Македонско еколошко друштво
Macedonian Ecological Society

IV КОНГРЕС НА ЕКОЛОЗИТЕ НА МАКЕДОНИЈА СО МЕЂУНАРОДНО УЧЕСТВО
И ОДБЕЛЕЖУВАЊЕ НА 40 ГОДИНИ ОД ФОРМИРАЊЕТО НА МАКЕДОНСКОТО ЕКОЛОШКО ДРУШТВО
Охрид, 12-15 октомври 2012 година

ЗБОРНИК НА ТРУДОВИ
PROCEEDINGS

4TH CONGRESS OF ECOLOGISTS OF THE REPUBLIC OF MACEDONIA WITH INTERNATIONAL PARTICIPATION
AND MARKING 40TH ANNIVERSARY OF THE MACEDONIAN ECOLOGICAL SOCIETY
Ohrid, Macedonia, October 12th-15th, 2012
Цитирање:
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.

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4TH CONGRESS OF ECOLOGISTS OF THE REPUBLIC OF MACEDONIA WITH INTERNATIONAL PARTICIPATION AND MARKING 40th ANNIVERSARY OF THE MACEDONIAN ECOLOGICAL SOCIETY

Секции на конгресот
1. Популации, заедници и еколошко моделирање
2. Структура и функционални карактеристики на копнени екосистеми
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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. Предела 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)
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7. Landscape ecology for sustainable environment
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9. Multi-level Ecological education
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AFFORESTATIONS IN CONDITIONS OF GLOBAL CLIMATE CHANGE IN BULGARIA – PROBLEMS, INVESTIGATIONS AND ADAPTATION MEASURES

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Abstract


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; Broadmeadow 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 changed, 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 %)
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°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°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°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

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

<table>
<thead>
<tr>
<th>No.</th>
<th>Components of the water balance</th>
<th>Cerris oak</th>
<th>Austrian black pine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Precipitation above the crowns</td>
<td>505.0</td>
<td>100.0</td>
</tr>
<tr>
<td>2.</td>
<td>Precipitation to the soil</td>
<td>444.5</td>
<td>88.0</td>
</tr>
<tr>
<td>2.1</td>
<td>Precipitation under the crowns</td>
<td>423.1</td>
<td>83.8</td>
</tr>
<tr>
<td>2.2</td>
<td>Stem flow</td>
<td>21.4</td>
<td>4.2</td>
</tr>
<tr>
<td>3.</td>
<td>Interception (1-2)</td>
<td>60.5</td>
<td>12.0</td>
</tr>
<tr>
<td>4.</td>
<td>Soil evaporation</td>
<td>118.4</td>
<td>23.4</td>
</tr>
<tr>
<td>5.</td>
<td>Transpiration</td>
<td>326.1</td>
<td>64.6</td>
</tr>
<tr>
<td>6.</td>
<td>Total evaporation (3+4+5)</td>
<td>505.0</td>
<td>100.0</td>
</tr>
<tr>
<td>7.</td>
<td>Infiltration (1-6)</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Afforestations in conditions of global climate change in Bulgaria – problems, investigations and adaptation measures

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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; e- 2080 realistic scenario; f- 2080 pessimistic scenario Zone A – very high vulnerability; Zone B (B) – high vulnerability; Zone C (B) – moderate vulnerability; Zone D (D) – low vulnerability; Zone E (D) – very low vulnerability; Zone F (F) – 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 Tutchakan and from Svishtov to Vidin;

Zone B (B): 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 and Strandzha Mt. 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 (B), 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.

**References**

Bolidger, J. (2002). Swiss forest and climate change: comparison of simulated quantitative


РЕВИТАЛИЗАЦИЈА НА ОПОЖАРЕНИ ШУМСКИ ЕКОСИТЕМИ ПРЕКУ ПРИРОДНО ОБНОВУВАЊЕ

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Апстракт


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 grow 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 шумски-те екосистеми, која во последните декении е се поизразена и за краток временски рок уништува големи површини под шума се шумските по- жари. Според податоците од инспекторатот при Министерството за земјоделство, шumarство 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 штапачки 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 способността 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 опожаренпрвишони од шумските екосистеми. Во тој контекст, многу важна е градбата и големината на семето, како и начинот на негови разнесување. Најдобри предиспозиции за разнесување на поголеми растојанија од матичните насади имаат видовите дрвја кои рас-полагаат со поситно семе, како и семе кое има крилица 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 недолошките, рељефните и климатските услови, кои имаат ограничувања улога врз распространувањето и адаптацијата на сите видови на определено подрачје. Истражувањето на природните- еколошките услови е особено важно, билеки од нив во голема мера зависи појавата, развитокот и опстанокот на природната обнова од шумските дрвја, а од суштинско значење за опстојувањето и трајнот одржив 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, билеки поради нивното состав, структура и голема количина на лесно запалив горлив материјал во многу случаи тие најголемо 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 споенишува 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 цриборови и белборови шум-
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Ски насади со возраст од 50 години и дрвна маса од повеќе од 60000 m³ (Посебен план за стопански насади со возраст од 50 години и дрвна маса од повеќе од 60000 m³). Опожарените шуми биле настани 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 претставувале шумско-одгледувачки мерки во два наврати- кареење на гранките, како и 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 неговото самоствопно 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).

Сл. 2. Изведување на санитарни сечи (2008)
Fig. 2. Forest sanitary cuts (2008)

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

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)

