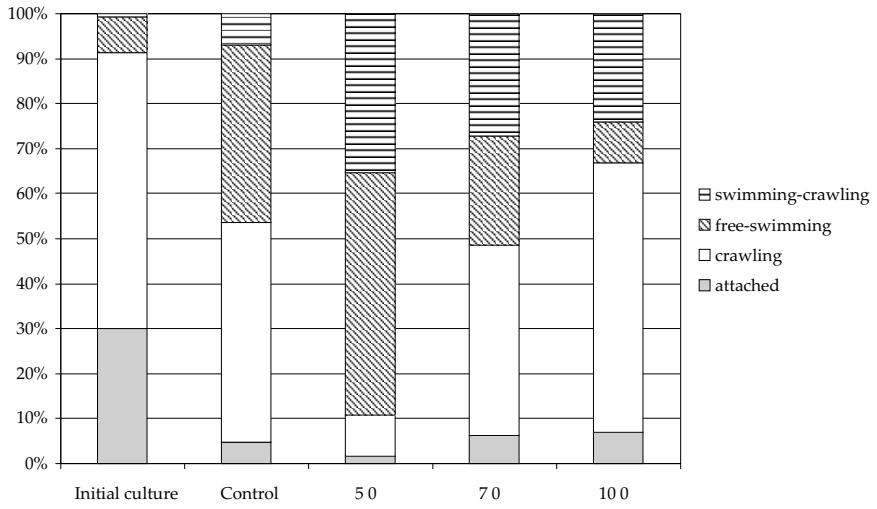

Fig. 3. Distribution of ciliate life forms (share in abundance) in activated sludge

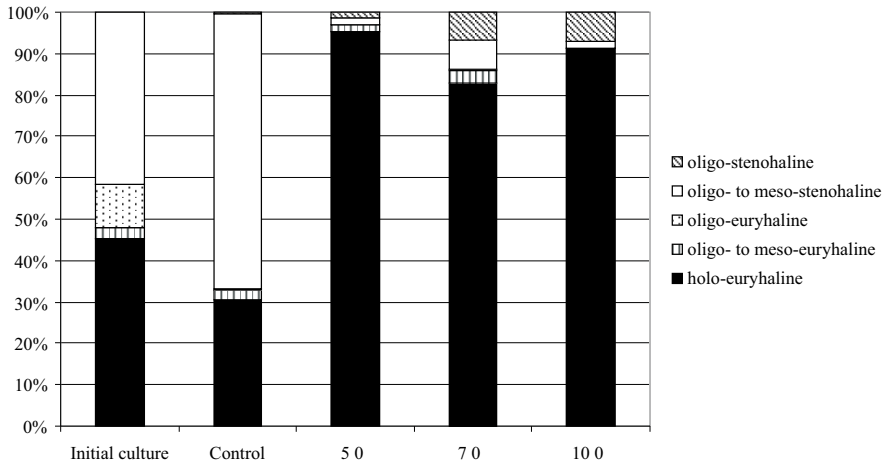

Fig. 4. Distribution of ciliate salinity tolerance groups (share in abundance) in activated sludge

dance of individual species didn't follow this trend as some species have either an affinity to NaCl or are sensitive to it.

The results of this study show that the most abundant species in NaCl treatments were those which are considered as holo-euryhaline species: *Cyclidium glaucoma, Acineria incurvata*, *Amphileptus pleurosigma* and *Litonotus* sp. 5 ‰ concentration of NaCl was very favourable to *Cyclidium glaucoma*, which dominated population. Bick (1964) found that the genus *Cyclidium* was very tolerant to salinity and, in his experiments, species of this genus often dominated the populations.

In contrast, some taxa proved to be extremely sensitive to NaCl. This includes taxa of crawling ciliates such as *Aspidisca cicada, Aspidisca lynceus* and *Chilodonella uncinata.* The species *Coleps hirtus*, *Drepanomonas revoluta*, *Epystilis sp*. as well as species from Suctoria and Rotifera taxa were absent from the treated samples. The effect of sodium chloride depends on the ecological characteristics of each species (Salvadó 2001). The most sensitive species were α-β-mesosaprobic, *Litonotus lamella*, *Aspidisca cicada* and *Trochilia minuta.*

Taxa we found in activated sludge are consistent with typical microfauna of activated sludge (Curds 1982). By analyzing the share of each group it was confirmed that ciliates are the dominant group in activated sludge microfauna (Da Motta et al. 2001, Papadimitriou et al. 2004). There was an exception in 10 ‰ treatment where Testacea held a 53 % share, explained by the fact that *Euglypha* is a resistant and adaptable taxon (Madoni 2011). In addition to *Euglypha* sp., taxa that acclimatised to NaCl were, previously mentioned, *Cyclidium glaucoma* and *Litonotus* sp. as well as *Ohytrichidae*, *Vorticella convallaria*, *Vorticella microstoma*, *Tetrahymena pyriformis* and *Opercularia coartata,* the latter being found in all treatments in the beginning of the experiment, just like Nematoda.

In terms of taxa number and abundance, there was almost complete recovery of community in treatment with 5 ‰, so this concentration led to reversible changes. According to Smurov and Fokin (1999), this concentration is probable salt limit for freshwater ciliates, along with some metazoan species.

By analyzing life forms of microfauna we confirmed the findings of Martín-Cereceda et al. (1996) that in stable activated sludge most common forms are attached and crawling species, while increase of abundance of swimming and swimming-crawling forms indicates changes in the environment. If the swimming forms are dominant then the bacteria population will be larger and there'll be more organic matter (Papadimitriou et al. 2007). In our experiment, this was the case in the 5 ‰ treatment. As we never analyzed bacteria dynamics these arguments are based on assumptions.

During the entire experiment, attached forms of ciliates were the least represented in the microfauna which can be related to two factors. First, Na^+ destabilize the floccule structure (Hashad et al. 2006) and, second, attached and swimming organisms are competing for food (Papadimitriou et al. 2007). Since attached and crawling life forms are dependent on the floccule, it was expected that the presence of sodium chloride would have more influence on these organisms. Compared to the initial sample, number of attached life forms was reduced, even in the control. Probable cause for this is laboratory conditions, changing the micro-environment.

Conclusions

Sodium chloride, in concentrations of 5, 7 and 10 ‰ reduces biodiversity of activated sludge.

Concentration of 5 ‰ caused reversible changes in terms of taxa number and abundance, while 7 and 10 ‰ led to irreversible changes in those community parameters.

Samples treated with NaCl were dominated by holo-euryhaline species, while oligo- to steno-mesohaline spesies were dominant in the control.

Most sensitive species proved to be: *Aspidisca cicada*, *Aspidisca lynceus*, *Chilodonella uncinata*, *Coleps hirtus*, *Drepanomonas revoluta* as well as all the species belonging to the groups Suctoria and Rotifera.

Presence of NaCl in tested concentrations leads to a change in life forms present in activated sludge; with higher concentrations more swimming-crawling and swimming forms are found.

Percentage of attached life forms is lower in all treatments than it was in the initial sample, probably due to laboratory conditions.

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Summary

Since the salinity significantly affects the physical and biochemical properties of the activated sludge, the effects of sodium chloride (NaCl) on heterotrophic microorganisms in activated sludge were studied. Laboratory cultures with 5, 7 and 10 ‰ NaCl concentrations were prepared using activated sludge from the Central Wastewater Treatment Plant for the city of Zagreb. Taxa were identified and enumerated. An increase in salt concentration affected the microbial community by causing changes in abundance and taxa number. Species that proved resistant to sodium chloride were the holo-euryhaline species of ciliates, namely *Cyclidium glaucoma* and *Acineria incurvata*. These species were also dominant in samples containing NaCl. Most sensitive species proved to be the oligo-stenohaline species of ciliates (*Coleps hirtus*, *Aspidisca cicada*, *Drepanomonas revoluta*) as well as all the species belonging to the groups Suctoria and Rotifera. We found that sodium chloride, in these concentrations reduced the biodiversity of activated sludge, but while presence of NaCl in concentrations 7 and 10 ‰ proved irreversible, the 5 ‰ treatment showed signs of recovery in respect to biodiversity. We, also, observed a change in life forms found in activated sludge, with more crawling-swimming and swimming forms present as concentration of NaCl increases. Attached life forms were less abundant in all cases than in the initial sample, but this may be due to laboratory conditions destabilizing the floccules. This study evaluates the effects of different concentrations of NaCl on activated sludge microorganisms and their community composition. The study also contributes to the understanding of activated sludge composition during seawater intrusions into wastewater treatment plants.

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LAND COVER SUCCESSION AS A RESULT OF CHANGING LAND USE PRACTICES IN NORTHEAST MACEDONIA

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Abstract

Jovanovska, D. & Melovski, Lj. (2013). Land cover succession as a result of changing land use practices in Northeast Macedonia. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 28, Skopje.

The paper presents the results of a comparative GIS analysis of habitats and land cover change patterns in northeast Macedonia. The habitats were mapped in 1995 and 2011 along 500 m to one kilometer wide and 88 km long corridor. The mapping was carried in course of the Environmental Impact Assessment studies for the railway construction Kumanovo – Deve Bair as part of the European Transport Corridor 8. The aim of the presented study was to document changes in land cover within 16 years period of time and to identify the reasons that led to present landscape structure and habitat composition in the area.

The most considerable changes in the land cover along the surveyed corridor were observed at hill pastures (dry grasslands), followed by agricultural land, settlements and forests. The results provide management guidelines for sustaining the land use practices that have the greatest role in shaping the landscape in the area.

Keywords: land cover, land use, landscape, habitat, change, northeast Macedonia

Апстракт

Јовановска, Д. и Меловски, Љ. (2013). Улога на промената на практиките на искористување на земјиштето во сукцесија на стаништата во Североисточна Македонија. Зборник на трудови од IV Конгрес на екологите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 28, Скопје.

Во трудот се презентирани резултатите од компаративната ГИС анализа на стаништата и промената во покровноста на земјиштето во североисточна Македонија. Картирањето на стаништата е направено во 500 m до еден километар широк и 88 km долг коридор дефиниран целно за изработка на оценката за влијанието врз животната средина за изградба на железничката линија Куманово-Деве Баир во 1995 и 2011 година. Целта на студијата е да се документираат промените во покровноста на земјиштето настанати во период од 16 години и да се идентификуваат причините кои довеле до сегашната пределна структура.

Најзначајни промени во покровноста на земјиштето по должина на истражуваниот коридор се забележани кај брдските пасишта, потоа кај земјоделските површини и населените места и шумите. Резултатите можат да бидат искористени во насока на креирање на планови за управување и одржување на практиките на искористување на земјиштето кои имаат најголемо значење во обликувањето на пределот во подрачјето.

Клучни зборови: покровност на земјиште, искористување на земјиште, станишта, промени, североисточна Македонија

Introduction

The present landscape mosaic has been generated under the influence of diverse natural and anthropogenic processes that continue to shape and alter its character (Turner et al. 2001; Lütolf 2006). In order to understand these changes, current landscape approach questions dynamics of land use and land cover over time, connecting land use change to a specific environmental-societal matters (Turner et al. 2007). Studies subjected to determination of the scale of change and its drivers have recognized land change as an influencing factor on ecosystem services (Lambin et al. 2003; Haines-Young, 2009), bio-

diversity composition and distribution (Liu & Ashton 1998; Falcucci et al. 2007; Furberg & Ban 2008; Holzhauer et al. 2008; Lütolf et al. 2009) and as a driver of landscape change (Burel & Baudry 2003; Turner et al. 2001). The need for assessment of land change has imposed a growing trend of development of various remote land use/ land cover change detection and modeling techniques in the past two decades (Brown et al. 2000; Chen 2003; Lu et al. 2004; Millington et al. 2007).

In spite of the prominence credited to land change worldwide, to date in Macedonia there are no published results regarding landscape pattern and land use change. Even so, the awareness of the importance of land change in the country is increasing. Several studies, in parallel with this one, have raised the matter of land use/land cover changes (Despodovska et al. 2013; Blinkov et al. 2012 *unpub.*; Redžović 2011 *unpub*.), still none has reflected land use/land cover change to the associated landscape.

In this paper we aim to identify the pattern of changes in land use/land cover in the northeastern Macedonia during 16 years period of time by using the available data on a narrow corridor as to relate the trends in land cover succession to its drivers by associating human population fluctuations data available for the same period.

Investigated area

The study area is represented by a narrow corridor along one section of the European Transport Corridor 8 from Kumanovo to Deve Bair - the border between Macedonia and Bulgaria (Fig. 8). Geomorphological, the western section of the area is part of Ruen structural block (Kumanovo area) while the eastern section is part of Osogovo block (Rankovce, Kratovo and Kriva Palanka area). The corridor passes through the valleys of rivers Kumanovska Reka, Pcinja and Kriva Reka. The area along the corridor line is characterized by volcanic siliceous rocks that dominate over the irregularly distributed limestone (Andonovski et al. 2001; Milevski 2007).

The area is mostly characterized by a moderate-continental climate, with Mediterranean climate influence along the river valleys. Increase in altitude from Kumanovo to Kriva Palanka results in lowering of average annual temperatures (Lazarevski 1993).

Administratively the corridor falls in the northeast Macedonia passing on the territory of four municipalities: Kumanovo, Rankovce, Kratovo and Kriva Palanka (State statistical office 2012; Fig. 8).

Even though the area is hardly urbanized, historically, it has been populated for thousands of years. The long lasting extensive human impact on the environment has resulted in specific appearance of human structures and agricultural systems, associated with considerable portion of habitats that remained semi-natural or natural. This formation of landscape structure is transitioning from *flatland and lower open hilly urban and rural landscape* through *mountain rural landscape* (characterized by settlements of scattered type and extensive land management) to *mountain broadleaved forest landscape*.

Materials and methods

The survey area is limited to 500 m to one kilometer wide and 88 km long corridor, mapped in 1995 and 2011, in course of two Environmental Impact Assessment (EIA) studies for the railway construction Kumanovo – Deve Bair. The available data on this narrow corridor were used to make general rapid assessment of land use/land cover (LULC) change in larger areas in order to overcome the absence of historical LULC data.

Data for quantification of LULC for 2011 were generated from topography maps, scale 1:25000 (Agency for Real Estate Cadaster of the Republic of Macedonia), combined with 2007 Google Earth satellite imagery and field survey data. Computer processing was performed with the software package ArcGIS 9.3 using visual interpretation of multi-temporal image composite and on-screen digitizing of changed areas (Lu et al. 2004). LULC for 1994 was quantified using EIA for corridor 8 – Biotope maps drawn on topography maps (1:25000) that were georeferenced and digitized for the purpose. LULC change transformation for both layers had corresponding LULC types and were originally drawn on identically scaled maps, therefore thematic aggregation errors were not considered. In order to attain the areas of LULC for each period of time the two vector layers were after treated with extract and overlay analysis tools. This step allowed correction of all dubious changes incurred as a result of map aggregation to be corrected in accordance with obtained field data. The resulting LULC coverage data further served to estimate the annual rate of change, calculated according to the equation given by Mas et al. 2004.

The attributes in the original legends from the two habitat maps were reclassified in order to obtain 25 LULC types that according to their contribution in landscape character were additionally grouped in 10 LULC categories (Tab. 1).

Layers of regional and municipal division of Macedonia were used to present the results separately within the municipalities along the corridor. To relate the LULC changes with population trends and land use practice change over time we used available data from the State Statistical Office of the Republic of Macedonia (1994, 1997, 1999, 2002, 2007, 2012). The presentation of the results within the ad-

Tab. 1. LULC reclassification scheme adopted from Falcucci et al. 2007 (thematic generalization sensu Petit & Lambin 2002).
Таб. 1. Шематски приказ на класификација на типови на искористеност на земјиште, прилагодено од Falcucci et al. 2007 (тематска генерализација според Petit & Lambin 2002).

1995 LULC types	2011 LULC types
Abandoned arable land	
Abandoned fields or meadows; Abandoned fields overgrown with shrubs and meadows	Abandoned arable land
Agricultural land	
Acres; Acres with fruit and wild trees	Agricultural land-fields and acres
Heterogeneous agriculture	
Orchards; Vineyards	Orchards; Vineyards
Dry meadows; Grasslands with planted non fruit trees	Meadow
Arranged areas	Anthropogenic tree belt; Small broadleave tree plantation
Pastures and dry grasslands	
Grasslands in beech forest	Unmanaged mesic grasslands
Hill pastures (dry grasslands)	Hill pasture (dry grasslands)
Hill pastures on stony ground (dry grasslands)	Hill pasture on stony ground (dry grasslands)
Forests	
Hill pastures with sparse shrubs (dry grasslands)	Hill pasture with sparse shrubs (dry grasslands)
Mixed thermophylous forests with different stages of degradation	Degraded mesophillous forest; Degraded thermophillous oak forest; Degraded xerothermophillous oak forest
Mixed mesophylous forests; Mixed mesophylous forests, north slopes	Mesophillous oak forest; Thermophilous oak forest; Xerothermophillous oak forest
Beech forests	Beech forests
Shruby grassland terain in shalow dailes; Woodlands in shallow dailes	Forest ravines and dails
Forest plantations	
Black locust's forests	Black locust plantation
Forests of Pinus nigra	Conifer tree plantation
Mixed conifer-black locust plantation with oak	Mixed conifer-black locust plantation with oak
Riverine/riparian	
Willow grows, forests and scrublands along the rivers and springs	Riparian shrub communities; Riparian willow-poplar belt; Riparian willow-poplar woodland
Grasslands along the rivers and springs; Wet meadows	Wet meadow
River	Epipotamal stream; Hiporhithral stream; River gravel bank
Barren areas	
Rocky/sandy areas with almost no vegetation	Rocky sites;
Rural areas	
Rural areas and settlements; Gardens	Rural settlements
Urban/artificial areas	
Urban area	Urban area; Park
Industrial objects; Cattle breeding areas; Pond	Man-made structure; Artificial pond; Road

ministrative boundaries of municipalities enables relevant overview of the statistical data regarding drivers of change.