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 изврши проучување на 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 „Паркоч“ се поставени 14 пробни површини со правоаголна форма и различни димензии. Во зависност од густина на големината на пробните површини се поставени во дијаметри од 3 x 3 m, 4 x 4 m и 5 x 5 m. Пробните површини се поставени на репрезентативни места според маршрутата и тоа: 4 пробни површини на северна, 3 на јужна, 2 на западна, 2 на источна и 3 на рамен терен. Во рамките на пробните површини извршени се биометриски мерења на обновата при што се утврдени основни биометриски показатели, од кои понатаму согласно методологијата на Шафар одредени се развојните стадии и природната обнова. Во текот на набљудувањето е оцена на квалитетот и виталноста на единките од природната обнова. Сите измерени еднакви во пробните површини се групираат во три групи: I група се категоризирани сите еднакви кое се здрави и витални, имаат право стебленце и правилно развиена крошна, II група се категоризирани еднакви кое според своите квалитативни карактеристики заостануваат зад еднаквите од прва категорија, но се во добра здравствена состојба, а III група се категоризирани еднаквите кое 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 обновите на 1 ha.
која пробна површина пресметана е бројноста на единките на  единица површина од 1 ha, а податочите се изнесени во табели. Понатаму, извршена е компаратива со податоците добиени од други истражувања на други локалитети констатирани во слични истражувања. Употребената номенклатура на шумските заедници е според Prodro- mus phytocoenosum Jugoslaviae (1986), а научните и народните називи на шумската дендрофлора според Џеков (1988) и Em (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 Џиловски и др. (1996), на ова подрачје превладува ладната континентална клима со одредено влијание на планинската клима. Средната годишна температура пресметана според кривите на вертикални градиенти за ова подрачје изнесува од 8,6 до 9,6ºC, или средно около 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 дебела почва, свежа, со тенок слој на хумус и ли-стинец од типот еутричен камбисол. Почвениот тип на истражуваното подрачје се карактеризира со висок процент на участво 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-ветеративско-почвеното реонирање на Република Македонија припаѓа во ладно континенталното подрачје (Џиловски и др. 1996). И покрај тоа што ова е подрачје което обично доминира климазоналната асоцијација Orno-Querco- betum 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 единочни или примеси во мали групи од плоскач и цер,
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веќе после 5 години од опожарувањето се развила бројна природна обнова од следните шумски видови дрвја: бел бор, плоскач, цер, козја врба, црн бор и јасика. На подрачјето се застапени и поголем број на грумушести и тревести рас tenja, 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 leucanthus, Hypericum sp., Sorbus torm
inalis, Pyrus pyraster, Pyrus americana, Pyrus spinosa и dr. С 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

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

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

<table>
<thead>
<tr>
<th>Вид / Квалитет</th>
<th>Species / Quality</th>
<th>добар good</th>
<th>%</th>
<th>среден medium</th>
<th>%</th>
<th>лош bad</th>
<th>%</th>
<th>вкупно total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quercus frainetto (плоскач)</td>
<td>1 200</td>
<td>67</td>
<td>400</td>
<td>22</td>
<td>200</td>
<td>11</td>
<td>1 800</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Quercus cerris (цер)</td>
<td>600</td>
<td>60</td>
<td>200</td>
<td>20</td>
<td>200</td>
<td>20</td>
<td>1 000</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Salix caprea (козја врба)</td>
<td>6 400</td>
<td>49</td>
<td>4 800</td>
<td>36</td>
<td>2 000</td>
<td>15</td>
<td>13 200</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Pinus silvestris (бел бор)</td>
<td>1 600</td>
<td>47</td>
<td>1 230</td>
<td>36</td>
<td>600</td>
<td>17</td>
<td>3 430</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Pinus nigra (црн бор)</td>
<td>400</td>
<td>50</td>
<td>200</td>
<td>25</td>
<td>200</td>
<td>25</td>
<td>800</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Populus tremula (ясика)</td>
<td>1 200</td>
<td>67</td>
<td>400</td>
<td>22</td>
<td>200</td>
<td>11</td>
<td>1 800</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Вкупно / Total</td>
<td>11 400</td>
<td>52</td>
<td>7 230</td>
<td>33</td>
<td>3 400</td>
<td>15</td>
<td>22 030</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

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

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

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и дабот плоскач со 28% од вкупниот број единки. Значително учење има и којата 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 бел плоскач 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 (27%), а најмал со лош квалитет (21%).

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 бел плоскач со 67%, а потоа од белиот бор со 21%. Бројноста на другите видови е под 10%. Најголем број од единките на природната обнова се со добар квалитет (42%).

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 којата врба со 32%, а потоа дабот плоскач 18%. Со по 14% се застапени дабот цер и јасика (*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 бел плоскач со 54%, а потоа дабот плоскач 16%, дабот цер 11%, којата 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 (неодрасnut).

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

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

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

<table>
<thead>
<tr>
<th>Вид / Квалитет</th>
<th>Species / Quality</th>
<th>добар</th>
<th>good</th>
<th>%</th>
<th>среден</th>
<th>medium</th>
<th>%</th>
<th>лош</th>
<th>bad</th>
<th>%</th>
<th>вкупно</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Quercus frainetto</em> (плоскач)</td>
<td>2 148</td>
<td>58</td>
<td>904</td>
<td>25</td>
<td>637</td>
<td>17</td>
<td>3 689</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Quercus cerris</em> (цер)</td>
<td>1 274</td>
<td>50</td>
<td>770</td>
<td>30</td>
<td>504</td>
<td>20</td>
<td>2 548</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Salix caprea</em> (која врба)</td>
<td>2 281</td>
<td>69</td>
<td>637</td>
<td>19</td>
<td>400</td>
<td>12</td>
<td>3 318</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pinus silvestris</em> (бел бор)</td>
<td>7 096</td>
<td>56</td>
<td>4 978</td>
<td>39</td>
<td>637</td>
<td>5</td>
<td>12 711</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pinus nigra</em> (црн бор)</td>
<td>1 111</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1 111</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Вкупно / Total</strong></td>
<td>13 910</td>
<td>59</td>
<td>7 289</td>
<td>31</td>
<td>2 178</td>
<td>10</td>
<td>23 377</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Ревитализација на опожарени шумски екосистеми преку природно обновување

открытый конгресс экологов Македонии

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

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

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

Од извршените теренски мерните добиени 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 терен.
рен до 5% на северна експозиција. Во развојниот стадиум одраснат подмладок се застапени пого- лем број единки (од 9% на јужна 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 достигнуваат 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, која сочинува карактеристична за стопанските шуми кога се предмет на обновителни процеси. Таа 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 буковите 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 процесите на природната обнова од бел бор на плоскостна има поголем број од природната обнова на оваа експозиција, таа е нешто подобна природната обнова на белото дрво. Интензитетот на развојниот стадиум одраснат младик го укажува дека на оваа експозиција развитокот на единките од црн бор се со добар квалитет, тоа кое сочинува 50 до 67% од природната обнова. На овие експонации забележливо учество до 28% имаат дабовите и јасиката врбите.
Ревитализација на опожарени шумски екосистеми преку природно обновување

Во поглед на квалитетот и виталноста на природната обнова, забележив е високиот процент на единки со добар квалитет кој кај добивите се движи меѓу 50 и 72%. На ова придонесуваат вкупните природни услови билејки овој тип на месторастење е многу повелен за развиток на плоскачот и церот. Висок процент на учество на единки со добар квалитет на дабовите се движи меѓу 50 и 72%, како 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, може да се очекува дека во следните развојни стадии на шумата нивното учество постепено ќе се намалува.

Во однос на развојните стадии на шумата, забележиво е дека природната обнова од бел бор и цар 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%.

Найбрз развиток во петте години после шумскиот пожар имаат добивите 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 двета вида од даб, малку понапреден во развојот е дабот цер.

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)

Сл. 8. Природно обновување (2012)
Fig. 8. Natural regeneration (2012)
Најбрзо после пожарот во првите две години се појавиела природна обнова од даб плоскач и даб цер, која е од изданково потекло (Сл. 7). Во првите две 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 и примарните месторастења (Ацевски и Симовски, 2012), како и малото учество на црниот бор. Треба да се има предвид дека изнесената фактотска 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.

Бројноста на единките на сите експозиции ќе се намaluва, 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 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 дрво: 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 на 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 лијарски видови, а на другите делови ќе доминира белiot бор.

Дабовите се во повисоки развојни стадиуми поради нивното изданково потекло, кое со една спо собност за побрз растеж во првите години. Поради тоа, тие се во повисоки развојни стадиуми на шумата во однос на други видови, а особено во однос на црниот и белiot 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.

Опожарениот шумски екосистем на локалитетот „Паркач” целосно ќе се обнови, но со значително учество на лијарски видови дрво и за подолг временски период.

Литература


Филиповски, Г., Ризовски, Р., Ристевски, П. (1996). Карakteristikи на климатско-вегетациско-почвените зони (региони) во Република Македонија. МАНУ.


Колевска, Д. Д., Велковски, Н. (2009). Појава на поник од багрем (Robinia pseudoacacia L.) на опожарени шумски површини. Шумарски преглед на Шумарското факултет во
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.
Вовед

Република Македонија е миколошки релативно добро истражена. Во последно време се вршат континуирани систематски истражувања екологија и дистрибуција на габите од типот Ascomycota на планинскиот масив Добра Вода.

Извод


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 линиколните 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 селингиколни. Најзастапени редови се Pezizales со 17 вида, Xylariales (5) и Helotiales (4), а најзастапени фамилије се: Pyronemataceae со 5 вида, Morchellaceae со 4 вида, Xylariaceae со 3 вида итн. Како најчести видови аскомицети на планината Добра Вода можеме да ги истакнеме следниве: Bisporella citrina, Diatraype 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.

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

Abstract


This paper includes results from eco-taxonomic studies of fungi such as Ascomycota. The study was conducted during the period from 2002 to 2009, 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 33 species 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 each respectively. The most common Ascomycetes species in Dobra Voda Mountain are the following: Bisporella citrina, Diatriae 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 mycorrhizal or parasitic species.

Keywords: Ascomycetes, fungi, distribution, ecology, Dobra Voda, Macedonia.
Екологија и дистрибуција на габите од типот Ascomycota на планинскиот масив Добра Вода

Субстрат каде е најден (почва, живо дрво, пенушка, гранки, лисица)
- Шумската заедница (букова, дабова, азонална вегетација)
- Животна форма (паразит, сапроб или микоризен вид)
- Податоци за наоѓалиштето на видот (надморска височина)
- Датум на наоѓање
- Френквениција 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 претставува 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). Исто така, Добра Вода претставува 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-југозапад. Во подрачјето на планинскиот масив Добра Вода минираат дабови и букови шумски заедници, низ кои се протегаат и други заедници, главно од азонален тип на дистрибуција. Регистрираниот вид е собиран на различни локалитети во истражуваното подрачје. За секој вид се колектирани по неколку примероци, неопходни за подетална анализа. Идентификацијата на собраниот материјал се вршеше во Миколошката лабораторија при институтот за Биологија, на ПМФ-Скопје. За детерминиране 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), Corfíxen 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, преувреден, 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 следниве податоци:

- Име на видот на латински со повисоките систематски категории (род, фамилија, ред, тип)
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
1. Microsphaera alphitoides Griffon & Maubl.
   - с. Јагол Долени, 900-950 м, Quercetum frainetto-cerris, на Quercus sp., 23.10.2007.

Ред: Helotiales Nannf. ex Korf & Lizon
Фамилија: Bulgariaceae Fr.
2. Bulgaria inquinans (Pers.) Fr.

Фамилија: Helotiaceae Rehm
3. Ascochryne sarcoides (Jacq.) J.W. Groves & D.E. Wilson
   - с. Поповјани, Горица, 800м, на Quercetum frainetto-cerris, на Quercus sp., 23.10.2007, MAK 07/8149.
5. Sclerotinia pseudotuberosea (Rehm) Rehm
   - Горица, во близина на селото Поповјани, 800 м, ас. Quercetum frainetto-cerris, 23.10.2007.
   - Радилица, над селото Јагол, 900 м, дабова шума, Quercetum frainetto-cerris, 23.10.2007.

Ред: Pezizales J Schröt.
Фамилија: Discinaceae Benedix

Фамилија: Helvellaceae Fr.
7. *Helvella acetabulum (L.) Quël.
   - с. Поповјани, Горица, 800м, Quercetum frainetto-cerris, на почва 23.04.2008 год.
8. Helvella lacunosa Fr.
Фамилија: Morchellaceae Rehb.
- Поповјански Лаг, с. Поповјани и Жубрино, 750 м, азонална вегетација со Populus sp., крај река, 23.04.2008.
12. Verpa bohemica (Krombh.) J. Schröt.

Фамилија: Pezizaceae
13. *Peziza celtica* (Boud.) M.M. Moser
14. *Peziza domiciliana* Cooke
- С. Јагол, на влажна почва со зици на опожареност, 750-800 м., (Quercetum frainetto-cerris), 20.10.2007.
15. Peziza vesiculosa Bull.