Results

In the past 16 years, approximately 66% of the LULC individual plots recorded along the surveyed corridor have undergone through conversion or modification. The most considerable changes were generally observed in agricultural land (Fig 1; Tab. 2), than urban/artificial areas (51.76% gain), riverine/riparian areas (45.76% loss) and pastures and grasslands (40.49% loss) followed by rural areas (33.12% gain) and forests (25.05% gain). (Fig. 1 and Tab. 2). The results are presented in relative figures (%) since the analyses were carried on a small portion of land surveyed as a linear corridor. Regardless of the changes presented in relative numbers, the most striking change influencing landscape pattern in absolute values is determined in dry grassland habitats with evaluated rate of change of 3.19 per year (*r*) followed by agricultural land (generalized overview) with evaluated average rate of change of 2.62, than urban (*r*=2.64), rural areas (*r*=1.80) and forests (*r*=1.41).

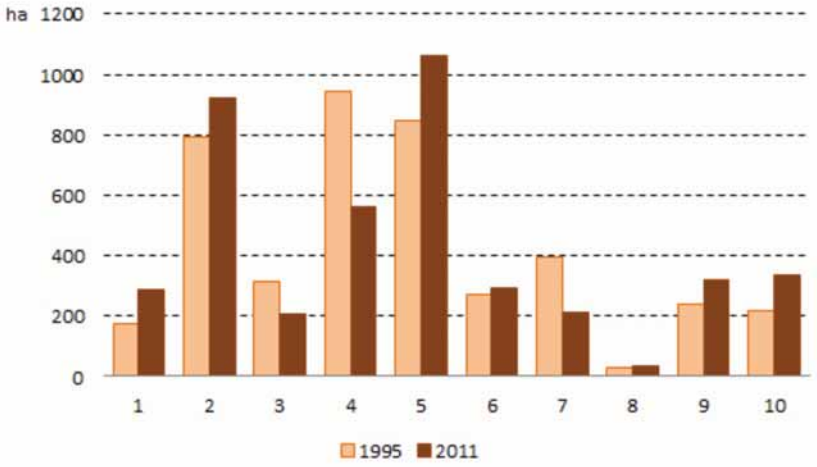

Fig. 1. General overview of land cover change along the surveyed corridor. 1-Abandoned arable land; 2-Agricultural land; 3-Heterogenuous agriculture; 4-Pastures and grasslands; 5-Forests; 6-Forest plantations; 7-Riverine/riparian; 8-Barren areas; 9-Rural areas; 10-Urban/artificial areas.

Сл. 1. Општ преглед на промените во искористеноста на земјиштето по должина на истражуваниот коридор. 1-Напуштено обработливо земјиште; 2-Земјоделски површини; 3-Хетерогено земјоделско земјиште 4-Брдски пасишта; 5-Шуми; 6-Шумски насади; 7-Водни/крајречни станишта; 8-Голини и карпи; 9-Рурални подрачја; 10-Урбани/изградени подрачја.

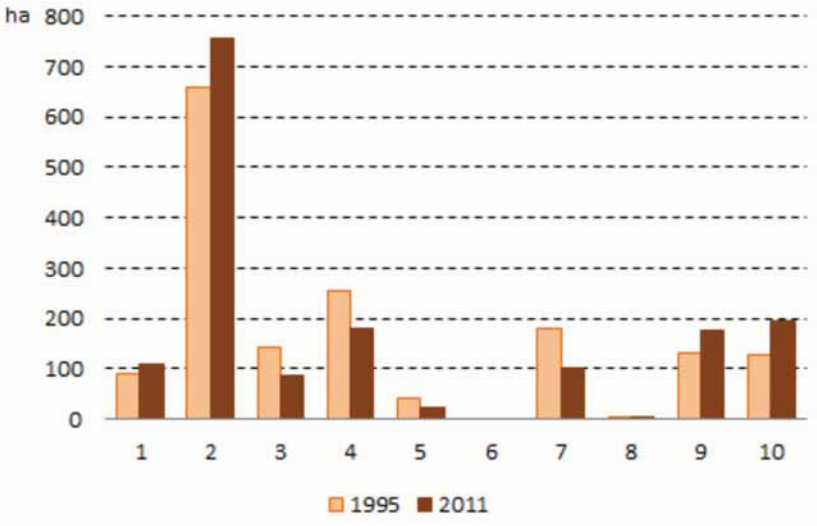

Fig. 2. Overview of LULC change in the area of Kumanovo (Legend as in Fig. 1).

Сл. 2. Преглед на промените во искористеноста на земјиштето во Куманово (Легенда како на Сл. 1).

Since the structure of the landscape along the corridor differs from Kumanovo to Kriva Palanka, the results will be further presented on the basis of the importance that LULC change have in shaping the landscape within the municipalities along the corridor.

The study corridor crosses the territory of Kumanovo municipality with 1630 ha (38.5 % of the total corridor). Back in 1995 the area of Kumanovo was dominated by agricultural land followed by urban and rural settlements. Forests were highly degraded and represented by small fragments preserved mostly along ravines and dales. Areas classified as riverine/riparian were represented mostly by wet meadows, willow/poplar groves and belts and scrublands along rivers (Fig. 2; Tab.2). In 2011 agricultural land use still dominated the area demonstrating increase of 14.80% (r=0.87). Heterogeneous agricultural land - areas under mowed meadows and permanent crops decreased in surface for 40.12%. This notable decrease in surface resulted in 19.19% increase of abandoned arable land (r=1.10) and in part contributed to the increase in areas under fields, acres and settlements. Areas under rural settlements have increased by 34.56% (r=1.87) and urban/artificial areas have increased by 51.81%. The increase in areas under settlements affected agricultural land, areas under pastures and grasslands along with areas under forests. The increase of both agricultural land and settlements has too affected areas under wet meadows, as a result of which riverine/riparian areas have decreased (Fig. 2; Tab. 2).

Five hundred and nineteen hectares (12.3%) of the study corridor fall into Rankovce municipality. In 1995 the area of Rankovce too was dominated by agricultural land use. In Rankovce the agricultural land with permanent crops exceeded areas of fields and acres. Pastures and grasslands were an-

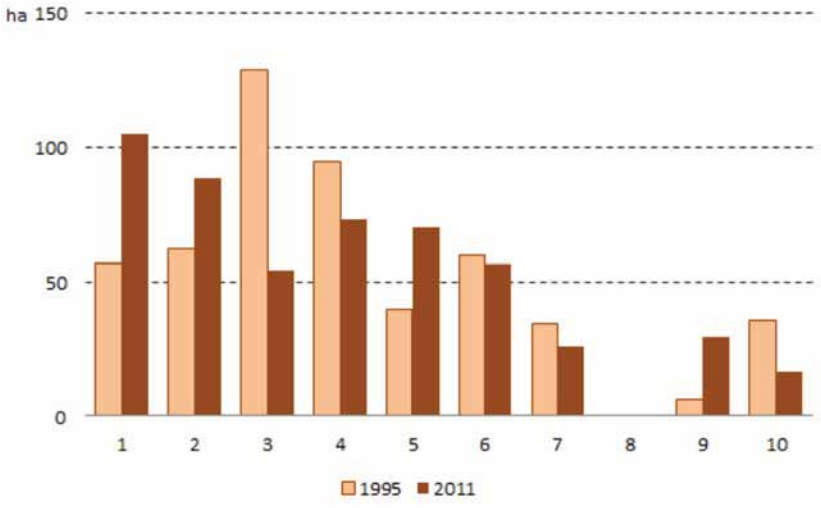

Fig. 3. Overview of LULC change in the area of Rankovce. (Legend as in Fig. 1).
Сл. 3. Преглед на промените во искористеноста на земјиштето во Ранковце. (Легенда како на Сл. 1).

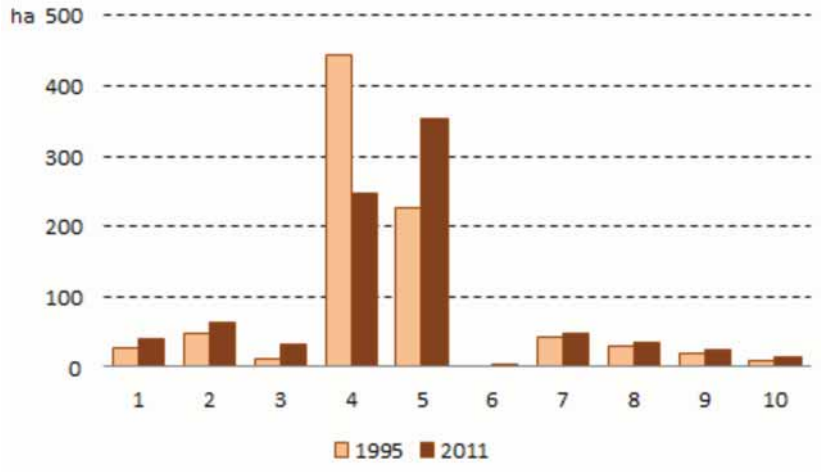

Fig. 4. Overview of LULC change in the area of Kratovo. (Legend as in Fig. 1).
Сл. 4. Преглед на промените во искористеноста на земјиштето во Кратово. (Легенда како на Сл. 1).

Tab. 2. Land use/land cover change as a percentage of the whole surface of the total study area and separately as a percentage of the area within each municipality for 1995 and 2011 accordingly. The table also contains data for the annual rate of change (*r*); n.r. – not registred.

Таб. 2. Промена во искористување на земјиштето изразена процентуално во однос на површината на истражуваниот коридор и поодделно како процент во однос на површината која секоја од општините ја зафаќа во истражуваниот коридор. Во табелата е даден и преглед на годишната стапка на промена (*RCY*); n.r. – ирелевантно (не може да се пресмета).

	Along the survay corridor			**Kumanovo**			**Rankovce**			**Kratovo**			**Kriva Palanka**		
LULC Types/categories	1995	2011	r	1995	2011	r	1995	2011	r	1995	2011	r	1995	2011	r
Abandoned arable land	4,12%	6,75%	3,14	5,55%	6,61%	1,10	10,92%	20,22%	3,93	3,16%	4,61%	2,38	n.r.	2,73%	/
Agricultural land	18,76%	21,84%	0,96	40,51%	46,50%	0,87	11,93%	17,08%	2,27	5,51%	7,49%	1,94	1,99%	1,09%	3,70
Heterogenuous agriculture	7,48%	4,84%	2,69	8,69%	5,20%	3,15	24,82%	10,40%	5,29	1,46%	3,82%	6,19	2,76%	2,71%	0,10
Pastures and grasslands	22,33%	13,29%	3,19	15,60%	11,13%	2,09	18,29%	14,12%	1,61	51,61%	28,75%	3,59	12,46%	4,96%	5,60
Forests	20,03%	25,05%	1,41	2,58%	1,37%	3,85	7,73%	13,53%	3,56	26,34%	41,29%	2,85	48,43%	53,76%	0,65
Forest plantations	6,38%	6,92%	0,50	n.r.	n.r.	/	11,53%	10,86%	0,37	n.r.	0,13%	/	12,79%	15,51%	1,21
Riverine/riparian	9,28%	5,03%	3,75	11,03%	6,24%	3,50	6,63%	4,99%	1,76	5,00%	5,58%	0,69	11,07%	3,07%	7,71
Barren areas	0,74%	0,83%	0,71	0,07%	0,08%	0,42	n.r.	n.r.	/	3,51%	3,94%	0,72	n.r.	n.r.	/
Rural areas	5,69%	7,58%	1,80	8,07%	10,86%	1,87	1,22%	5,62%	10,04	2,36%	2,82%	1,12	6,76%	7,38%	0,54
Urban/artificial areas	5,19%	7,88%	2,64	7,91%	12,01%	2,64	6,92%	3,17%	4,77	1,05%	1,57%	2,58	3,73%	8,78%	5,49

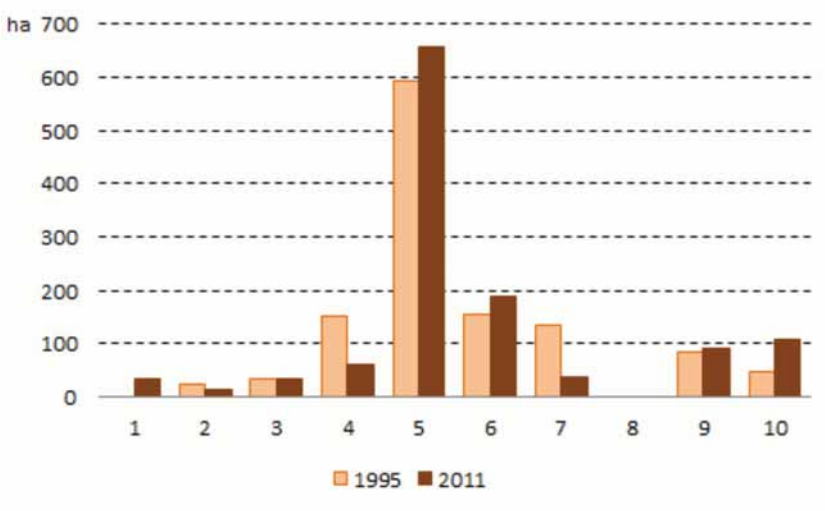

Fig. 5. Overview of LULC change in the area of Kriva Palanka. (Legend as in Fig. 1).
Сл. 5. Преглед на промените во искористеноста на земјиштето во Крива Паланка. (Легенда како на Сл. 1).

other significant constituent of the landscape structure. Forests were found to be in a degraded state and in part supplemented by forest plantations. Populated places had a rural character (Fig. 3; Tab. 2). Sixteen years later Rankovce was still dominated by agricultural land use but with noticeable changes in agricultural practices: areas under permanent crops have declined (58.09% loss) on account of which areas under fields and acres (43.17% gain; r=2.27) and abandoned arable land (85.18% gain; r=3.93) have increased. Areas under pastures and grasslands demonstrate 22.81% loss as a result of shrub encroachment. Succession has raised the forests coverage for 75.07% (though negligible in absolute values). The area of rural settlements has increased, while artificial areas mark decrease. In Rankovce there are still no areas that could be classified as urban (Fig. 3; Tab.2).

Eight hundred and fifty eight hectares (20.3%) of the surveyed corridor fall into Kratovo municipality. In 1995 the area within the studied corridor in Kratovo municipality was mostly used as pastures and grasslands wile areas under forests were mostly presented by oak stands in different stages of degradation. Land used for agriculture was mostly represented by extensively managed parcels of fields and acres. Small percentage from the area was assigned as rural (Fig.4; Tab. 2). In 2011 the area under forests (56.76% gain; *r*=2.85) have twofold overcome the areas under hill pastures (61.23% loss; *r*=3.59) which were transformed into transitional scrubland/ woodland (an increase of 42.16%). Land used as agriculture increased for 35.90%, while heterogeneous agricultural land too marks increase (Fig.4; Tab. 2). Riverine/riparian areas have shown increase of 11.64% compared to 1995. Rural areas and artificial areas have slightly increased, as well (Fig.4; Tab. 2).

The study corridor in the territory of Kriva Palanka municipality occupies 1225 ha (28.9%). In 1995 the area was mostly covered with forests. In addition to the natural forest, part of the area was covered by conifer and black locust plantations. Land used as pastures was mostly represented by hilly dry grasslands and by grasslands in beech forest. Rural areas were twice exceeding the urban areas (Fig.5; Tab. 2). In 2011 the area was still dominated by forests that compared with 1995 increased by 10.97% (*r*=0.65) similarly as areas under forest plantations that increased by 21.25% (*r*=1.21). There was a substantial decline (60.25%) in land used as pastures (*r*=5.60), especially areas under hilly dry grasslands (80.81% decline; *r*=9.80) on account of which transitional woodland/scrubland has increased twofold. A decline in land use for agriculture (45.33% loss; *r*=3.70) could also be observed, while abandoned arable land has been recorded for the first time. In 2011 areas under rural settlements have slightly increased (9.06% gain), while urban settlements have doubled (Fig. 5; Tab. 2).

Discussion

Overall results indicate that in the timeframe of only 16 years (1995-2011) land cover has changed from pastures and grasslands through shrubby/transitional woodland to forests. Agricultural land that was once represented by a significant portion of permanent crops has undergone change in two directions. It was either transformed into more intensively managed fields and acres or left to abandonment. The evident changes, as the expansion of areas under settlements (Kumanovo and Kriva Palanka municipalities), is in consistence with population growth

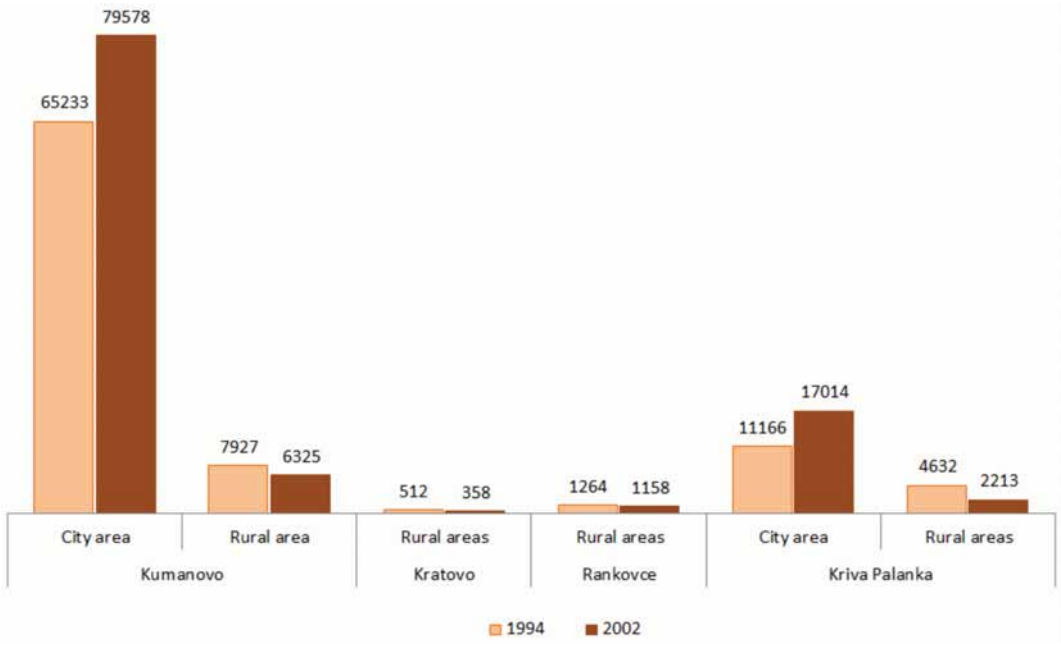

Fig. 6. Population trend overview in Kumanovo, Kratovo, Rankovce and Kriva Palanka according to census of population, households, dwellings and agricultural holdings in the Republic of Macedonia for 1994 and 2002.

Сл. 6. Преглед на трендот на промени во бројната состојба на населението во Куманово, Кратово, Ранковце и Крива Паланка согласно пописот на населението, домаќинствата, становите и земјоделските стопанства во Република Македонија за 1994 и 2002.

trends in urban areas (Fig. 6) and population decline trends in rural areas as Kratovo and Rankovce municipalities (State statistical office of the Republic of Macedonia 1994, 2002).

In the frame of the surveyed period of change in Kumanovo area there was a decline in areas under forests, pastures and heterogeneous agricultural land. The observed decline is a result of the intensification of agriculture, and extension of urban settlements toward formerly rural areas (Fig. 2). The change is gradual and a result of population growth (Fig. 6). Thou significant in relative figures, the changes are insignificant in absolute figures (hectares). Therefore, observed changes in Kumanovo do not seem to have a significant impact of the present pattern of lowland urban or rural landscape.

The trend in agricultural conversion observed in Kumanovo becomes more evident in Rankovce area (Fig. 3). Populated places along this part of the surveyed corridor (although with increased surface) can all be assigned as rural according to their character. Still the increase in settlements‘ area is not in accordance with the population trend observed from 1994 to 2002 (Fig. 6) unless there was a population increase trend from 2002 to 2011 (the population census for 2011 was not conducted). Additionally, an increase of rural area can be explained with construction of new summer houses and tourist facilities. We could assume that decrease in areas used as pastures on account of increase of forest cover could be a result of changes in livestock practices. Even that no statistical data could be related to this change (there are no census data for livestock for Rankovce municipality; Fig. 7), we observed more than 40% decline in cattle sheds (field data).

The tendency of abandonment of land used as pastures is even more emphasized in Kratovo municipality (at least the part that belongs to the surveyed corridor) because of open hilly and rural mountainous landscape character in the area. The significant decline of nearly 61.23% of areas under hill pastures on account of the 42.16% increase of transitional hill pastures to scrubland is considered to be a result of the abandonment of cattle breeding practices due to the population decrease and change of age structure (Fig. 6).

The pattern of loss of areas used as pastures was also observed in Kriva Palanka. This pattern is resulting from scrubland to forest transition (Fig. 5). Additional reason for the decrease in areas under pastures is an increasing trend in afforestation (State statistical office 1999; PE “Macedonian Forest” *personal communication*). The trend in declining of areas under pastures on account of increase in transitional scrubland to forest is considered to be driven by the abandonment of cattle breeding practices (Fig. 7) which in turn can be indirectly related to urban to rural migrations (Fig. 6; State statistical

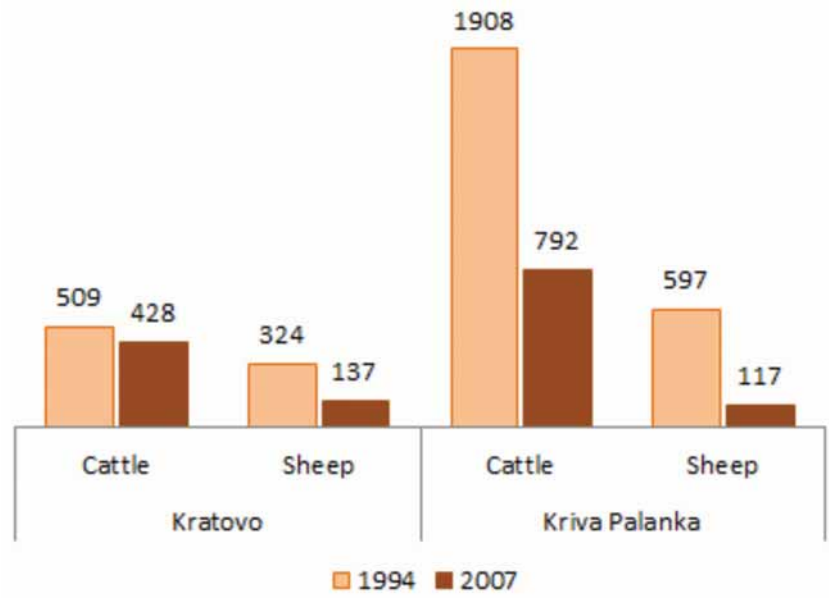

Fig. 7. Cattle breading trend overview in Kratovo and Kriva Palanka according to census of population, households, dwellings and agricultural holdings in the Republic of Macedonia for 1994 (book VI) and Agricultural census 2007 (breeding of goats was forbidden until 1990).

Сл. 7. Преглед на трендот на сточарските практики во Кратово и Крива Паланка според пописот на населението, домаќинствата, становите и земјоделските стопанства во Република Македонија за 1994 година (книга VI) и пописот на земјоделство за 2007 (одгледувањето кози беше забрането до 1990 година).

office 2012). Consequently, the observed population dynamic has led to an increase in urban areas and settlements and decrease in fields and acres.

The analysis of land use/land cover change over time, lack and incompatibility of statistics could be considered as impediment and even though available statistical data allowed proper discussion of the results it could not give a specific explanatory contribution to each driver of change. Moreover, this study does not dissociate the general development policies that according to Lambin et al. (2001) in most cases predefine the direction of change of land use practices, or at the very least influence their manifestation, as in Kumanovo and Kriva Palanka case.

Trends of change recorded in the narrow study corridor are consistent with findings of Redžović (2011 *unpub.*) for Osogovo region for years 1950, 1970 and 2004 that confirms the pattern of change observed in Rankovce, Kratovo and Kriva Palanka). The same pattern of change was observed on Galichica Mountain (southwest Macedonia) for the period 1950 through 1970 to 2007 by Despodovska et al. (2013). Similar patterns of land use change that are related to population structures and dynamics have been observed throughout the Mediterranean (Pinto-Correia 1991; Falcucci et al. 2007; Millington et al. 2007).

Discussed LULC changes are based on observations on a narrow study corridor and in a relatively close timeframe. Still, according to Burel & Baudry (2003) addressing "mechanisms of change on a small scale" is an important implement for addressing large-scale transformations. Any identified land use/land cover change in a certain timeframe can reveal general principles of the future land use change pattern (Lambin et al. 2003). It is considered that if persistent, land use/land cover changes can further generate change in existing landscape pattern and habitat structure (Turner et al. 2001; Burel & Baudry 2003) and thus affect species diversity and distribution (Liu & Ashton 1998; Falcucci et al. 2007; Furberg & Ban 2008; Holzhauer et al. 2008; Haines-Young 2009; Lütolf et al. 2009).

It is expected that the most affected landscapes will be hilly rural pastures, hilly xero-thermophillous forest landscape and mountain rural landscape that are considered to be a specific feature of the region. The recognition of the value of the landscapes in the region, specifically the characteristic Mountainous Rural Landscape on Osogovo, has resulted in an initiative for establishing a protected area-Protected landscape on Osogovo (Macedonian Ecological Society 2011). The trend of abandonment of extensive agricultural practices, can affect the heterogeneity of agro-biodiversity and alter the existing landscape pattern (Turner et al. 2001). Potential changes in the landscape pattern in the region can lead to loss of its distinctiveness. In this regard as accentuated by Kennedy et al. (2009) timely consideration of land use/land cover change gives per-

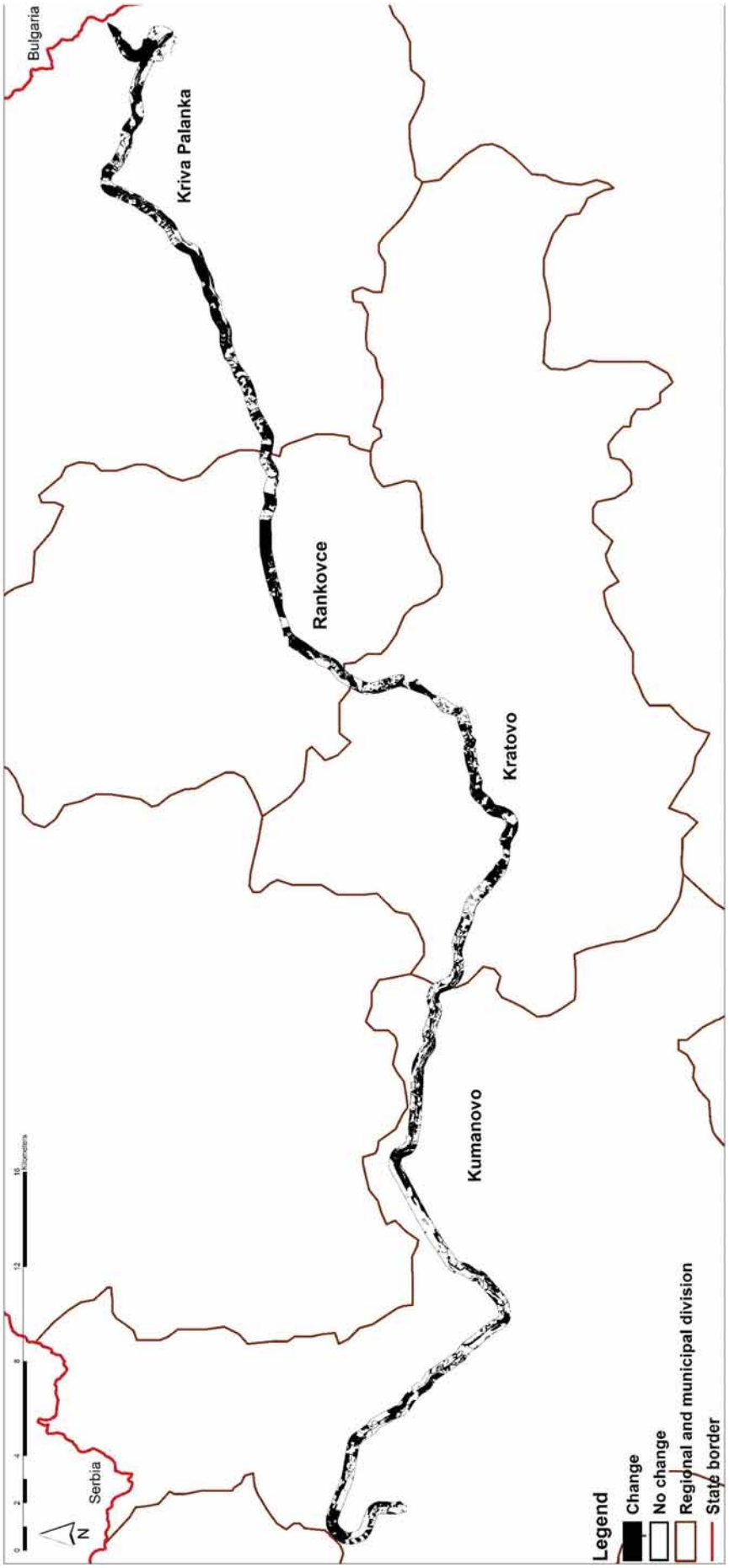

Fig. 8. Land use/land cover map overview of detected change in northeast Macedonia between 1995 and 2011 (concept adopted by Petit & Lambin 2002)
Сл. 8. Прегледна карта на промените во искористеноста на земјиштето во североисточна Македонија во периодот од 1995 до 2011 (според концептот на Petit & Lambin 2002) .

ception into the landscape stressors and drivers of change, thus enabling for management plans to be directed towards treating the cause rather than its consequence.

Conclusions

The analysis of LULC change in northeast Macedonia for the short period of time (from 1995 to 2011) has shown significant change in land cover pattern due to the change of land use practices. Land use/land cover change was the most evident in hilly dry grasslands that declined in area on account of the increase of forest. Agricultural land and settlements have also undergone substantial changes. The smallest change was observed in areas that are not attractive for human use - barren land and rocks.

These changes are driven by the population increase trend in urban areas associated with intensification of land use practices - especially observed in Kumanovo and Kriva Palanka municipalities. Due to the differences in landscape structure and the innate differences in socio-economic development between the two municipalities (marginal position of Kriva Palanka municipality enabled persistence in its rural character) the changes in both municipalities are manifested differently. In Kumanovo population increase trend resulted in intensification of agriculture and urbanization of formally rural areas increasing the pressure on surrounding habitats. In Kriva Palanka one can observe that population growth and rural to urban migrations not only doubled the urban areas but resulted in abandonment of land used for agriculture and pastures that led to marked increase of scrubland and forest cover.

Corridor passes through the entirely rural parts of Kratovo and Rankovce municipalities (Rankovce is completely rural). In these areas one can observe a trend of abandonment, similar to the one observed in Kriva Palanka, resulting in scrubland and forest encroachment. This trend of is considered to be an indirect reflection of the population migration and driven by abandonment of livestock breeding practices.

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Резиме

Мозаикот од предели кој денес го препознаваме е условен од комбинација на различни природни и антропогени процеси кои секојдневно го обликуваат и менуваат неговиот карактер (Turner et al 2001; Lütolf 2006). За да може да ги објасни овие промени пределната екологија пристапува кон преиспитување на промената во покровноста на земјиштето и промената во искористување на земјиштето. Дефинирање на динамиката на овие промени дава одговор на бројни прашања релевантни за животната средина и општеството (Turner et al. 2007).

Во контекст на оваа проблематика, во трудот се дискутираат промените во покровноста на земјиштето и стаништата во североисточна Македонија за периодот од 1995 до 2011. Промените се документирани врз основа на податоците од студиите за оценка на влијанието врз животната средина за изградба на секција од европскиот транспортен коридор 8 Куманово-Деве Баир Компаративна ГИС обработка на податоците за овој тесен линеарен коридор овозможи детална анализа на настанатите промени. Достапните статистички податоци за населението и земјоделските стопанства во тој период послужија за да се идентификуваат причините кои ги иницирале тие промени.

Изразено во апсолутни вредности, најзначајни промени по должина на целиот коридор беа забележани кај брдските пасишта, потоа кај земјоделските површини, населените места и шумите (Сл. 1; Таб. 2). Следејќи ја пределната структура на подрачјето, понатамошната анализа на резултатите е направена одделно во рамки на административните граници на општините Куманово, Ранковце, Кратово и Крива Паланка (Слики 2-5; Таб. 2), додека забележаните промени се разгледуваат согласно улогата која ја имаат во обликување на пределот.