Фамилија: Pyronemataceae Corda
16. *Anthracobia macrocystis* (Cooke) Boud.
17. *Anthracobia maurilabra* (Cooke) Boud.
- Горица, западно од селото Поповјани, ас. Quercetum frainetto-cerris, 850м., на опожарено место, 08.11.2008 година.
18. *Anthracobia subatra* (Rehm) M.M. Moser
- С. Премка планински манастир Челоица 750 м, опожарена почва, боров насад.
19. *Humaria hemisphaerica* (Hoffm.) Fuckel
- С. Тун, 800 м., на почва, Шумjak, ас. Quercetum frainetto-cerris, 01.11.2007
20. Otidea concinna (Pers.) Sacc.
21. Otidea onotica (Pers.) Fuckel

Фамилија: Hyaloscyphaceae
22. *Hymenoscyphus calyculus* (Sowerby) W.Phillips
- с. Папрадиште, 1350-1500 м, ас. Calamintho grandiflorae-Fagetum, 01.11.2007
23. *Hymenoscyphus separabilis* (P. Karst.) Dennis
24. Sarcoscypha coccinea (Scop.) Lambotte
- с. Жубрино, 750 м, 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 лици на Acer sp. 23.10.2007.

Фамилија: Nitschkiaeae (Fitzp.) Nannf.
- с. Кафа, 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 гранич од Quercus sp, 18.01.2007 год.
- с. Папрадиште, 1350-1500 м., ас. Calamintho grandiflorae-Fagetum, 01.11.2007.

Фамилија: Xylariaeae Tul. & C. Tul.
29. Hylomycon fuscum (Pers.) Fr.
- с. Кафа, 1350 м., ас. Calamintho grandi
Емри Мурати и Митко Караделев

**Зборник на трудови од IV Конгрес на еколозите од Македонија**

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

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. 27.09.2007 година.

32. **Trichoderma viride** Tulasne & Tulasne 1860

33. **Nectria cinnabarina** (Tode) Fr.
с. Јагол Доленци, 800 м., 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 parma* J. Breitenb. & Maas Geest.
5*Helvella acetabulum* (L.) Quel.
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 видовите на габите од типот Ascomycota. Истражувани се следните шумски заедници: *Quercetum frainetto-cerris, Calamintho grandiflorae-Fagetum*, азонална вегетација, боров насад итн., при што е утврдено следното:


**Референци**


http://www.indexfungorum.org/Names/Names.asp
http://www.mycobank.org/MycoTaxo.aspx


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Summary

On the territory on Dobra Voda Mountain massive, 33 species of ascomycota were registered, 19 lignicolous 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 following 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 domiciliiana, Anthracobia macrocystis, Anthracobia maurilabra, Anthracobia subatra, Hymenoscyphus separabilis.
ECOLOGICAL AND MORPHOLOGICAL CHARACTERISTICS OF RARE AND ENDANGERED PLANT Ramonda serbica FROM DIFFERENT LOCALITIES OF THE REPUBLIC OF KOSOVO

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Abstract


The rare and endangered species 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 Dellocti). The area of the localities varies widely - from several m² to more than 4 km². 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), CO₂ 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 et al. 2011):

- **ANR** – Average number of rosettes per m²
- **NJP** – Number of young plants per m² (Fig. 1a)
- **NVA** – Number of vegetative adults per m² (Fig. 1b)
- **NGA** – Number of generative adults (vegetative+sexual reproduction) per m² (Fig. 1c)
- **NAP** – Number of ageing plants (with necrosis and/or irreversible dissec-tions) per m² (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 cm² per plant
- **TLA** – Total leaf area in cm² per plant

The average of these parameters (plant density and phenology) was calculated for five square spots (subpopulations) 1x1 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).
Ecological and morphological characteristics of rare and endangered plant *Ramonda serbica* from different...
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* (Pteroqv et al., 1975). Southern populations of *A. lyra* were flowered earlier than northern ones in all environmental conditions (Rihiimaki 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 pentametric 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 pentametric 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 Shkëmbi i përgjakur, 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 cm² (LA) were in the Radaci and Gorge of river Sushica (12.52 and 12.61 cm²) 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.

### Table 2: Mean of spatial parameters, plant density and phenology differences per 1 m² of habitats of some more representative *R. serbica* localities.

<table>
<thead>
<tr>
<th>Code of locality</th>
<th>Area (m²)</th>
<th>ANR</th>
<th>NJP</th>
<th>NVA</th>
<th>NGA</th>
<th>NAP</th>
<th>TF</th>
<th>TS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>280</td>
<td>21.00 ± 0.61</td>
<td>3.50 ± 0.11</td>
<td>7.00 ± 0.20</td>
<td>3.85 ± 0.11</td>
<td>6.65 ± 0.19</td>
<td>June 3rd-4th</td>
<td>July 3rd-4th</td>
</tr>
<tr>
<td>2</td>
<td>240</td>
<td>17.85 ± 0.52</td>
<td>1.05 ± 0.03</td>
<td>4.20 ± 0.12</td>
<td>7.00 ± 0.20</td>
<td>6.50 ± 0.16</td>
<td>June 1st-2nd</td>
<td>July 3rd-4th</td>
</tr>
<tr>
<td>3</td>
<td>4000</td>
<td>11.53 ± 0.59</td>
<td>0.12 ± 0.18</td>
<td>6.30 ± 0.29</td>
<td>10.15 ± 0.29</td>
<td>5.60 ± 0.03</td>
<td>June 3rd-4th</td>
<td>June 3rd-4th</td>
</tr>
<tr>
<td>4</td>
<td>500</td>
<td>19.95 ± 0.57</td>
<td>0.70 ± 0.10</td>
<td>3.50 ± 0.29</td>
<td>10.15 ± 0.16</td>
<td>5.60 ± 0.16</td>
<td>June 3rd-4th</td>
<td>June 3rd-4th</td>
</tr>
<tr>
<td>5</td>
<td>2200</td>
<td>40.25 ± 1.16</td>
<td>7.70 ± 0.52</td>
<td>18.20 ± 0.24</td>
<td>8.05 ± 0.18</td>
<td>6.30 ± 0.18</td>
<td>June 2nd-3rd</td>
<td>June 3rd-4th</td>
</tr>
<tr>
<td>6</td>
<td>180</td>
<td>27.30 ± 0.78</td>
<td>3.15 ± 0.22</td>
<td>9.45 ± 0.52</td>
<td>14.00 ± 0.40</td>
<td>6.00 ± 0.18</td>
<td>June 3rd-4th</td>
<td>June 3rd-4th</td>
</tr>
<tr>
<td>7</td>
<td>850</td>
<td>23.80 ± 0.68</td>
<td>3.50 ± 0.27</td>
<td>5.95 ± 0.40</td>
<td>7.70 ± 0.02</td>
<td>6.50 ± 0.02</td>
<td>June 1st-2nd</td>
<td>June 4th</td>
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<tr>
<td>8</td>
<td>160</td>
<td>29.75 ± 0.86</td>
<td>3.50 ± 0.22</td>
<td>10.15 ± 0.17</td>
<td>14.00 ± 0.22</td>
<td>6.00 ± 0.19</td>
<td>June 2nd-3rd</td>
<td>June 4th</td>
</tr>
<tr>
<td>9</td>
<td>240</td>
<td>50.75 ± 1.46</td>
<td>7.70 ± 0.29</td>
<td>16.80 ± 0.40</td>
<td>5.95 ± 0.24</td>
<td>20.30 ± 0.58</td>
<td>June 2nd-3rd</td>
<td>June 4th</td>
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<tr>
<td>F</td>
<td>162.37</td>
<td>353.69 ± 0.06</td>
<td>310.35 ± 0.02</td>
<td>155.95 ± 0.02</td>
<td>634.52 ± 0.02</td>
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<td>0.000 ± 0.00</td>
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</tr>
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</table>
**Tab. 3.** Mean of some morphological differences per plant of some more representative *R. serbica* localities.