Трендот на пораст на бројноста на населението во урбаните подрачја и интензивирање на практиките на искористување на земјиштето се особено забележителни во Куманово и делумно во Крива Паланка (Сл. 6; Сл. 7) Трендот на пораст на бројноста на населението во Куманово резултира со ширење на урбаните подрачја и интензивирање на земјоделските практики што резултира со зголемен притисок врз околните живеалишта. Во Крива Паланка може да се забележи дека растот на населението и миграциите на релација село-град не само што придонеле кон двојно зголемување на урбаните подрачја туку резултирале со напуштање на земјоделството и површините користени како пасишта што довело до нивно обраснување со грмушки и пораст на површините под шуми. Во Кратово и Ранковци, каде коридорот поминува низ целосно рурални средини, набљудуваниот тренд на напуштање на површините под пасишта, сукцесивно обраснување со грмушки и следствено пораст на површините под шуми е индиректен одраз на негативниот миграцискиот тренд на населението проследено со значително занемарување на сточарските практики.

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ПОТЕНЦИЈАЛОТ НА ЕКОЛОШКАТА СТАПКА КАКО ИНДИКАТОР ЗА СЛЕДЕЊЕ НА АНТРОПОГЕНОТО ВЛИЈАНИЕ ВРЗ ПРИРОДНИТЕ РЕСУРСИ ВО СКОПСКИОТ РЕГИОН

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Апстракт

Оџаклиеска, Х. и Димитровска, О. (2013). Потенцијалот на еколошката стапка како индикатор за следење на антропогеното влијание врз природните ресурси во скопскиот регион. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 21, Скопје.

Опстанокот на човештвото зависи од природните ресурси и повеќе од неопходно е да знаеме во колкава мера ги користиме и колку треба да ги користиме. Еколошката стапка (Ecological Footprint - EF) ја квантифицира потребата на човекот од екосистемските услуги и служи како интегрален индикатор кој го одразува националниот и глобалниот одржлив развој. Со примена на методологијата за пресметување на еколошката стапка (Ecology footprint Accounts - EFA) ќе се овозможи проценка на површината на земјиште неопходно да ја задоволи постојната побарувачка на ресурси од природата. Од технички аспект, EFA мери колку природа, изразена во вообичаената единица на „биопродуктивен простор заедно со светската просечна продуктивност“ се користи ексклузивно за производство на ресурсите кои дадена популација ги конзумира и го абсорбира отпадот кој истата го создава. Со имплементација на соодветни предлог мерки за рационално и ефикасно користење на шумите предизвикот за заштита на животната средина во секојдневната пракса, ќе биде уште поголем. Цел на истражувањето е да се утврди притисокот кој го врши антропогениот фактор врз шумите, како природен ресурс, во Скопскиот Регион.

Клучни зборови: еколошка стапка, биолошки капацитет, природни ресурси, животна средина

Abstract

Odzaklieska, H. and Dimitrovska, O. (2013). The potential of ecological footprint as an indicator for monitoring the anthropogenicimpact on natural resources in the Skopje Region. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 21, Skopje.

The survival of humanity depends on natural resources, so we must know how much we use them now and how much we should use them in the future. Ecological Footprint - EF quantifies the human need of ecosystem services and serves as an integral indicator that reflects the national and global sustainable development. The methodology for calculating the Ecological Footprint (EFA – Ecological Footprint Accounts) will allow estimation of the surface of the land necessary to meet existing demand for resources from nature. From a technical perspective, EFA measure how much nature, expressed in common units of “bioproductive land with world average productivity” is used exclusively to produce the resources that population consumes and to absorb the waste that the same population creates. By implementation of appropriate measures for rational and efficient use of forests, the challenge for environmental protection in everyday practice will become even greater. The main purpose of the study is to determine the pressure by an anthropogenic factor on forests, as natural resource, in the Skopje region.

Key words: ecological footprint, biocapacity, natural resources, environment

Вовед

Еколошката стапка (анг. ecological footprint) е статистичка алатка која мери еден аспект од одржливиот развој: Колку од регенеративниот капацитет на планетата е потребен за да ги обезбеди ресурсите и екосистемските услуги неопходни за задоволување на потребите на човекот и колкав регенеративен капацитет човекот има на располагање од постојните еколошки средства (Galli et al. 2012).

Првата академска публикација за еколошката стапка е од William Ress (Ress, 1992) додека, подоцна концептот за еколошка стапка го развил Mathis Wackernagel (Wackernagel, 1994). Во 2003 година е основана групација Global Footprint Network, со седишта во Окланд, Брисел и Женева, која има за цел еколошките ограничувања да ги постави во фокусот на вниманието во процесот на донесување на одлуки, преку примена на еколошката стапка како статистичка метода за пресметување на природните ресурси и притисокот на антропогениот фактор врз истите во однос на нивниот регенеративен капацитет.

Оваа техника е адаптирана и применета од многу организации вклучувајќи го и Светскиот фонд за диви животни (World Wildlife Fund) кој ја мери употребата на ресурси на секоја земја во светот и ги споредува овие употребени ресурси со ресурсите кои ги имаме на располагање. (Live Planet Report, 2002).

Цел на истражувањето е проверка на можностите за примена на методологијата за пресметување на притисокот на антропогениот фактор врз природните ресурси во однос на нивниот регенеративен капацитет, конкретно во Скопскиот Регион, преку анализа на антропогениот притисок врз шумските ресурси и нивниот биолошки капацитет.

Материјал и методи

Во истражувањето се користени литературни податоци за еколошката стапка на Република Македонија и нејзиниот биолошки капацитет (Galli at al., 2012).

Еколошката стапка ги одредува биолошки продуктивното земјиште и водните површини кои и се неопходни на популацијата за да ги произведе обновливите ресурси и екосистемски услуги што ги користи. Од друга страна пак, биолошкиот капацитет, ги следи биолошки продуктивното земјиште и водните површини кои се достапни во земјите, регионите, или на глобално ниво, и нивниот капацитет да ги произведат обновливите ресурси и екосистемски услуги неопходни за задоволување на потребите на дадената популација (Galli et al. 2012).

Биолошки продуктивното земјиште и водните површини кои ги генерираат обновливите ресурси и екосистемски услуги од кои човештвото има потреба се дефинирани како еколошки средства (Galli et al. 2012). Се изразуваат во вообичаената единица глобални хектари (gha), или биолошки продуктивни хектари со просечна продуктивност на глобално ниво. Тие вклучуваат:

- Земјоделско земјиште за снабдување со храна од растително потекло и влакнести производи,
- Пасишта и земјиште за снабдување со храна од животинско потекло,
- Водени површини за обезбедување на храна од акватични видови,
- Шумски површини за обезбедување на производи од дрво и други шумски сортименти,
- Земјиште кое го абсорбира создадениот отпад (емисии на CO_2) и
- Изградено земјиште на кое се лоцирани објектите за домување, индустриски капацитети и урбана инфраструктура.

Побарувачката на една нација за ресурси и екосистемски услуги се пресметува преку додавање на увезените и одземање на извезените производи на вкупното производство на истите на националното ниво. Овие пресметки ја покажуваат побарувачката на биолошкиот капацитет на една нација (Kitzes at al. 2007).

домашно производство + увоз - извоз = потрошувачка

Пресметувањето на домашната побарувачка, увозот и извозот на ресурси и екосистемски услуги на национално ниво е изводливо, бидејќи во поголем број земји, меѓу кои и Република Македонија, се следат овие параметри. Но, на регионално или општинско ниво не е воспоставен систем на следење на потрошувачката на ресурси и екосистемски услуги кои регионалното население ги произведува, увезува или извезува.

При пресметување на регионалната еколошка стапка, се користат податоци за просечната еколошка стапка по жител и просечниот биолошки капацитет по жител на национално ниво. Потоа, се врши проценка на регионалната еколошка стапка со користење на неколку варијабли, меѓу кои личната потрошувачка во домаќинствата, приход по жител, просечна големина на домаќинството, население и густина на население и друго. Овие варијабли ги одразуваат локалните варијации во начинот на живот и нивоата на потрошувачка за подрачјето што е предмет на анализа и помагаат во утврдување на локалните промени во еколошката стапка на национално ниво.

Пристапот „од врвот надолу" за пресмету-

вање на еколошката стапка на регионално ниво прв почнал да го применува Wackernagel во 1998 година.

Предмет на истражувањето во овој труд се шумските површини од кои се добиваат примарни и секундарни производи од дрво, од една, и се сметаат за биопродуктивна површина која го абсорбира емитираниот CO_2, како отпад, од друга страна.

Анализата на можностите за пресметување на еколошката стапка е направена врз основа на бројот на население и површината на анализираното подрачје, како варијабли, и вредностите на просечната еколошка стапка по жител и биолошки продуктивно земјиште по жител на национално ниво во 2008 година.

Истражувано подрачје

Скопскиот регион го зафаќа северниот дел на Република Македонија и се простира во Скопската Котлина на површина од 181290 ha или 7,3% од вкупната површина на Реп ублика Македонија (ДЗС, 2009). Иако зафаќа најмала површина, во споредба со другите региони, според податоците за 2008 година, е најнаселен, со 596447 жители, или 29,1% од вкупното население и истовремено е и најгусто населениот регион со 329 жители на km^2 (ДЗС, 2012). Во регионот се сконцентрирани најголемиот дел од индустриските, трговските и услужните капацитети.

Во овој регион се наоѓа и главниот град на Република Македонија, Скопје, кој е економски, административен, универзитетски и културен центар на државата.

Резултати и дискусија

Просечната еколошка стапка по жител на Република Македонија во 2008 година изнесува 5,36 gha/жител или 11, 01 милиони gha (Galli et al. 2012). Имајќи во предвид дека во текот на 2008 година во Скопскиот Регион живееле вкупно 596447 жители (ДЗС, 2009), биолошки продуктивното земјиште потребно да ги задоволи потребите на населението во регионот зафаќа површина од приближно 3,2 милиони gha. Во споредба со површината од 181290 ha (ДЗС, 2009), што ја зафаќа Скопскиот Регион, за задоволување на потребите за живот, населението имало потреба од 17 пати поголема површина.

Ако се земе во предвид дека биолошки продуктивната површина потребна да ги задоволи потребите на граѓаните во Република Македонија изнесувала 11,01 милиони gha (Galli et al. 2012), приближно 5 пати поголема од површината на Република Македонија, населението во Скопскиот Регион има приближно 4 пати повисок стандард или поголема побарувачка на ресурси и екосистемски услуги за задоволување на потребите за живот од просечниот граѓанин во Републиката.

Просечниот расположив биолошки капацитет по жител во Република Македонија во 2008 година изнесувал 1,55 gha/жител (Galli et al. 2012) или 3,19 милиони gha (Galli et al. 2012). Расположивата биолошки продуктивна површина на Скопскиот Регион во анализираната година изнесувала 0,92 милиони gha и е за повеќе од 3 пати помала од вредноста на биолошки продуктивната површина потребна да ги задоволи потребите за населението во Регионот.

Овие податоци посочуваат дека во 2008 година, иако во Скопскиот Регион постоел еколошки дефицит и практично населението не можело да потроши повеќе екосистемски услуги од оние што ги имало на располагање односно, можело да ги обезбеди во границите на регионот, добар дел од побарувачката за екосистемски услуги била покриена со ресурси надвор од неговите граници.

Просечната биолошки продуктивна површина под шума по жител, неопходна за задоволување на потребите на населението на национално ниво во 2008 година изнесувала 0,33 gha/жител (Galli et al. 2012). Биолошки продуктивната површина неопходна за задоволување на потребите на населението со шумски ресурси и екосистемски услуги во Скопскиот Регион во 2008 година изнесувала 0,2 милиони gha.

Просечната расположива биолошки продуктивна површина под шуми по жител на национално ниво во 2008 година изнесувала 0,70 gha/жител (Galli et al. 2012). Одтука, расположивата биолошка продуктивна површина под шуми во Скопскиот Регион истата година изнесувала 0,4 милиони gha.

Резултатите посочуваат дека расположивата биопродуктивна површина под шуми во регионот е за 2 (два) пати поголема од биолошки продуктивната површина под шуми неопходна да ги задоволи потребите на населението во Регионот, односно, дека искористувањето на шумските ресурси во Скопскиот Регион се движи во одржливи рамки.

Просечната биолошки продуктивна површина по жител, потребна да го абсорбира емитираниот CO_2, кој се создава како резултат на антропогените активности, во 2008 година, на национално ниво, изнесувала 3,87 gha/жител (Galli et al. 2012). Одтука, биолошки продуктивната површина потребна да ги абсорбира емисиите на CO_2, во Скопскиот Регион, во текот на 2008 година изнесувала 2,31 милиони gha. Оваа површина е за приближно 6 (шест) пати поголема од расположивата биолошки продуктивна површина под шуми во регионот, како абсорбент на емисиите на CO_2.

Биолошкиот капацитет на шумите во Скоп-

скиот Регион е многу поголем во однос на притисокот што го врши антропогениот фактор врз нив, но не и доволен за да ги апсорбира емисиите на CO_2 како отпад, кои се создаваат како резултат на антропогените активности.

Во периодот што следи, неопходно е да се продолжи со рационално и ефикасно користење на шумите и секако да се превземат мерки за намалување на емисиите на CO_2, посебно во секторот згради, меѓу кои подобрување на енергетската ефикасност во постојните и запазување на прописите за енергетска ефикасност при изградба на новите објекти. Според проекциите за намалување на емисиите на CO_2 за градот Скопје доколку би се превземале соодветни мерки во секторот транспорт тие би се намалиле за 43,3% а во секторот згради за 19,9% или вкупната емисија на CO_2 во градот Скопје би се намалила за 23,1% (SEAP 2011).

Заклучок

Како регион со најголема густина на населението во однос на останатите региони во Република Македонија, со релативно мала површина на шуми и со исклучително висок удел во емисиите на CO_2 на национално ниво, Скопскиот Регион има голем удел во вредноста на стапката на јаглерод по жител, односно еколошката стапка по жител на национално ниво.

Во периодот што следи, неопходно е да се продолжи со рационално и ефикасно користење на шумите и секако да се превземат мерки за намалување на емисиите на CO_2.

Пресметување на еколошката стапка за Скопскиот Регион е повеќе од потребна ако се има во предвид дека во последните години се настанати промени како во однос на популацијата и површините под шума така и во однос на емисиите на CO_2 што секако иницираат и промени во вредноста на еколошката стапка. Вклучувањето на повеќе варијабли при утврдување на еколошката стапка и биолошкиот капацитет на регионално ниво остава простор за понатамошни научни истражувања и прецизирање на добиените податоци.

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Summary

As a region with the highest population density in relation to the other regions in the Republic of Macedonia, with a relatively small area of forests and extremely high share of CO_2 emissions at a national level, the Skopje Region has a large share in the value of the national carbon footprint per capita.

In the following period, it is necessary for the people to proceed with the rational and efficient use of the forests and implementing measures for CO_2 emission reduction.

Calculation of the ecological footprint of Skopje Region is more than needed, if we take into account that in recent years there have been changes in terms of population and forest area and in terms of CO_2 emissions which will certainly initiate changes in the value of the ecological footprint of the Region.

The inclusion of more variables in the calculation methodology will give more precise values for the ecological footprint and biocapacity at the regional level.

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CALCULATION OF SUPPORTING RATES FOR AUTOCHTHONOUS BUSHA CATTLE BREED AS A METHOD IN IMPLEMENTING AGRI-ENVIRONMENTAL MEASURES

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Апстракт

Џабирски, В., Буневски, Г., Порчу, К., Мартиновска Стојческа, А. и Милевска, Ј. (2013). Пресметка на стапки на поддршка за одгледување на автохтони Буша говеда, како метод во спроведувањето на агроеколошки мерки. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 21, Скопје.

Агроеколошките мерки се наменети за поттик на фармерите во заштитата и подобрување на животната средина и биодиверзитетот на нивните фарми како и зачувувањето и развој на фармски системи со високи природни вредности. Целта на овој труд е да ја одреди висината на поддршка на автохтоната буша раса говеда, во контекст на постоечките мерки на агроеколошката политика. Користениот метод за пресметка на агроеколошките калкулации се базира на парцијално буџетирање како рамка употребена за споредба на трошоците и приходите при одгледување на традиционалната буша во споредба со вообичаената производна практика кај високо производните раси говеда. Овој метод ги потенцира промените во приходот и трошоците произлезени од примената на специфичните алтернативи. На тој начин, сите аспекти на профитот на фарма кои се непроменливи се исклучени. Генерално, фиксните трошоци се земени како еднакви а промената произлегува од варијабилните трошоци и соодносот на ниво приносот / цената на производителот. Теоретската пресметка на индикативното ниво на поддршка за одгледување на автохтоната буша раса на говедо, понатаму беше базирана на примената на формулата YS=E x CE x GD, каде: YS=годишна поддршка, E=економската загуба, CE=коефициент на загрозеност, GD=географска дистрибуција. Споредбената анализа на приходот и трошоците кај фармите на буша наспроти референтната вообичаена практика на говедарските фарми, покажа дека даде за компензација на економската загуба износот се движи од 11,142 до 14,668 денари. Резултатите од емпириските податоци и теоретските процени на предметните референтни фарми, категоризирани според расата говеда и големината на стадото, укажуваат на големи варијации во висината на поддршката. Овие аспекти треба да бидат земени во предвид при понатамошното вреднување на агроеколошките мерки.