<table>
<thead>
<tr>
<th>Code of locality</th>
<th>NPP</th>
<th>NFP</th>
<th>% T</th>
<th>% P</th>
<th>% H</th>
<th>NL</th>
<th>LA</th>
<th>TLA</th>
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<td>16.50&lt;sup&gt;D&lt;/sup&gt;</td>
<td>80.50&lt;sup&gt;B&lt;/sup&gt;</td>
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<td>108.39&lt;sup&gt;C&lt;/sup&gt;</td>
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<td>±0.46</td>
<td>±3.23</td>
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<td>1.77&lt;sup&gt;A&lt;/sup&gt;</td>
<td>27.95&lt;sup&gt;A&lt;/sup&gt;</td>
<td>70.81&lt;sup&gt;D&lt;/sup&gt;</td>
<td>1.24&lt;sup&gt;E&lt;/sup&gt;</td>
<td>16.58&lt;sup&gt;B&lt;/sup&gt;</td>
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<td>78.34&lt;sup&gt;BC&lt;/sup&gt;</td>
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<td>250.17&lt;sup&gt;A&lt;/sup&gt;</td>
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<td>68.00&lt;sup&gt;D&lt;/sup&gt;</td>
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<td>80.65&lt;sup&gt;B&lt;/sup&gt;</td>
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<td>71.43&lt;sup&gt;CD&lt;/sup&gt;</td>
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<td>90.28&lt;sup&gt;A&lt;/sup&gt;</td>
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<td>20.50&lt;sup&gt;A&lt;/sup&gt;</td>
<td>11.28&lt;sup&gt;AB&lt;/sup&gt;</td>
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<td>±&lt;sup&gt;0.54&lt;/sup&gt;</td>
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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 cm²; TLA – Total leaf area in cm²; 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 Delledoc dhe Guri i Delledoc 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 (530 m a.s.l. – Gorge of Prizren), sometimes reaching the subalpine belts (1651 m a.s.l. – Guri i Delledoc). Directions for the most of localities was northern and north-eastern, but there were cases with north-western directions (Guri i Delledoc dhe Guri i Delledoc 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 m² (Table 2). The total area of occupancy of the species on our country is more than 100 km².

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 regeneration of that population/subpopulation was higher. Associated plant species that occurred at more than four localities: *Ceterach officinarum, Popipodium vulgare, Asplenium trichomanes, Arabis caucasica, Mycellis muralis, Geranium robertianum, Geranium lucidum*, *Saxifraga paniculata, Saxifraga rotundifolia, Hedera helix, Lilium martagon, Doronicum columnae, Hieracium waldsteinii, Asplenium scolopendrium, Hieracium sp., Fraxinus ornus, Erysimum 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.

Associated plants species that only occurred at one locality:
- Gorge of Zhlebi (1): *Sedum acre, Leucanthemum vulgare, Rubus idaeus, Cryptogramma crispa, Viola bifolia, Campanula grandiflora, Geranium sylvaticum, Veronica urchicifolia, Thalictrum minus; Gorge of river Sushica (3): Hieracium bifidum, Hieracium murosum;*  
- Canyon of Rugova (4): *Hesperis dinarica, Sedum telephium;*  
- Gorge of Koprivnik (5): *Crepis albanica, Lamium album, Campanula crassipes, Amphoricarpus neumayeri, Gnaphalium roeseri;*  
- Gorge of river Prizreni (6): *Leonotodon hispidus, Hieracium racemosum, Arabis verna, Cyclamen hederifolia;*
Gorge of Rusenica (7): Micromeria cristata, Daphne oleoides; Ostrya carpinifolia, Semprevivum hirtum, Achillea holosericea, Cerasium decalvans, Thesium dollineri, Scabiosa crenata, Carumum gracca, Mimartia verna, Alyssum saxatile, Leontodon hirsutus, Cryptogramma crispa;


Shkëmbi i përgjakur (9): Galium lucidum, Semprevivum tectorum, Semprevivum 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 garrancicum, Achillea aegeratifolia, Micromeria cristata, Hesperis dinarica, Amphoricarpus neu-mayeri, Gnaphalium roeseri, Daphne oleoides, Semprevivum 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 they 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 m² and number of young plants per m² 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 m² and associated plants with Muscoid sp. are very important and have great impact on the higher number of young plants per m².

- Almost at all localities where the number of rosettes per m² 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.

References


Jovanovic, Z., Rakic, T., Stevanovic, B., Radovic, S. (2011). Characterization of oxidative and antioxidative events during dehydration and rehydration of resurrection plant Ramonda na-
Ecological and morphological characteristics of rare and endangered plant *Ramonda serbica* from different...


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

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Abstract


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


Според досегашните истражувања на дистрибуцијата 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 бележки од различни истражувачи 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 поправкашните истражувања овој број да се зголеми.