Клучни зборови: говедо буша, агроеколошки мерки, висина на подршка

Abstract

Dzabirski, V., Bunevski, G., Porchu, K., Martinovska Stojcheska, A. & Milevska, J. (2013). Calculation of supporting rates for autochthonous busha cattle breed as a method in implementing agri-environmental measures. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 21, Skopje.

Agri-environmental measures are designed to encourage farmers to protect and enhance the environment on their farmland in biodiversity and preservation and development of high nature value farming systems. The aim of this paper is to determine the supporting rates for the autochthonous Busha cattle breed in context of the current agri-environmental policy measures. The method used in the calculation of the agri-environmental budgets is based on partial budgeting, as a planning and decision-making framework used to compare the costs and benefits betweet different farms wich are breeding different cattle breeds. . It emphasizes the changes in income and costs that result from implementing a specific alternative. Thus, all aspects of farm profits that are unchanged are excluded. In

general, the fixed costs are regarded as equal, and change is foreseen in the variable costs and in the yield/producer price level. Theoretical calculation of indicative supporting rates for breeding autochthonous Busha cattle was further based on application of the calculation formula**:** YS=E x CE x GD, where: YS= yearly support, E= economic loss, CE=coefficient of endangerment, GD= geographical distribution. Comparative income and costs analysis of the Busha cattle farms versus the reference usual practice on cattle farms should range from 11,142 MKD to 14,668 MKD for compensation of the economic loss. The results of the empirical data and the desk survey of reference case farms categorized by cattle breed and by herd size revealed certain variations of the supporting rates. These aspects should be taken into consideration for further validation of the agri-environmental measure.

Key words: Busha cattle, agro-environmental measures, supporting rates.

Introduction

Agri - environmental measures (AEM) represent a group of measures which provide different level of support to farmers. The main aim of those measures can be identified through providing protection and improvement of the environment. One of the core characteristics of the measures is their voluntary acceptance and implementation. In fact, AEM can be defined as direct payments which provide a higher level of environmental protection and better management of the environment than application of good agricultural practice. AEM can be defined as national, regional or local, which need to be adapted to the respective farming systems and environmental conditions in the country. Although AEM have a scope yet each measure contains two main objectives: reducing environmental risks as a result of the development of agriculture and nature conservation and landscape environment (Commission of the European Communities, 2005).

The main difference in the creation and application of AEM can be identified in the level of coverage of farmers or users. Two types or two approaches can be appointed. The first type is known as the „broad brush or light green“ measure; it is a measure that includes a large number of farmers or users and greater territory, where the criteria to participate are quite modest. The second type of programs are known as „deep and narrow or dark green“ programs, and they cover certain specific topics from the environment and they have more specific participation criteria. AEM are realized for the first time in several EU countries during the eighties, though as accompanying measures of the Common Agricultural Policy these measures were implemented for the first time in 1992. Additional provisions have been incorporated in 1999 in the Rural Development Regulation in order to achieve coherence with the Rural Development Plans. The impact of AEM is quite complex and often their measurement is difficult and they are also hard to analyze. Evaluation through the classical approach usually includes the correlation of each measure with its impact on the environment. Usually the evaluation is limited due to the lack of empirical data and the inability to isolate a single measure and to evaluate its impact. Organic farming, genetic diversity and maintenance of existing sustainable and extensive systems are part of AEM that are actively applied in most countries. Therefore the mentioned measures include general directions such as: reduction of inputs, extensification of livestock production, farming of local breeds of animals that are highly adapted to the conditions of breeding and biodiversity conservation (Uthes et al., 2007).

Even when the biodiversity conservation and management of genetic resources is covered by AEM, some specific conditions must be fulfilled in order for AEM to be realized. Namely, AEM can be provided for “local breeds indigenous to the area and in danger of being lost to farming” (Council Regulation (EC) No. 1257/1999) if the breeds significantly contribute to maintenance of the local environment and typical breeding systems in the country. Eligibility of local breeds (cattle, sheep, goats, pigs, equines or poultry) for inclusion in the appropriate payment structure are defined in Commission Regulation (EC) No. 817/2004 were the threshold of each population is determined. A number of breeding females from each species, beneath which a breed is considered to be endangered and which are included in recognized register, represent the main threshold parameter. According to this regulation, the following thresholds are recognized: 7.500 heads of breeding females for cattle per cattle breed, 10.000 heads of breeding females for sheep per sheep breed, 10.000 heads of breeding females for goats per goat breed, 5.000 heads of breeding females for equidae per equidae breed, 15.000 heads of breeding females for pigs per pig breed and 25 000 for avian species.

Sometimes for decision making it is necessary to impute costs that cannot normally be collected within the accounting system and will not require cash outlays. These imputed costs are called opportunity costs. “An opportunity cost is a cost that measures the opportunity that is lost or sacrificed when the choice of one course of action requires that an alternative course of action be given up” (Drury, 2006). In this sense, partial budgets are identifying the time value of money. That is done with a calculation of opportunity costs for the annual operating inputs and costs which are small because of the short period. But in long-run these costs are of great importance for the capital investments and they usual-

Tab. 1. Description of the case farms included in the survey

Case farm	FDF	FCF	FBF	CBF
Type of farm	Family	Family	Family	Ag. company
Number of cows	20	6,5	20	300
System of breeding	Milk	Milk	Cow-calf/milk-cheese	Cow-calf
Feeding system	In-door	In-door with grazing	Indoor/ grazing	Predominantly grazing

ly require a large amount of money spread in deferent periods of many years (Kay *et al.*, 2008). When available, the market prices are used to determine the economic value. But when market prices are not available to estimate those values, the opportunity cost which is one of the more powerful concepts in economics and it is a measure of how much of an earning opportunity is foregone by using a resource in its current employment is used (Drummond & Goodwin, 2004).

In order to raise Busha breed and to be profitable with this technology of production, it has to be compensated with a financial supporting rate or agri-environmental subsidy which will cover the economic loss of the farmer. The non-economic consideration is that the farmer should became aware of the environmental consciousness in agricultural production and contribute at building higher nature value farming systems, which leads to stirring the environmental friendly consciousness on a global level. Also, to keep the autochthonous Busha cattle breed is of great importance for the Macedonian livestock production. That's the opportunity cost or better said benefit on a long run which cannot be converted into a numbers and calculated in these calculations.

In a nutshell, the aim of this paper is to determine the supporting rates for the autochthonous Busha cattle breed in context of the current agri-environment policy measures.

Material and method

The method applied in the calculation of the agri-environmental budgets is based on partial budgeting used to compare the costs and benefits of breeding the traditional Busha, as compared to usual practice and production of higher-yielding cow breed. The partial budgeting approach emphasizes the changes in income and costs that result from implementing a specific alternative. Thus, all aspects of farm profits that are unchanged are excluded. In general, the fixed costs are regarded as equal, and in this case therefore omitted, so change is foreseen only in the area of the variable specific costs and in the yield/producer price level. The partial budget is flexible enough, analyses the impact of the profit on a certain change and can be used for analyzing a number of important decisions as modifying production practice is (www. Penn State).

In order to fulfil the given aim of the paper, four reference types of farms were taken into consideration: family dairy farms (FDF) breeding Holstein –Frisian cattle, family crossbreed farm (FCF) breeding crossbreeds between Busha cattle and other dairy or dual purpose breeds, family Busha farm (FBF) breeding only Busha cattle breed, and one commercial Busha farm (CBF) breeding Busha cattle. The empirical data part was organized through creation of specific cases, based on concrete data obtained from operating cattle farms. For this purpose, three case farms were interviewed in-depth in order to get required production and economic data that served for the partial budget analysis (farm with Holstein-Fresian cows and two with Busha cows). The usual practice case farm was constructed on the base of the average statistical data. All data are relevant for the year 2011.

Theoretical calculation of indicative supporting rates for breeding autochthonous Busha cattle was further based on application of the calculation formula**:** YS=E x CE x GD, where: YS= yearly support, E= economic loss, CE=coefficient of endangerment, GD= geographical distribution (Kastelic et al., 2006).

Results and discussion

The technology that is supported by an agri-environmental measure is compared to an average usual practice of mixed breeds, as well as to the performance of a case farm with high-yielding Holstein-Friesian breed.

The results obtained from the empirical data and the desk surveys of reference farms reveal that the highest incomes has the case of family farm with Holstein-Friesian cattle (143,433 MKD per head), followed by the usual practice constructed farm (70,722 MKD), while the Busha cattle farms had distinctively lower income per animal (28,110 MKD in the milk/meat farm and only 3294 MKD per head at the meat only oriented farm). The level of costs is relatively proportional to the given income, hence the variable costs are the highest at the family farm with Holstein-Friesian cattle (119,150 MKD), giving a gross margin of 24,283 MKD per head. The usual practice is evaluated at lower variable cost level (54,930 MKD), thus the gross margin per head is 15,792 MKD. The farms with Bu-

sha have lower level of variable costs; the case farm that produces both milk and partially processed it into cheese, as well as selling meat, has annual variable cost of 18,900 MKD per head, and a gross margin of 4.760 MKD per head. The lowest costs are present at the case farm of Busha with cow-calf system that has meat as primary output (2,025 MKD) and has the lowest gross margin per head of 1269 MKD per head. From this it can also be seen that with the choice when breeding Busha there is no need for that much of a working capital in comparison to raising a Holstein-Friesian cattle, where the variable costs are much higher thus the farmers have to be have higher availability of liquid funds. With regard to the variable cost structure, the more intensive the system, the higher the feed costs; the feed costs constitute for 78% of the total variable costs in the case of the high-yielding Holstein-Friesian cattle. The feed cost take around 56% of the variable costs at usual practice farms with mixed breeds, and only 12-13% at Busha farms, since the animals are mostly fed at pasture.

The results presented in the following table summarize the calculation of partial differences; the partial differences between the different case range from 11,142 MKD to 14,668 MKD when Busha farms are compared to the usual practice. The disparity is even more considerable when the Busha case farms are compared to the high-yielding Holstein-Friesian farm, hence the difference ranges from 19,719 MKD to 23,245 MKD, depending on the farm comparison basis. This amounts contain the corrective coefficients of endangerment and geographical distribution, estimated at 1,01 and 1,00 respectively. Corrective coefficients of endangerment and geographical distribution used in this research are according to Kastelic et al., 2006. The partial difference in this context refers to the economic loss that the farmer who does the usual practice mixed breeds or high-yielding breeds would have if he/she raises the autochthonous Busha breed.

The subsidies are an important source of income for the farmers; the subsidies are given per head (amounting from 540 to 2,700, in a scaling system). In addition, a milk quantity linked subsidy is given, amounting 3,5 MKD/l in 2011. A high-yielding breed such as Holstein-Friesian at the case farm produced an average 6,700 l/cow thus being eligible for 23,450 MKD subsidies in 2011. Since Busha breed is low-yielding it cannot benefit from the milk-linked subsidies; in our case farms, the farm with mixed milk/cow-calf system gained 1,750 MKD in subsides while the case farm producing only fed animals could not benefit from this subsidy option. Additionally, the Busha breeders can apply for organic production subsidies (additional 30% from the basic amount of 2700 MKD per head, also in a scaling system), that amount to 360 denars/head in this case (IPARD Agency, 2011). In this respect, the partial differences with available subsidies are at respectively higher level.

Conclusions

There should be compensation for the farmers breeding autochthonous Busha cattle breed in context of the current agri-environment policy measures.

The amount should range from 11,142 MKD to 14,668 MKD when Busha farms – as calculated when these farms were compared to the usual practice farms in the country.

Defining and implementation of specific AEM for Busha breeders in the future will represent solid base for preservation of this indigenous cattle breed in the country.

Determination of calculations for supporting rates for other indigenous breeds in the near future should be performed.

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Tab. 2. Calculated partial differences corrected with the coefficients of endangerment and geographical distribution

Case farm	FDF	FCF	FBF	CBF
Partial difference without financial support/subsidies (1269 MKD=0)	23245	14668	3526	0
Partial difference without financial support/subsidies (4760 MKD=0)	19719	11142	0	-3526

* coefficient of endangerment (CE) = 1,01, coefficient of geographical distribution(GD) = 1,00

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УСВОЈУВАЊЕ НА МАГНЕЗИУМ КАЈ ЛУЦЕРКА ВО ЗАВИСНОСТ ОД ФАЗАТА НА РАЗВИТОК И СНАБДЕНОСТА НА ПОЧВАТА СО МАГНЕЗИУМ (Mg) И НЕКОИ ДРУГИ МАКРОЕЛЕМЕНТИ

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Извод

Јусуфи, Е. (2013). Усвојување на магнезиум кај луцерка во зависност од фазата на развиток и снабденоста на почвата со магнезиум (Mg) и некои други макроелементи. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 21, Скопје.

Во трудот е прикажан интензитетот и усвојувањето на magnesium (Mg)кај луцерка во зависност од некои еколошки и физиолошки параметри.

Луцерката сорта Банат ЗМС II е одгледувана во полски услови во четири локалитети на Р. Македонија. Истата луцерка е одгледувана и во вегетациони садови исполнети со 12 kg воздушно сува почва од опитните локалитети прихранети со 10 gr/сад NPK + микроелементи .

Мостри од растителен материјал (лисја и стебленца) се земени во две фази на развиток (пред цветање и цветање).

Измерената содржина на магнезиум во луцеркините стебленца наспроти лисјата во фаза пред цветање е пониска за 25,10%, односно во фаза на цветање за 43,12%. Високата снабденост на луцерка со Mg во с. Радуша, во лисја (1,92%) и стебленца (0,81%) е поради повисоката снабденост на почвата (195,5 mg/100 g), додека пониската содржина на Mg во луцерката на с. Коџилари, посебно во стебленцата е резултат на повисоката снабденост на почвата со калиум (68,20 mg/100 g) кој го успорува усвојувањето на магнезиум. Подобрата застапеност на изменливиот калциум во почвата на с. Јегуновце (622,5 mg/100 g) покажа негативно влијание врз усвојувањето на магнезиум кај луцерка. Во с.Сарај содржината на Mg од 0,62% во лисјата и 0,42% во стебленцата е е значително пониска наспроти истата во с.Радуша, додека во однос на другите варијанти нема значителни разлики со исклучок на стебленцата на с. Коџилари каде содржината на Мг е значително пониска за 26.2% (0.31%). Во фаза на цветање е измерена значително пониска содржина на MgO во сувата маса на стебленцата, за разлика од лисјата каде има тенденција на зголемување.

Прихранувањето на луцерка со NPK (15:30:15) + микроелементи во опитот со вегетациони садови покажа депресивен ефект врз усвојувањето на Mg, посебно изразено во стебленцата поради антагонистичкото делување на калиумот.

Клучни зборови: луцерка, почва, фази на развиток,сува маса, антагонизам, макроелементи

Abstract

Jusufi, E. (2013). Adoption of the Magnesium in alfalfa depending of the development phase and the soil supplement with Magnesium and some other macroelements. Proceedings of the IV Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 21, Skopje.

In this article intensity and adoption of Mg in alfalfa depending of some ecological and physiological parameters is presented.

The alfalfa, sort ‘Banat ZMS II’ is cultivated in field conditions in four locations in Republic of Macedonia. The same alfalfa is cultivated in vegetation pots filled with 12 kg of air dry soil from the experimental locations which are fertilized with 10g/ per pot NPK + microelements

The samples from the vegetable material (leaves and stems) are taken in two stages of development (before bloom and bloom).

The measured content of the Mg in alfalfa stems against the leaves in the stage before bloom is lower for 25.10%, i.e. in the stage of bloom for 43.12%.

The higher content of Mg in alfalfa in v. Raduša in leaves (1.92%) and stems (0.81%) is due to higher supplementation of the soil (195.5 mg/100g), while the lower content of Mg in alfalfa of v. Kodzilari, especially in the stems is a result of the higher supplement of the soil with potassium (68.20 mg/100g), which has slows the adoption of Mg. The better representation of changeable Ca in soil of v. Yegunovce (622.5 mg/100g), has been shown negative impact in adoption of Mg in alfalfa. In v.Saray the content of Mg from 0.62 % in leaves and 0.42 % in stems is significantly lower versus the same in v.Radusa ,while in other variants are no significant differences with the exception of the stems in v. Kodzilari where the magnesium content is significantly lower for 26.2% (0.31% Mg).At the bloom stage, the experimental alfalfa has shown significant decrease of the MgO content in the dry mass of the stems, while in the leaves there is clear tendency of increase.

The executed fertilization of the alfalfa with NPK (15:30:15) + microelements in the experiment with vegetation pots has shown depressive effect on the Mg adoption, especially expressed in the dry mass of the stems as a result of antagonistic influence of the potassium.