Ключни зборови: *Macrolepiota*, габи, дистрибуција, екологија, Македонија
Ecology and distribution on the genus Macrolepiota (Basidiomycota, Fungi) in Macedonia

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); Macrolepiota procera (Karadelev and coworkers 2002b); Macrolepiota konradii, Macrolepiota procera, Macrolepiota rhacodes (Karadelev et al. 2003a); Macrolepiota mastoidea, Macrolepiota procera, Macrolepiota rhacodes (Karadelev & Rusevska 2004); Macrolepiota 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, H2O, 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

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

Fig. 1. Distribution of Macrolepiota excoriata in Macedonia

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

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.

Kozhuf Mt.: vill. Konjari, 1000 m, Festuco heterophyllae-Fagetum, 13.10.2000, exs. MCF 00/4620; Bistra Mt.: Mavrovo, Bunec, Experimental plot, 1350 - 1400 m, meadow, 25.09.1998, exs. 21; MCF 98/1841.
3. *Macrolepiota heimii* (Locq.) Bon
Ref.: Collections: MCF.

4. *Macrolepiota konradii* (Huijsman ex P.D. Orton) M.M. Moser
Ref.: Karadelev et al. 2003a, Collections: MCF.

5. *Macrolepiota mastoidea* (Fr.: Fr.) Singer
Ref.: Karadelev 2000d, Karadelev 2001a, Karadelev, Rusevska 2004, Karadelev et al. 2008d
Collections: MCF.

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


**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 Tu in 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., Quercetum 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-
with *Betula*) 03.10.2010 exs. MCF 10/12216; Zhirovica vill. (above), Brezna, Festuco viridiflorae-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, Osij, 300 m, meadow, 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; The confluence of Pechina river and Vardar river: Pechina 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, Kuchibe (Veije 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*, *Quercus petraea*, *Castanea*, *Carpinus*), 11.10.2006, exs. MCF 08/10396; Ljubanci vill., around St. Nikola monastery, 800 m, *Quercus-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. Gorgjija monastery, Coceffero-Carpinetum orientalis, 16.12.2006; Veles: Izvor vill., Umin Dol, 300 m, *Quercus-Carpinetum orientalis*, 5.11.2007, exs. MCF 07/8352.

6. *Macroliophotria procera* (Scop.: Fr.) Singer


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* plantations, 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, Buneck, beech forest; Demir Hisar: Čagor, near 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., Quercetum frainetto-cerris, 22.10.2005, MMS; Trpejca vill., 800 m, oak forest; Jakupica Mt.: Cheples, 12.8.1995; Chestak, near vill. Oreshce, 800-900 m, Quercetum frainetto-cerris, 15.7.1999, exs. MCF 99/2022; Gorno Vranevce vill., 8.11.1998; Karabaliia: Bolovan, 150 m, Juglando-Platanetum orientalis, 27.9.2003, exs. MCF 03/3444; Kavadarc: Vitachevo, near the lake, *Pinus* and *Quercus* forest, 17.10.1998; Vitachevo, *Pinus* plantings, 28.9.1998; Kichevo: Starec vill., meadow, 8.10.2006; Kozhuf Mt.: Konjsko vill., meadow, 5.10.1996; Visoka Chuka, 1000 m, Festrucu heterophyllae-Fagetum, July1998; Kozjak: Nagorichani vill., by the r. Pechina, azonal vegetation, September 2005; Kumanovo: Zhegljane vill., *Pinus* plantings, 31.10.2007; Marivo: 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, Festrucu heterophyllae-Fagetum (with *Betula*), 3.10.2010; Ograzden Mt.: Chanaklija, 425 m, forest with *Pinus*; Ezrov Rid, 1100-1200 m, 10.09.1995 forest from *Fagus* and *Pinus*; Osogovski Planini Mt.: Konopnica vill. 1100 m, meadow, 14.7.2003; Proshpitip (vir:inity): 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 (Veije vill.), 1600-2000 m, high-mountain pastures, 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. Pantalejmon monastery, mixed plantings (*Castanea, Quercus*) 27.09.2009; Vodno 2.11.1992; Skopje vicinity: Vodno, between St. Pantalejmon 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, degraded 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; Rashatak vill., oak, 1.10.1998; Rashatak 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.: Duracka 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.

Discussion

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 (Figure 1).

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 heterophyllea-Fagetum. According to this data, it is rare species. Kozhuf Mt. is a new locality for the mycobionta 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 a 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 (Quercus-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. Fruitings in late summer. According to Karadelev 2000d, Karadelev et al. 2001a, Karadelev & Rusevska 2004, Karadelev et al. 2008d, this species is present 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, Quercetum frainetto-cerris, near Skopje (Quercus-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 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. Fruitings in spring till late autumn. According to Karadelev 1999b, Karadelev & Rusevska 2000, Karadelev 2000a, Karadelev & Rusevska 2004, 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-Aibietum me ridionale, Calamintho grandiflorae-Fagetum, Querc co- 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. This species is edible.

**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. hortensis. 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.

**References**


Macedonia. Macedonian Mycological Society. Skopje. pp. 1-299. (in Macedonian)


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

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Abstract


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 gypsum rocks. Acarospora cervina, Caloplaca variabilis, Diplopannema 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.
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 (Kaçaroglu, 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 alozica* (A. Massal.) Mig. 3
- *Caloplaca chalybaea* (Fr.) Müll. Arg 1
- *Caloplaca dolomiticola* (Hue) Zahlbr. 1
- *Caloplaca flavovirescens* (Wulfen) Dalla Torre & Sarntn. 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.) Röhrl. 2, 3, 5
*Lecanora flotowiana Spreng. 1
Lecanora usbekica Poelt 5
*Leucodia carpathica Körb. 3
*Leucoria patavina (A. Massal.) Knopf & Leuckert 3
Leucoria stigmatea
Lecidella stigmatea
Lecidella carpathica
Lobothallia alphoplaeca
Lobothallia radiosa
Lobothallia alphoplaca
Muellerella lichenicola
Muellerella pygmaea (Körb.) 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
Protocarpus 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 epicarpiphinea on Caloplaca agardhiana, Muellerella lichenicola on Caloplaca holocarpa, Muellerella pygmaea on Aspicilia contorta subsp. hoffmanniana and Zwackhiomyces spininctrinoides 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.

**Acknowledgement**

We express gratitude to Adil KIRIŞ for helping us in the field work.