Key words: Alfalfa, soil, development stages, dry mass, antagonism, macroelements, microelements

Introduction

For its nutritive values and the vast presence in the nutrition of domestic animals, especially the ruminants, alfalfa is one of the leading fodder cultures, Sredanović et al., 1991, Mc Dowel (1992).

Many factors influence alfalfa's growth, of which special role plays the agro-chemical composition of the soil (Gagachev & Jekić, 1989; Zlatareva & Nikolay, 1999; Kozarova, 1984; Correa et al., 2001; as well as the development phase (Balde et al., 1993; Boshnyak., Styepanovic, M., 1983;)

Many authors connect the mechanism of absorption of minerals from the soil, or the transportation of ions, with the matabolic processes in the plants, especially with the process of expiration, photosynthesis and other (Kastori, 1983; Marschner, 1995; Harscharn & Williams, 2003).

According to Neubert *et al.,*1970, Mg contents of 0.30 to 1.00 mg/kg in dry matter are considered as optimum Mg contents in alfalfa, 1.00 – 2.00 mg/kg are considered high, and contents over 2.00 mg/kg are considered as toxic for animals. .

Material and methods

Alfalfa sort Banat ZMS II was cultivated in field conditions and vegetation pots as well.

The experiment with alfalfa in field conditions was performed on 4 locations (the villages of Saray – Skopje region, Yegunovce – Tetovo region, Raduša – Skopje region, and Kodzilari – Veles region), with known agro-chemical soil composition (Table 1).

For the cultivation of experimental alfalfa in vegetation pots, a total of 80 pots were placed (20 pots for each location), filled up with soil (12 kg/pot) from the above mentioned locations. Parallely, for each location pots were placed where alfalfa's fertilization with artificial fertilizer F-Top NPK (15:30:15 + mikcroelements (ME) was done.

Tab. 1. Agro-chemical soil composition

Location	mg/100g soil			
			exchangeable	
	NH_4N	K	Ca	Mg
Saray	0,49	3,33	526.0	19,0
Yegunovce	0,77	4,87	622.5	29,3
Raduša	2,01	9,89	582.51	195.5
Kodzilari	2,21	68,2	815.0	63,7

Alfalfa samples (leaves and stems) were taken in two pheno-phases, before blooming and blooming.

Magnesium contents (MgO) in dry matter was determined by wet combustion with HNO_3, $HClO_4$, H_2SO_4 (10 : 1.0 : 0.25), whereas the reading was done by an atomic absorption spectro-photometer (A.A.C.).

Results

From the data brought on Mg contents in the experimental alfalfa's leaves and stems (field condition experiment) in the before blooming phase (Table 2.), it can be established that the same in the dry matter ranges from 0.39% (Kodzilari).

From the presented data for the Mg content in dry matter of experimental alfalfa (field conditions) before blooming phase (table 2) can be concluded that the Mg content in dry matter of alfalfa stems ranges from 0.39 % in variants of v. Kodzilari to 1.11% in variants of v. Radusa and the same content in terms of the measured in leaves are lower for 35.84%;35.72% (v. Radusa; v. Kodzilari), i.e. for 13.03%; 15.81% (v. Saray and v. Yegunovce). In the blooming phase in experimental alfalfa is observed a significantly decreasing of the Mg content in dry matter of stems, respectively from 26.8 % in vari-

Tab. 2. The content of magnesium in the dry matter of leaves and stems

Location	% MgO						
	Leaves			Stems			stems/ leaves
	before blooming						%
		%			%		
Saray	0.59 ± 0.02	100.0	100.0	0.51 ± 0.06	100.0	100.0	86.97
Yegunovce	0.53 ± 0.07	88.8	100.0	0.44 ± 0.08	86.0	100.0	84.19
Raduša	1.73 ± 0.12	292.7	100.0	1.11 ± 0.12	215.9	100.0	64.16
Kodzilari	0.60 ± 0.01	101.9	100.0	0.39 ± 0.03	75.3	100.0	64.28
	Blooming						
Saray	0.62 ± 0.04	100.0	105.6	0.42 ± 0.10	100.0	81.7	67.31
Yegunovce	0.57 ± 0.02	92.2	109.5	0.40 ± 0.09	95.9	91.2	70.08
Raduša	1.92 ± 0.11	308.2	111.2	0.81 ± 0.04	193.3	73.2	42.22
Kodzilari	0.65 ± 0.02	103.7	107.5	0.31 ± 0.03	73.8	80.1	47.91

ants of v.Radusa (0.81%) to 8.8% in v.Yegunovce (0.40%),versus the content of Mg in leaves where there is a tendention of increasing for 5.6% (v. Saray), 7.5%(v. Kodzilari),9.5% (v. Yegunovce) and 11.2 % (v. Radusa).

For the very rich with Mg soil in Raduša (195.5 mg/100g), in alfalfa's dry matter higher Mg contents were measured, namely 1.92% in the leaves or 0.81% in the stems (blooming phase). In the two phenophases, the lowest average Mg contents were measured in alfalfa's stems in Kodzilari variant, which in comparison to the one of Saray variant is 24.7% lower (before blooming), or 26.2% (blooming phase).

The content of Mg alfalfa cultivated in vegetation pots, has shown values within optimal amounts (0.31-1.0 % Mg),with the exception of the v.Radusa variant where the same are significantly higher.In the phase before blooming,dry matter of non-fertilized alfalfa from v.Radusa variants showed a significantly higher Mg content versus in v.Saray i.e. for 126.67% (1.70%) in leaves and 0.42% in the stems.The content of Mg measured in dry matter of v.Yegunovce (0.75% in leaves and 0.60% in stems) did not show significant difference according to the same values in v.Saray (<5%),In the blooming phase the content of Mg in dry matter of leaves is insignificantly higher than the ones before the blooming phase (<5%),unlike in stems where it comes to a significant decrease of the Mg contents,where in

Tab. 3. The content of Mg in dry matter of alfalfa leaves and stems

Location	v. phase	% MgO					
		Leaves			stems		
		Unfertilized					
v.Saray	before blooming	0.75 ± 0.03	100.0	100.0	0.67 ± 0.04	100.0	100.0
v.Yegunovce		0.71 ± 0.02	94.7	100.0	0.63 ± 0.02	94.0	100.0
v.Raduša		1.70 ± 0.03	226.7	100.0	1.18 ± 0.10	176.1	100.0
v.Kodzilari		0.60 ± 0.02	80.0	100.0	0.42 ± 0.03	62.7	100.0
v.Saray	blooming	0.78 ± 0.03	100.0	104.0	0.65 ± 0.02	100.0	97.0
v.Yegunovce		0.75 ± 0.02	96.2	105.6	0.60 ± 0.03	92.3	95.2
v.Raduša		1.79 ± 0.03	229.5	105.3	0.81 ± 0.03	124.6	68.6
v.Kodzilari		0.62 ± 0.03	79.5	103.3	0.33 ± 0.04	50.8	78.6
		Fertilized					
v.Saray	before blooming	0.72 ± 0.02	100.0	100.0	0.48 ± 0.02	100.0	100.0
v.Yegunovce		0.69 ± 0.03	95.8	100.0	0.46 ± 0.02	95.8	100.0
v.Raduša		1.69 ± 0.03	234.7	100.0	0.74 ± 0.03	154.2	100.0
v.Kodzilari		0.62 ± 0.02	86.1	100.0	0.36 ± 0.02	75.0	100.0
v.Saray	blooming	0.75 ± 0.03	100.0	104.2	0.32 ± 0.03	100.0	66.7
v.Yegunovce		0.73 ± 0.04	97.3	105.8	0.30 ± 0.03	93.7	65.2
v.Raduša		1.72 ± 0.03	229.3	101.8	0.56 ± 0.04	175.0	75.7
v.Kodzilari		0.63 ± 0.01	84.0	101.6	0.28 ± 0.02	87.5	77.8

v.Kodzilari is 21.4% (0.33% Mg) and v.Radusa is 31.4% (0.81% Mg) (Table.3).In the dry matter of the stems from v.Yegunovce and v.Saray,the decrease is insignificant in the blooming phase (< 5%).

In the two phenophases, the average Mg values in the leaves' dry matter in the fertilized against non-fertlizied alfalfa plants on the experimental locations, are insignificantly lower (<1.56%), while in the stems a significant decrease of 34.10% can be noted. According to the values obtained for Mg in the dry matter of the fertilized plants in the before blooming phase, a distinguishly higher amount was measured in the leaves for 1.69% and the stems for 0.74% from Raduša, while the lowest were in the leaves (for 0.62%) and the stems (for 0.36%) from Kodzilari (Table 3).

Discussion

Mg absorption showed dependence on alfalfa's growth phase, where its contents in alfalfa's dry matter in the before-blooming phase is higher than the one in the blooming phase, which was established by the research done by Brink & Marten ,1989; Boshnyak & Styepanović,1983. The more intense Mg absorption in alfalfa in the location of Raduša, where the highest amounts of soil magnesium are present (195.5 mg/100g), indicated the positive correlation between its absorption and the soil richness, established by Kozarova,1984; Gagačev & Jekić ,1989.. The lower Mg contents in the leaves and the stalks from Kodzilari, besides the good soil richness with Mg (63.75 mg/g), is a consequence of the high soil richness with K_2O (68.20 mg/100g) and NH_4N (2.21 mg/100g), which ones slow down its absorption (Harscharn & Williams, 2002; Correa et al., 2001). The existing antagonism between Mg and K is confirmed by Stoyanov et al.,1979; Heenan & Campbell,1981. The lower Mg contents in Yegunovce variant, compared to that from Saray variant, is an expression of better soil richness with calcium, which also shows inhibitory action towards Mg absorption, (Marschner,1995; Harscharn. & Williams, 2003; Stoyanov et al., 1979.

The alfalfa's fertilization performed during vegetation regarding Mg contents in the leaves and the stems showed a depression effect which was significant in the stems, above all because of the increased amounts of accumulated calcium as an expression of its more intense absorption (Heenan & Campbell, 1981; Harscharn & Williams, 2002; Jusufi & Zekiri, 2011).

Conclusion

- Alfalfa in the villages of Saray, Yegunovce and Kodzilari is optimally enriched, while the one from Raduša is very well enriched.

- Alfalfa's dry matter has shown sigfnificantly higher Mg contents in the before-blooming phase, compared to the one in the blooming phase.

- In the blooming pahse there is significant Mg contents' decrease in the stems dry matter;

- Absorbed amounts of Mg in dry matter are in positive correlation with the level of soil richness with Mg;

- The higher soil richness with K and Ca showed a negative influence on the degree of absorbed Mg.

- Alfalfa's fertilization showed a depression effect on Mg contents, which is especially notable in the stems.

- The significantly lower Mg contents in dry matter of non-fertilized alfalfa is above all an expression of the increased amounts of added K, which demonstrates antagonism towards Mg absorption.

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Summary

Alfalfa is one of the most important fodder cultures, first of all because of its high yields and the qualitative compositions that are depending on the agro-chemical properties of the soil and the external ecological conditions.

In the experiment performed on agricultural soil on 4 locations: the villages of Saray, Yegunovce, Radusa and Kodzilari (field conditions and vegetation pots), a significant correlation between the amount of Mg absorbed in the dry matter and the Mr, Ca and K contents in the soil was established. Also, during growth, dynamics in Mg contents in the leaves and the stems was noted, which is of special importance for the way and the time of its exploitation.

Key words: alfalfa, soil, field conditions, vegetation pots, dry matter.

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DRESSING PERCENTAGE AND YIELD OF WHITE RICE IN *Bianca* AND *Galileo* - TWO NEWLY INTRODUCED RICE VARIETIES (*Oryza sativa* L.), GROWN UNDER AGRO-ECOLOGICAL CONDITIONS OF MACEDONIA

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Abstract

Andreevska, D., Andov, D., Simeonovska, E. (2013). Dressing percentage and yield of white rice in *Bianca* and *Galileo* - two newly introduced rice varieties (*Oryza sativa* L.), grown under agro-ecological conditions of Macedonia. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 21, Skopje.

In this paper, the results of investigation of two newly introduced rice varieties *Bianca* and *Galileo* are presented, regarding the dressing percentage of white rice, yield of white rice as well as 1000 grain weight. In order to compare these results, the same parameters were explored also on two standard varieties *Prima riska* (Macedonian variety) and *R-76/6 (*domesticated Italian variety), traditionally grown under agro-ecological conditions of Macedonia (the region of Kocani, locality "Bosevica"). The research was carried out during 2009 and 2010 by setting up field trials (randomized block system). The soils of the locality "Bosevica", where the field trials were set up on are of alluvium soil type, carbonate-free at the examined depths. The soil texture was fine sandy loam. The pH of the soil solution was acid; the content of humus was low, the content of total nitrogen was strongly correlated to the content of humus. The soil was medium supplied with easily available potassium and phosphorus. In general, the climatic conditions during both years of investigation were favourable for rice cultivation. The dressing percentage of white rice (whole grains) as well as byproducts of rice milling (brokens, bran and husks) were determined by milling on laboratory mill (three average samples of paddy rice, each weighing 100g). The duration of milling was 1.40 minutes. According to the obtained results, the highest average percentage of the whole grains (55.14%) followed by the highest yield of white rice (4289.00 kg ha^{-1}) was achieved in the standard variety *R-76/6*, in both years of investigation. The lowest average percentage of the whole grains (35.40%) as well as the lowest yield of white rice (3008.67 kg ha^{-1}) was obtained in the newly introduced variety *Galileo*. The percentage of the whole grains (white rice) in the other standard variety *Prima riska* was 48.82%, the yield of white rice was 4159.34 kg ha^{-1}; the values of the same traits in the second introduced variety *Bianca* were 50,31% and 4068,84 kg ha^{-1} respectively. The investigated rice milling performances differed during the two years of investigation, caused by the influence of the environmental conditions. Also, the varietal diversity was stated in the considered quality characteristics of milled rice, due to genetic diversity among the four investigated varieties.

Key words: rice, varieties, agro-ecological conditions, percentage of the whole grains, yield of white rice

Извод

Андреевска, Д., Андов, Д., Симеоновска, Е. (2013). Рандманот и приносот на бел ориз кај *Бианка* и *Галилео* - две ново интродуирани сорти ориз (*Oryza sativa* L.) одгледувани во агроеколошките услови на Македонија. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 21, Скопје.

Во трудот се презентирани резултатите од испитувањето на рандманот, приносот на бел ориз и масата на 1000 зрна кај две новоинтродуирани италијански сорти ориз: *бианка* и *галилео.* Истите параметри се испитани паралелно и на две стандарни сорти: *прима риска* (македонска сорта) и *P-76/6* (одомаќинета италијанска сорта), традиционално одгледувани во агроеколошките услови на Македонија (во Кочанскиот регион, локалитет „Босевица"), со цел да се споредат резултатите. Истражувањата се спроведени во текот

на 2009 и 2010 година во полски експерименти по методот на рандомизиран блок систем. Почвите од локалитетот „Босевица“ (каде што се спроведени полските експерименти) се од алувијален почвен тип, бескарбонатни во испитуваните длабочини, а според маханичкиот состав, тоа се ситно песокливи иловици. Реакцијата на почвениот раствор е кисела, според содржината на хумус се слабо хумусни, а содржината на вкупен азот е во тесна корелација со хумусот. Почвите се средно обезбедни со лесно достапен калиум и фосфор. Во двете години на истражување климатските услови беа поволни за производство-одгледување на оризот. Според добиените резултати може да се констатира дека највисок просечен рандман (цели зрна-55,14%) и принос на бел ориз (4289,00 kg ha^{-1}), од двете години на испитување е добиен кај стандардната сорта *р-76/6*. Најнизок просечен рандман (35,40%) и најнизок принос на бел ориз (3008,67 kg ha^{-1}) е постигнат кај новоинтродуцираната сорта *галилео*. Рандманот и приносот на бел ориз кај стандардната сорта *прима риска*-изнесуваат: 48,82%, односно 4159,34 kg ha^{-1}, а кај другата испитувана сорта *бианка* – 50,31% и 4068,84 kg ha^{-1} соодветно. Од спроведените истражувања може да се констатира дека квалитетот на оризот при лупењето - рандманот и приносот на бел ориз се разликуваат во различните години на испитување, односно зависат од агроеколошките услови на одгледување. Исто така, во однос на испитуваните својства, констатирана е и сортна специфичност, односно разлики во вредностите што се должат на генетските особини на сортите.

Клучни зборови: ориз, сорти, агроеколошки услови, рандман, принос

Introduction

After the rice crop harvest, the first obtained product is rough rice, also called paddy rice. Being encased by hulls, the paddy rice is not ready for human consumption. Therefore, the harvest is followed by post-harvest processing in specially equipped milling factories.

The paddy rice processing comprehends the following operations: cleaning, drying, hulls removing, separation of the hulled from non-hulled rice, whitening, separation of the whole grains from brokens, removing small stones, assorting the grains according to their colour, packing and storing. Dehulling results in few different fractions as de-hulled grains, hulled grains, grains' particles (or so-called brokens), hulls and bran (flour). De-hulled grains are brown-colored, therefore they are also called brown rice, husked rice or cargo.