**References**


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

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Abstract


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 km². According to the IUCN Red List criteria, the conservation status of this taxon is Critically Endangered (CR (C2a(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* Büreš, 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 km² 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 km²) 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
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 (MGRmin) of the Balkan lynx by counting the number of grid cells with more than 50% positive answers per 100 km². The Maximum Grid Range (MGRmax) 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-

Fig. 1. The study area divided in regions.
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 100km² in the reference area, over the whole distribution range of the Balkan lynx. We used the simple equation:

\[
\frac{X \times Y}{100}
\]

where X is the minimum or maximum value of the Area of Occupancy (AOOmin or AOOmax, 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 (AOOmin) 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 (AOOmax) 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.

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

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 Martaneshe 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_{max} 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 C1, 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\textsubscript{min}) of the Balkan lynx inside the investigated area is 3700 km\textsuperscript{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\textsubscript{max}), we counted 99 grid cells which equal 9900 km\textsuperscript{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, 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\textsubscript{min}) where the Balkan lynx is likely to be present is 4007 km\textsuperscript{2}, while the Maximum Area of Occupancy (AOO\textsubscript{max}) is 19886 km\textsuperscript{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\textsubscript{min}) - 10124 km\textsuperscript{2} and the Maximum Extent of Occurrence (EOO\textsubscript{max}) - 58435 km\textsuperscript{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\textsuperscript{2} (Stojanov et al. 2010). Taking into account the standard deviation from the 2010 session (± 0.31 individuals per 100 km\textsuperscript{2}), the minimum population density is 0.49, while the maximum is 1.11 individuals per 100 km\textsuperscript{2}.

Pessimistic scenario: I have taken the AOO\textsubscript{min} and:

- The lowest value of the population size: \[
\frac{4007 \times 0.49}{100} = 20 \text{ individuals.}
\]
- The mean value of the population size: \[
\frac{4007 \times 0.80}{100} = 32 \text{ individuals.}
\]
- The highest value of the population size: \[
\frac{4007 \times 1.11}{100} = 44 \text{ individuals.}
\]

Optimistic scenario: I have taken the AOO\textsubscript{max} and:

- The lowest value of the population size: \[
\frac{19886 \times 0.49}{100} = 97 \text{ individuals.}
\]
- The mean value of the population size: \[
\frac{19886 \times 0.80}{100} = 159 \text{ individuals.}
\]
- The highest value of the population size: \[
\frac{19886 \times 1.11}{100} = 220 \text{ individuals.}
\]

**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.
Distribution and conservation status of the Balkan lynx (*Lynx lynx balcanicus* Bureš, 1941)

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 km² 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).

---

Tab. 2. Threats to the Balkan lynx population.

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

← arrow indicates threats relevant for the past; ↔ stands for a present threat; → shows threats that might inflict the Balkan lynx 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 lynx population in a given country. The question marks state 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).
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 km² (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 km². 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 & Hañer (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).

**References**


Molinari-Jobin, A., Zimmermann, F., Ryser, A., Molinari, P., Haller, H., Breitenmoser-Würsten, Ch., Capt, S., Eyholzer, R. &


https://sis.iucnsis.org
www.eea.europa.eu/publications/COR0-landcover
http://en.wikipedia.org
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 Programmers. The questionnaire is divided in 5 parts: 1. The killing of the species- to collect information about the types...
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 km²) 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 km²). Besides the grid cell unit the study area was also divided in 3 regions for better detailed data analyses and comparison. These regions are:

<table>
<thead>
<tr>
<th>Nr</th>
<th>Place</th>
<th>Number of interviewers</th>
<th>Nr</th>
<th>Place</th>
<th>Number of interviewers</th>
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<td>Kukës</td>
<td>3</td>
<td>32</td>
<td>Xibër</td>
<td>1</td>
</tr>
</tbody>
</table>

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

- **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 it is difficult to find the tracks of her and cannot accuse anybody because lacking proofs.

-Hunting trophies

On Fig 4 is presented the hunting trophies where the highest 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 said 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.

-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).

-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.

-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 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


- 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).

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

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, Korçà 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 cor-rect inventory of wild animals in the territory of Al- bania. On 28000 square km there was no hunting preserve until today. There is a high number of ar-eas declared object of hunting, 11 in Librazhd, 9 in Pogradec, 9 in Elbasan and 15 in Mat. In all Bal-kan Peninsula in the last 50 years, Albania is one of the countries with higher rate loss of biological di-versity. Even though there is a low rate of hunting, although various amendments were made, the situa-tion 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 influ-enced the deterioration, to the danger of extinction of a major number of mammal populations. Accord-ing 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 hab- itats the impoverishment of habitats and applicabili-ty of the law on minimum levels.

**Recommendations**

Creation of a system for the collection of infor-mation and monitoring of wild fauna. Hunting as-sociations 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 maxi-mum. 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 re-porting of hunting counts in the inventory of spe-cies and makes an access to management develop-ment. 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.

**References**

http://www.face.eu
www.tovarcerulli.com
http://www.cic-wildlife.org
http://www.iwmc.org
http://www.moe.gov.al
CONTRIBUTION TO MACEDONIAN RED LIST OF FUNGI

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Abstract


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.

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).

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<td>B2ab(I,ii,iii)</td>
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<td>B2ab(iii,iv)</td>
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<tr>
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<td>Lactarius acris</td>
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<tr>
<td>Lactarius semisanguifluus</td>
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<td>Lactarius volemus</td>
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<td>Lentinus strigosus</td>
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<td>Lepiota grangei</td>
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<tr>
<td>Lepiota oreadiformis</td>
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<td>165 Phellodon melaleucus</td>
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<td>178 Pseudoomphalina kalchbrenneri</td>
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<td>179 Pyrofomes demidoffii</td>
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<td>180 Radigeria atrogleba</td>
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<td>182 Rhodophyllus whiteae</td>
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<td>185 Rutstroemia bulgarioides</td>
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<td>186 Sarcodon leucopus</td>
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<td>187 Sarcosphaera coronaria</td>
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<td>192 Skeletocutis tschulymica</td>
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<td>194 Stecherinum bourdotti</td>
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<td>D1</td>
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<td>196 Stecherinum subcinale</td>
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<td>D1</td>
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<td>198 Suillus sibiricus</td>
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<td>200 Trametes ljubarskyi</td>
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<td>201 Trichoglossum hirsutum</td>
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<td>203 Tricholoma lascivum</td>
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<td>204 Tulostoma caespitosum</td>
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<td>206 Tulostoma melanocyclum</td>
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<td>207 Tulostoma squamosum</td>
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<td>209 Verpa conica</td>
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<td>A3acd</td>
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<td>B2a</td>
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<td>211 Xerula melanotricha</td>
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<td>212 Xylobolus frustulatus</td>
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<td>A2ac</td>
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<tr>
<td>213 Xylobolus subpileatus</td>
<td>VU</td>
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References


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

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Abstract


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.