The next step in producing white rice is whitening of the cargo rice by using specific equipment. During the whitening, the bran layers and the small part of the endosperm are being removed. Milled rice (or white rice) represents de-hulled and whitened rice grains from which the embryo and hulls are removed.

The dressing percentage or the yield of white rice depends directly on the genotype (variety), but also on the applied technology as well as environmental factors (Kunze, 1985; Sürek and Beser, 1998; Srinivas and Bhashyam, 1985; Andov et al., 2003; Ilieva et al., 2000a, 2007, 2008, 2009).

In order to get higher yield and better grain quality in rice crop production, using high-yielding and good-quality rice varieties is crucial, beside the soil condition, climate and applied technology. Selection of rice varieties that are suiTab. to specific environmental conditions would provide full expression of their productive and quality traits.

Introduction of the new, high-yielding and good-quality rice varieties, parallel to breeding new varieties is the way to enrich the assortment of rice cultivars in the Republic of Macedonia (according to Andov et al. 2003, 2008/2009, 2010; Ilieva et al., 2000b, 2005/2006, 2007, 2008, 2010).

The aim of this research was to determine the dressing percentage, the yield of white rice and the 1000 grain weight in the two newly introduced rice varieties grown under the environmental conditions of the region of Kocani, Republic of Macedonia.

Materials and methods

Two newly introduced rice varieties *Bianca* and *Galileo* were investigated in comparison with standards *Prima riska (*Macedonian rice variety, released in 2004) and *R-76/6* (domesticated Italian rice variety, widely used in rice crop production in Macedonia).

Investigations were carried out during 2009 and 2010; field trials were set up at the locality Bosevica (experimental field of the Rice Department in Kocani, within the Institute of Agriculture in Skopje). The experimental design was randomized block system with three repetitions. Standard technology for rice production was applied.

Laboratory milling was carried out by using laboratory mill. In order to determine the dressing percentage - whole grains of the white rice as well as by-products (brokens, rice brans and hulls), three average paddy rice samples, (each weighing 100 g) were milled in total 1.40 minutes.

The obtained data were statistically performed by ANOVA and tested by LSD test.

The 1000 grain weight was assessed both to paddy rice and to white rice, on two samples per variety, each compounded of 500 grains.

Tab. 1. Some chemical properties of the soil from the locality "Bosevica"

Depth [cm]	$CaCO_3$ [%]	Humus [%]	Total [%]	pH		Available [mg/100 g]	
				H_2O	nKCl	P_2O_5	K_2O
0-20	-	2.16	0.09	5.79	4.92	17.85	14.02
20-40	-	1.50	0.06	5.88	5.07	11.57	12.04

Soil and climatic conditions

The field trials were set up on alluvium soil type (the experimental field on the locality "Bosevica"). At the examined depths (0-20 cm and 20-40 cm), the soil was carbonate-free. The soil texture was fine sandy loam. Other soil characteristics were as well: acid pH of the soil solution, low content of humus, total nitrogen content strongly correlated to the humus content. The examined soil was medium supplied with easily available potassium and phosphorus.

Regarding the climatic conditions during the rice vegetation period (from April to October) in 2009/2010, the average monthly air temperature was 19.9 °C, the average monthly maximum temperature 25.5 °C while the average monthly minimum temperature was 12.2 °C (Tab. 2). In 2009, the average monthly air temperature (20 °C) was slightly higher compared to 2010 (19.7 °C).

On average, the total sum of rainfalls during the investigation (2009/2010) was 331.6 mm. In the first year (2009), the maximum of rainfalls was measured in June (96.7 mm), and the minimum in July (11.0 mm). In the second year of investigation, the biggest sum of rainfalls was in October (119.5 mm), and the lowest in August (6.5 mm).

In general, the climatic conditions during both years of investigation were favorable for rice cultivation.

Results and discussion

1. Dressing percentage of white rice

The results of investigation of dressing percentage (whole grains percentage) are presented in Table 3.

The results of investigation of dressing percentage (whole grains percentage) show the highest average percentage of the whole grains (55.14%) in the standard variety *R-76/6*, in both years of investigation. The lowest average percentage of the whole grains (35.40%) was obtained in the newly introduced variety *Galileo* (Table 3).

In 2009, the standard variety *R-76/6* gained

Tab. 2. Data on meteorological elements during the rice vegetation period in Kocani

Year	Months							Average	
	IV	V	VI	VII	VIII	IX	X		
	Average monthly temperature [Cº]							Years	Veg.
2009	14.0	18.7	22.4	24.9	24.9	21.2	14.0	14.1	20.0
2010	13.7	18.5	22.1	24.9	26.9	19.3	12.2	14.3	19.7
Average	13.9	18.6	22.3	24.9	25.9	20.3	13.1	14.2	19.9
	Average monthly max.temperature [Cº]								
2009	19.6	25.0	28.5	31.7	30.8	26.6	19.8	19.4	26.0
2010	19.0	23.9	26.9	29.9	32.7	25.6	16.8	19.3	25.0
Average	19.3	24.5	27.7	30.8	31.8	26.1	18.3	19.4	25.5
	Average monthly min.temperature [Cº]								
2009	6.4	9.0	13.0	15.8	15.4	12.1	6.4	6.8	11.2
2010	8.3	11.8	15.2	17.0	18.7	12.4	8.2	8.9	13.1
Average	7.4	10.4	14.1	16.4	17.1	12.3	7.3	7.9	12.2
	Monthly rainfalls [mm]							Sum	
2009	36.0	59.7	96.7	11.0	33.0	34.5	44.0	576.3	314.9
2010	63.3	20.5	86.0	19.5	6.5	33.0	119.5	623.3	348.3
Average	49.7	40.1	91.4	15.3	19.8	33.8	81.8	599.8	331.6

the highest value for dressing percentage of white rice (53.23%), significantly higher compared to *Prima riska* and *Galileo* (differences were not significant while compared to *Bianca).* The lowest yield of white rice in 2009 was reached by the newly introduced variety *Galileo* (37.14%), significantly lower than other varieties.

In 2010, like in 2009, the highest dressing percentage of white rice was found in the standard variety *R-76/6* (57.05%); this value was significantly higher than *Bianca's* and *Galileo's* values (for both levels of probability), and *Prima riska'*s value (for probability level of 0,05). The lowest yield of white rice in 2010 was assessed for the variety *Galileo* (33.66%), significantly lower than all other examined varieties.

No significant differences ($p>0.05$) among investigated varieties, regarding the percentage of hulls and bran were found (Table 3).

The variety *Bianca* was characterized with the lowest percentage of hulls (19.56%), while the highest (21.04%) was found in *Galileo.* The range bran percentage was from 11.52% (*R-76/6)* to 13.85% (*Prima riska).*

According to Andov et al. (2003), the content of byproducts of rice milling (whole grains, brokens, hulls and bran) vary depending on the variety, year of vegetation and cropping system (rice as first or second crop).

Dressing percentage is influenced by the time of harvesting and grain moisture content.

High dressing percentage of white rice was obtained when the harvest had been conducted 36 to 39 days after flowering, with grain moisture content between 20% and 30% (Ali et al., 1993).

According to Ilieva et al. (2009), an optimal period for harvesting, determined for five different rice varieties (*Monticelli, Biser-2, San Andrea, R-76/6 and Prima riska)* was the period when the grain moisture content is 18% - 20%.

In both years of investigation, the highest dressing percentage of white rice was reached during the third period of harvesting (20% average grain moisture content).

2. Yield of white rice

The obtained results for the yield of white rice are presented in Table 4.

The highest average yield of white rice after post-harvest processing of the paddy rice was assessed for the standard variety *R-76/6* (4289.00 kg ha^{-1}), while the lowest was reached by newly introduced variety Galileo (3008.67 kg ha^{-1}). The yield of white rice of other two varieties was 4159.34 kg ha^{-1}, (standard *Prima riska*) and 4068.84 kg ha^{-1} (introduced variety Bianca).

In 2009, the highest yield of white rice was obtained for the variety *Bianca (*3922.67 kg ha^{-1}), significantly higher for both levels of probability compared to all other varieties *R-76/6, Prima riska* and *Galileo* (Table 4). The lowest yield of white rice in 2009 was determined for *Galileo* (2810.67 kg ha^{-1}), significantly lower than *R-76/6* (3471.67 kg ha^{-1}) and *Bianca* (3922.67 kg ha^{-1}).

Tab. 3. Dressing percentage [%]

Varieties	Year	Whole grains	Brokens			Total whole grains+ brokens	Chalky grains	Rice bran	Hulls
			1/3	2/3	Total				
Prima riska (st.)	2009	44.51	1.98	18.02	20.00	64.51	1.09	14.80	19.60
	2010	53.12	2.04	10.90	12.94	66.06	0.50	12.90	20.54
	2009/10	**48.82**	**2.01**	**14.46**	**16.47**	**65.29**	**0.80**	**13.85**	**20.07**
R-76/6 (st.)	2009	53.23	1.99	11.26	13.25	66.48	0.90	11.58	21.04
	2010	57.05	1.65	10.47	12.12	69.17	0.25	11.45	19.13
	2009/10	**55.14**	**1.82**	**10.87**	**12.69**	**67.83**	**0.58**	**11.52**	**20.09**
Bianca	2009	52.92	1.45	13.00	14.45	67.37	0.31	12.85	19.47
	2010	47.70	2.88	16.41	19.29	66.99	1.40	11.97	19.64
	2009/10	**50.31**	**2.17**	**14.71**	**16.87**	**67.18**	**0.86**	**12.41**	**19.56**
Galileo	2009	37.14	4.70	22.92	27.62	64.76	1.20	14.13	19.91
	2010	33.66	7.94	24.60	32.54	66.20	1.20	10.44	22.16
	2009/10	**35.40**	**6.32**	**23.76**	**30.08**	**65.48**	**1.20**	**12.29**	**21.04**
Year	*2009*	*2010*							
LSD $_{0.05}$	*2.17*	*3.86*							
LSD $_{0.01}$	*3.16*	*5.62*							

Tab. 4. Yield of white rice [kg ha^{-1}]

Varieties	Year		Average	Index from	
	2009	2010		*Prima riska*	*R-76/6*
Prima riska(st.)	3028.00	5290.67	**4159.34**	0	-3.02
R-76/6 (st.)	3471.67	5106.33	**4289.00**	+3.12	0
Bianca	3922.67	4215.00	**4068.84**	-2.18	-5.13
Galileo	2810.67	3206.67	**3008.67**	-27.66	-29.85
Average	**3308.253**	**4454.668**	**3881.46**		
$LSD_{0.05}$	*226.95*	*392.46*			
$LSD_{0.01}$	*330.56*	*571.63*			

In the vegetation year 2010, the highest yield of white rice was assessed for the variety *Prima riska* (5290.67 kg ha^{-1}), significantly higher compared to *Bianca* and *Galileo* only (differences were not significant for other standard *R-76/6)* (Tab. 4).

According to Andov et al. (2003), the average yield of white rice in few investigated varieties (*Monticelli, Osogovka, M-101, Onda, Lido* and *Radon)* was higher when the rice was first crop, than in case where the rice was second crop.

3. Mass of 1000 grains

The mass of 1000 grains is characteristic of the species and the cultivar. This characteristic vary in wide range depending on grain maturity level, grain origin, position on the panicle where the grain is forming on the mother plant, agro-ecological growing conditions, applied technology etc.

Grain moisture has an important influence on the mass of 1000 grains, hence it is necessary for the mass of 1000 grains to be related to grain dry matter content.

According to the results for mass of 1000 grains (paddy and white rice) presented in Tab. 5, the newly introduced Italian varieties *Bianca* and *Galileo*, as well as two standard varieties *Prima riska* and *R-76/6* are characterized with large grain dimensions.

The highest average mass of 1000 grains (paddy and white rice) was assessed for the variety Bianca (paddy - 43.45 g; white rice - 30.06 g), while the lowest values were obtained for the variety *R-76/6* (paddy - 39.15 g; white rice - 27.67 g).

Conclusions

From the conducted investigations and obtained results of the newly introduced Italian varieties *Bianca* and *Galileo*, compared to standard varieties *Prima riska* and *R-76/6* the following conclusions could be done:

* The highest average dressing percentage (whole grains -55.14%) and yield of white rice (4289 kg ha^{-1}) was achieved in the standard variety *R-76/6*, in both years of investigation.

* The lowest average dressing percentage (35.40%) as well as the lowest yield of white rice (3008.67 kg ha^{-1}) was obtained in the newly introduced variety *Galileo*. In the variety *Bianca* dressing percentage was 50.31% and yield of white rice - 4068.84 kg ha^{-1}.

* The dressing percentage of the second standard variety *Prima riska* was 48.82%, and the yield of white rice was 4159.34 kg ha^{-1}.

* The highest average mass of 1000 grains (paddy and white rice) was assessed for the variety Bianca (paddy - 43.45 g; white rice - 30.06 g), while the lowest values were obtained for the variety *R-76/6* (paddy - 39.15 g; white rice - 27.67 g).

* The milling quality parameters of rice (dressing percentage and yield of white rice) are geneticaly determined, but their values also depend on envi-

Tab. 5. Mass of 1000 grains [g]

Varieties	Paddy rice			White rice		
	Year		Average	Year		Average
	2009	2010		2009	2010	
Prima riska(st.)	40.77	39.96	**40.37**	28.98	28.40	**28.69**
R-76/6 (st.)	39.86	38.44	**39.15**	28.17	27.16	**27.67**
Bianca	43.95	42.94	**43.45**	30.41	29.71	**30.06**
Galileo	41.78	40.65	**41.22**	28.07	27.31	**27.69**

ronmental growing conditions that differ in different years of investigation.

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YIELD OF WHITE RICE AND BYPRODUCTS OF RICE MILLING IN SOME NEWLY INTRODUCED ITALIAN RICE VARIETIES GROWN UNDER AGRO-ECOLOGICAL CONDITIONS OF MACEDONIA

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Abstract

Andov, D., Andreevska, D., Simeonovska, E. (2013). Yield of white rice and byproducts of rice milling in some newly introduced Italian rice varieties grown under agro-ecological conditions of Macedonia. Proceedings of the 4th Congress of Ecologists of Macedonia with International Participation, Ohrid, 12-15 October 2012. Macedonian Ecological Society, Special issue 21, Skopje.

The dressing percentage of white rice, yield of white rice, byproducts of paddy rice milling as well as 1000 grain weight were investigated in three newly introduced Italian rice varieties *Brio, Ellebi* and *Opale.*

The same characteristics were explored also in two standard varieties *Prima riska* and *R-76/6* in order to compare the obtained results. The research was carried out during 2010 and 2011 by setting-up field trials (randomized block system) under the agro-ecological conditions of the Kocani region in Macedonia. The dressing percentage of white rice (whole grains) as well as byproducts of rice milling (brokens, bran and husks) were determined by milling on laboratory mill (three average samples of paddy rice, each weighing 100 g). The duration of milling was 1.40 minutes. The soils of the locality "Bosevica", where the field trials were set up on are of alluvium soil type, carbonate-free at the examined depths. The soil texture was fine sandy loam. The pH of the soil solution was acid; the content of humus was low, the content of total nitrogen was strongly correlated to the content of humus. The soil was medium supplied with easily available potassium and phosphorus. During the rice vegetation period (from April to October), the average monthly temperature in 2010/2011 was 19.9 °C, average maximum temperature was 25.4 °C, while average minimum temperature was 12.8 °C. The sum of monthly rainfalls (average value for both years of investigation) was 277.9 mm.

According to the obtained results, the highest average percentage of the whole grains in both years of investigation was found in the newly introduced variety *Ellebi* (64,46%), while the lowest one was in the other introduced variety *Opale* (40,70%). For comparison, the average percentage of the whole grains in the standard varieties was 48.77 % (*Prima riska*) and 54.79% (*R-76/6*). The highest average yield of white rice was reached by the newly introduced variety *Brio* (5138 kg ha^{-1}), and the lowest by the variety *Opale* (3439 kg ha^{-1}). Compared to them, the standard varieties obtained *4638* kg ha^{-1} (*Prima riska*) and 4671 kg ha^{-1} (*R-76/6)* average yield of white rice. The different values of the same milling characteristics (percentage of white rice, yield of white rice) were stated among different varieties, but also, the values within the same varieties varied in different years of investigation, due to the environmental factors.

Key words: rice, varieties, agro-ecological conditions, percentage of the whole grains, yield

Извод

Андов, Д., Андреевска, Д., Симеоновска, Е. Приносот на бел ориз и споредните производи кај некои новоинтродуирани италијански сорти ориз одгледувани во агроеколошките услови на Македонија. Зборник на трудови од IV Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 21, Скопје.

Рандманот, приносот на бел ориз и споредните производи добиени при белењето на суровиот ориз-арпа, како и масата на 1000 зрна ориз се испитувани кај три новоинтродуирани италијански сорти ориз: *брио, елеби* и *опале.* Истите својства се испитани и кај две стандардни сорти: *прима риска* и *P-76/6,* со цел да се споредат добиените резултати. Истражувањата се спроведени во текот на 2010 и 2011 година во полски експерименти по методот на рандомизиран блок систем, во агроеколошките услови на Кочанскиот регион во Македонија. Рандманот на белиот ориз - цели зрна и споредните производи при белењето на арпата (кршен

ориз, оризовите трици и лушпи) се одредени со белење на три просечни проби од 100 g арпа со лабораториска лупилница за време од 1,40 минути. Почвите од локалитетот „Босевица“ (каде што се спроведени полските експерименти) се од алувијален почвен тип, бескарбонатни во испитуваните длабочини, а според механичкиот состав, тоа се ситно песокливи иловици. Реакцијата на почвениот раствор е кисела, според содржината на хумус се слабо хумусни, а содржината на вкупен азот е во тесна корелација со хумусот. Почвите се средно обезбедени со лесно достапен калиум и фосфор. За време на вегетацијата на оризовата култура (април-октомври) средните месечни температури на воздухот 2010/11 година изнесуваат 19,9˚ C, максималните се 25,4˚ C, а минималните се 12,8˚ C. Вкупната (просечна) сума на врнежи за двете години на испитување во време на вегетацијата изнесува 277,9 mm. Според добиените резултати може да се констатира дека највисок просечен рандман од двете години на истражување е добиен кај новоинтродуцираната сорта *елеби* (64,46%), а најнизок просечен рандман е утврден кај сортата *опале* (40,70%). За споредба, просечниот рандман на бел ориз (цели зрна) кај стандардните сорти изнесува: кај *прима риска*- 48,77%, а кај *р-76/6*- 54,79 %. Највисок просечен принос на бел ориз при преработката на суровиот ориз е постигнат кај новоинтродуцираната сорта *брио* (5138 kg ha^{-1}), додека најнизок е оној на сортата *опале* (3439 kg ha^{-1}). Приносот на бел ориз кај стандардните сорти изнесува: 4638 kg ha^{-1} (*прима риска*) и 4671 kg ha^{-1} (*р-76/6)*. Рандманот и приносот на бел ориз се разликуваат како меѓу сортите, така и по годините на испитување.

Клучни зборови: ориз, сорти, агроеколошки услови, рандман, принос

Introduction

The yield of white rice (beside the yield of paddy rice) per unit area is a very important quality characteristic of each rice variety.

Compared to other cereals, where grain is milled in order to produce flour or different kinds of animal feeding products, rice grain is processed to become suitable for human consumption. The basic objective of a rice milling system is to remove the husk, the bran layers, the surface of the endosperm and the embryo, and produce whole white rice kernel which is without damages.

Until now, rice growers in the Republic of Macedonia have expressed their interest for those varieties with high yielding performances for paddy rice, because the rice price has been determined according only to paddy rice price, not taking into account its dressing percentage.

The farmer's profit was directly depending on the sold quantity of paddy rice.

The dressing percentage represents the quantity of white rice (whole kernels) obtained among all the byproducts during the post-harvest processing. In last couple of years, the rice price on the market has been determined according to the dressing percentage.

Not always, the varieties with high yielding abilities for paddy rice are also high yielding for white rice (Andov et al. 2003, 2008/2009; Ilieva et al., 2000).

The post-production of paddy rice results in certain categories of products: brown rice (or cargo), white rice, brokens, rice hulls and brans as byproducts.

The quantity of products obtained through milling paddy rice (in percents), or gained yield of white rice (in kilograms), are such parameters that differ depending on genotype/variety but are also influenced by environmental conditions (Ilieva et al., 2007, 2008, 2009).

The aim of this investigation was to assess the yield of white rice, the dressing percentage and the mass of 1000 grains of the three newly introduced rice varieties, presently grown within the environmental conditions of Macedonia.

Materials and methods

The research was carried out during 2010 and 2011 by setting-up field trials (randomized block system, three repetitions) in the region of Kocani, "Bosevica" locality. Standard production technology was applied. The field research was followed by laboratory analysis. The subject of investigation were three newly introduced Italian rice varieties *Brio, Ellebi* and *Opale*; their results were compared to standard varieties *Prima riska* (Macedonian variety) and *R-76/6 (*domesticated Italian variety), traditionally grown under the agro-ecological conditions of Macedonia.

Laboratory milling was carried out by using laboratory mill. In order to determine the dressing percentage - whole grains of the white rice as well as by-products (brokens, rice brans and hulls), three average paddy rice samples, (each weighing 100 g) were milled in total 1.40 minutes.

Obtained results were statistically performed by ANOVA and tested by LSD test.

The 1000 grain weight was assessed both to paddy rice and to white rice, on two samples per variety, each sample compounded of 500 grains.

Soil and climatic conditions

The soils of the locality "Bosevica", where the field trials were set up on are of alluvium soil type, carbonate-free at the examined depths (Table 1). The soil texture was fine sandy loam. The pH of the soil solution was acid; the content of humus was low, the

Tab. 1. Some chemical properties of the soil from the locality "Bosevica"

Depth [cm]	$CaCO_3$ [%]	Humus [%]	Total [%]	pH		Available [mg/100 g]	
				H_2O	nKCl	P_2O_5	K_2O
0-20	-	2,16	0,09	5,79	4,92	17,85	14,02
20-40	-	1,50	0,06	5,88	5,07	11,57	12,04

Tab. 2. Data on meteorological elements during the rice vegetation period (2010-2011) in Kocani

Year	Months							Average	
	IV	V	VI	VII	VIII	IX	X		
Average monthly temperature (ºC)								Years	Veg.
2010	13.7	18.5	22.1	24.9	26.9	19.3	12.2	14.3	19.7
2011	13.1	17.2	22.1	26.2	26.3	23.1	12.6	13.9	20.1
Average	13.4	17.9	22.1	25.6	26.6	21.2	12.4	14.1	19.9
Aver. monthly max.temperature (ºC)									
2010	19.0	23.9	26.9	29.9	32.7	25.6	16.8	19.3	25.0
2011	18.4	22.2	27.5	31.9	32.2	29.7	18.6	19.2	25.8
Average	18.7	23.1	27.2	30.9	32.5	27.7	17.7	19.3	25.4
Average monthly min.temperature (ºC)									
2010	8.3	11.8	15.2	17.0	18.7	12.4	8.2	8.9	13.1
2011	6.7	11.2	14.4	16.9	16.8	14.8	5.8	7.3	12.4
Average	7.5	11.5	14.8	17.0	17.8	13.6	7.0	8.1	12.8
Monthly rainfalls (mm)								Sum	
2010	6.3	20.5	86.0	19.5	6.5	33.0	119.5	623.3	348.3
2011	1.5	42.5	44.0	23.5	16.5	30.0	35.5	296.0	207.5
Average	39.4	31.5	65.0	21.5	11.5	31.5	77.5	459.7	277.9

content of total nitrogen was strongly correlated to the content of humus. The soil was medium supplied with easily available potassium and phosphorus.

During the rice vegetation period (since April to October), the average monthly temperature in 2010/2011 was 19.9 °C, average maximum temperature was 25.4 °C, while average minimum temperature was 12.8 °C (Table 2.).

In 2010 the average monthly air temperatures (19.7 °C) were slightly lower than in 2011 (20.1 °C).

The sum of monthly rainfalls (average value for both years of investigation) was 277.9 mm.

In the first year of investigation during the rice vegetation period (since April to October), the highest precipitation was measured in October (119.5 mm) and the lowest in August (6.5 mm).

In the second year of investigation, the highest amount of rainfalls was in June (44.0 mm,), while the lowest in April (15.5 mm).

The climatic factors in different plant growth stages play an important role for determination of the yield of white rice. During grain filling and ripening stage, air temperatures affect the paddy rice quality and consequently the dressing percentage. Rainfalls during the harvest could decrease the paddy rice and white rice quality performances.

Results and discussion

1. Dressing percentage of white rice

The results of investigation of dressing percentage (whole grains percentage) are presented in Table 3.

According to the obtained results, the highest average percentage of the whole grains (64.46%), was achieved in the newly introduced variety *Ellebi*, in both years of investigation. The lowest average percentage of the whole grains (40.70%) was obtained in the variety *Opale.*

In 2010, the highest dressing percentage of white rice was obtained for the variety *Ellebi* (64.96%), significantly higher compared to both standards.

The lowest dressing percentage of white rice was determined in in the variety *Opale* (36.43%) that was significantly lower than the percentage of all the varieties (both standards and introduced) in this research.

In 2011, the highest dressing percentage of white rice was also obtained for the variety *Ellebi* (63.95%) significantly higher compared to all the

Tab. 3. Dressing percentage [%]

Varieties	Year	Whole grains	Brokens			Total whole grains+ brokens	Chalky grains	Rice bran	Hulls
			1/3	2/3	Total				
Prima riska(st.)	2010	53.12	2.04	10.98	13.02	66.14	0.72	12.90	20.24
	2011	44.42	1.70	19.17	20.87	65.29	0.27	14.89	19.55
	2010/11	**48.77**	**1.87**	**15.08**	**16.95**	**65.72**	**0.50**	**13.90**	**19.90**
R-76/6 (st.)	2010	57.05	1.65	10.40	12.05	69.10	0.32	11.45	19.13
	2011	52.53	1.39	13.56	14.95	67.48	-	12.48	20.04
	2010/11	**54.79**	**1.52**	**11.98**	**13.50**	**68.29**	**0.16**	**11.97**	**19.59**
Brio	2010	58.63	0.80	9.60	10.40	69.03	0.77	9.25	20.95
	2011	60.82	0.93	6.04	6.97	67.79	-	10.77	21.44
	2010/11	**59.73**	**0.87**	**7.82**	**8.69**	**68.41**	**0.77**	**10.01**	**21.20**
Ellebi	2010	64.96	1.07	2.92	3.99	68.95	0.86	13.00	17.19
	2011	63.95	1.77	2.66	4.43	68.38	0.62	14.00	17.00
	2010/11	**64.46**	**1.42**	**2.79**	**4.21**	**68.67**	**0.74**	**13.50**	**17.10**
Opale	2010	36.43	11.30	19.50	30.80	67.23	0.27	10.80	21.70
	2011	44.97	1.72	20.89	22.61	67.58	0.52	12.30	19.60
	2010/11	**40.70**	**6.51**	**20.20**	**26.71**	**67.41**	**0.40**	**11.55**	**20.65**
Year	*2010*	*2011*							
$LSD_{0.05}$	*5.27*	*1.01*							
$LSD_{0.01}$	*7.67*	*1.47*							

varieties (both standards and introduced).

The lowest dressing percentage of white rice in 2011 was achieved in the standard variety *Prima riska (*44.42 %), significantly lower than varieties *R-76/6, Brio* and *Ellebi.*

According to Andov et al. (2003), the content of byproducts of rice milling (whole grains, broken, hulls and bran) vary depending on the variety, year of vegetation and cropping system (rice as first or second crop).

In the research of Ilieva et al. (2009), dressing percentage of white rice in five rice varieties: *Monticelli, Biser-2, San Adrea, R-76/6 and Prima riska (*each harvested in five different terms) was explored. Values varied depending on year of investigation, variety and time of harvesting.

2. Yield of white rice

Yield of white rice is mainly genetically determined (as varietal characteristic), but it is also highly depending on growing conditions and applied technology.

In each single variety, grown under certain agro-ecological conditions, the expected yield of white rice depends on the yield of paddy rice and the dressing percentage during the post-production.

In 2010, the yield of white rice in different growing regions in Italy ranged from 5390 kg ha^{-1} to 9120 kg ha^{-1} (variety *Brio)*; from 6470 kg ha^{-1} to 8980 kg ha^{-1} (variety *Ellebi*) and from 7370 kg ha^{-1} to 9550 kg ha^{-1} (variety *Opale*) (according to Relazione Annuale, 2010).

The obtained results for the yield of white rice are presented in Table 4.

The highest average yield of white rice was reached by the newly introduced variety *Brio* (5138 kg ha^{-1}), and the lowest by the variety *Opale* (3439 kg ha^{-1}). Compared to them, the standard varieties obtained 4638 kg ha^{-1} (*Prima riska*) and 4671 kg ha^{-1} (*R-76/6)* average yield of white rice.

In 2010, the highest yield of white rice (but not significantly higher than the two standard varieties) was assessed for the variety *Brio* (5307 kg ha^{-1}). In the same year, the lowest yield of white rice (significantly lower than two standards) was obtained by the newly introduced variety *Opale* (3259 kg ha^{-1}).

In 2011, the highest yield of white rice, significantly higher than the two standard varieties for both levels of probability was reached by the variety *Brio* (4969 kg ha^{-1}).

Significantly higher yield of white rice than standards' values was obtained by the newly introduced variety *Ellebi* - 4603 kg ha^{-1} (for both levels of probability compared to the standard *Prima riska* and for the level of p=0.05 compared to the standard *R-76/6*).

The lowest yield of white rice in 2011 was found in the newly introduced variety *Opale* (3619 kg ha^{-1}), that was significantly lower than the value

Tab. 4. Yield of white rice [kg ha^{-1}]

Varieties	Year		Average	Index from	
	2010	2011		*Prima riska*	*R-76/6*
Prima riska(st.)	5290	3986	**4638.00**	0	-0.71
R-76/6 (st.)	5106	4236	**4671.00**	+0.71	0
-Brio	5307	4969	**5138.00**	+10.78	+10.00
Ellebi	5241	4603	**4922.00**	+6.12	+5.37
Opale	3259	3619	**3439.00**	-25.85	-26.38
Average	**4840.60**	**4282.60**	**4561.60**		
$LSD_{0.05}$	*470.57*	*267.04*			
$LSD_{0.01}$	*685.39*	*388.94*			

of the standard *R-76/6* for both levels of probability, and significantly lower than the value of the standard *Prima riska* only for the level of probability p=0.05.

3. Mass of 1000 grains

The mass of 1000 grains is the characteristic of the species and the cultivar. This characteristic varies in wide range depending on grain maturity level, grain origin, position on the panicle where the grain is formed on the mother plant, agro-ecological growing conditions, applied technology etc.

The mass of 1000 grains is an important parameter which is used to estimate the seeding rate.

Grain moisture has big influence on the mass of 1000 grains, hence it is necessary for the mass of 1000 grains to be related to grain dry matter content.

The results for the mass of 1000 grains (paddy and white rice) are presented in Table 5.

According to the results, the newly introduced *Brio, Ellebi* and *Opale* are characterized as small-size grains' varieties, therefore reaching the lower values of the mass of 1000 grains, compared to both standard varieties that represent large-size grains' varieties.

The highest average mass of 1000 grains (paddy and white rice) was assessed for the standard variety *Prima riska* (paddy - 41,17 g; white rice - 27.87 g), while the lowest values were obtained for the newly introduced variety *Ellebi* (paddy - 25.40 g; white rice - 17.86 g).

The varieties *Brio* and *Opale* achieved the similar results for the mass of 1000 grains under the growing conditions of Italy and Macedonia.

Regarding the variety *Ellebi*, results for the mass of 1000 showed lower values when growing in Macedonia compared to Italy (XLIII Relazione Annuale, 2010).

Conclusions

From the conducted investigations and obtained results of the three newly introduced Italian varieties, compared to standard varieties used, the following conclusions could be reached:

- The highest average dressing percentage in both years of investigation was achieved in the newly introduced Italian variety *Ellebi* (64.46%) and the lowest in the variety *Opale* (40.70%).
- The average dressing percentage of white rice (whole grains) in standard varieties was 48.77% (*Prima riska)* and 54.79% (*R-76/6)*.
- The highest average yield of white rice after processing the paddy rice was achieved by the variety *Brio* (5138 kg ha^{-1}), and the lowest by the variety *Opale* (3439 kg ha^{-1}).
- The average yield of white rice of standards

Tab. 5. Mass of 1000 grains [g]

Varieties	Paddy rice			White rice		
	Year		Average	Year		Average
	2010	2011		2010	2011	
Prima riska(st.)	39.96	42.38	**41.17**	28.40	27.33	**27.87**
R-76/6 (st.)	38.44	39.94	**39.19**	27.16	27.99	**27.58**
Brio	26.73	27.76	**27.25**	18.73	18.73	**18.73**
Ellebi	24.64	26.16	**25.40**	17.85	17.86	**17.86**
Opale	31.91	32.36	**32.14**	21.80	21.96	**21.88**

was *4638* kg ha^{-1} (*Prima riska)* and 4671 kg ha^{-1} (*R-76/6)*.

- The highest average mass of 1000 grains (paddy and white rice) was assessed for the standard variety *Prima riska* (paddy - 41.17 g; white rice - 27.87 g), while the lowest values were obtained for the newly introduced variety *Ellebi* (paddy - 25.40 g; white rice - 17.86g).
- The different values of the same milling characteristics (percentage of white rice, yield of white rice) were stated among different varieties in this research, but also, the values within the same varieties varied in different years of investigation, due to the environmental factors.

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