After macrofungi samples were identified and dried, we protected them in polyethylene 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 Explorer 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 fuscα** (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 2,863.

**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.

*Helvella leucomelaena* (Pers.) Nannf.
Çandır village, Karaguz locality, on debris, 41°42′575′′N, 36°31′39′′46E, 380 m, 09.01.2011, Kaşık 2,830.

**MORCHELLACEAE**

*Morchella conica* Krombh.
Kargı, Taşdibi village, burned area, 41°23′984′′N, 36°30′67′′19E, 291m, 16.04.2011, Kaşık 2,874.

*Morchella elata* var. *elata* Fr.
Çandır village, Karaguz locality, on debris, 41°42′575′′N, 36°31′39′′46E, 380 m, 09.01.2011, Kaşık 2,836.

*Morchella esculenta* (L.) Ces. & De Not.
Çandır village, Karaguz locality, on debris, 41°42′575′′N, 36°31′39′′46E, 380 m, 09.01.2011, Kaşık 2,835.

**PEZIZACEAE**

*Sarcosphaera coronaria* (Jacq.) J. Schrödt.
Çandır village, Boynuzlu locality, on debris, 41°42′896′′N, 36°31′23′′33E, 290 m, 09.01.2011, Kaşık 2,874.

**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**

*Helvella concentrica* (Bolton) Ces. & De Not.
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.

*Helvella leucomelaena* (Pers.) Nannf.
Çandır village, Karaguz locality, on debris, 41°42′575′′N, 36°31′39′′46E, 380 m, 09.01.2011, Kaşık 2,830.

**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 ESCULENTA** (L.) 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, 280m, 17.04.2011, Kaşık 2,916.
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36°31′11″55E, 334 m 19.03.2012, Kaşık 2,948.

**Exidia glandulosa** (Bull.) Fr.
Sığla forest, on branches, 41°37′40″3′N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,755.

**BOLETACEAE**

**Boletus pulverulentus** Opat.
Sığla forest, on debris, 41°37′40″3′N, 36°30′81″26E, 198 m, 22.10.2010, Kaşık 2,727.

**DACRYMYCETACEAE**

**Calocera cornea** (Batsch) Fr.
Sığla forest, on branches, 41°37′40″3′N, 36°30′81″26E, 198 m, 22.10.2010, Kaşık 2,729.

**Dacrymyces variisporus** McNabb
Sığla forest, on branches, 41°37′40″3′N, 36°30′81″26E, 198 m, 16.05.2011, Kaşık 2,931.

**DIPLOCYSTIDIACEAE**

**Astraeus hygrometricus** (Pers.) Morgan
Sığla forest, on debris, 41°37′40″3′N, 36°30′81″26E, 198 m, 04.02.2011, Kaşık 2,872.

**ENTOLOMATACEAE**

**Entoloma incanum** (Fr.) Hesler
Sığla forest, on debris, 41°37′40″3′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′40″3′N, 36°30′81″26E, 198 m, 19.03.2012, Kaşık 2,957.

**GANODERMATACEAE**

**Ganoderma applanatum** (Pers.) Pat.
Sığla forest, on stump, 41°37′40″3′N, 36°30′81″26E, 198 m, 16.04.2011, Kaşık 2,898.

**Ganoderma lucidum** (Curtis) P. Karst.
Sığla forest, on stump, 41°37′40″3′N, 36°30′81″26E, 198 m, 16.04.2011, Kaşık 2,899.

**GEASTRACEAE**

**Geastrum fimbriatum** Fr.
Çandır village, Karaguz locality, on debris, 41°42′57″6′N, 36°31′39″4′E, 380 m, 09.01.2011, Kaşık 2,833.

**GLOEOPHYLLACEAE**

**Gloeophyllum sepiarium** (Wulfen) P. Karst.
Çandır village, Şahana locality, on debris, 41°43′17″8′N, 36°31′31″5′E, 283 m, 08.01.2011, Kaşık 2,789.

**GOMPHIDIACEAE**

**Chroogomphus helveticus** (Singer) M. M. Moser
Melikler Peninsula, on debris, 41°42′57″6′N, 36°31′39″4′E, 380 m 17.04.2011, Kaşık 2,913.

**Chroogomphus rutilus** (Schaeff.) O. K. Mill.
Sığla forest, on debris, 41°37′40″3′N, 36°30′81″26E, 198 m, 22.10.2010, Kaşık 2,740.

**HYDNACEAE**

**Hydnum repandum** L..
Melikler Peninsula, on debris, 41°45′27″3′N, 36°31′09″8′E, 280 m 09.01.2011, Kaşık 2,848.

**HYGROPHORACEAE**

**Hygrophorus agathosmus** (Fr.) Fr.
Çandır village, Belentaşı locality, on debris, 41°44′67″2′N, 36°31′36″7′E, 305 m, 08.01.2012, Kaşık 2,771.

**Hygrophorus eburneus** (Bull.) Fr.
Melikler Peninsula, on debris, 41°45′27″3′N, 36°31′09″8′E, 280 m 09.01.2011, Kaşık 2,849.

**HYMENOCHAETACEAE**

**Fuscoporia torulosa** (Pers.) T. Wagn & M. Fisch
Çandır village, Boynuzu locality, on stump, 41°42′50″8′N, 36°31′34″3′E, 290 m, 17.04.2011, Kaşık 2,907.

**Inonotus rheades** (Pers.) Bondartsev & Singer
Sığla forest, on stump, 41°37′40″3′N, 36°30′81″26E, 198 m, 16.04.2011, Kaşık 2,898.

**INOCYBACEAE**

**Crepidotus mollis** (Schaeff.) Staude
Melikler Peninsula, on branches, 41°45′27″3′N, 36°31′09″8′E, 280 m 04.02.2011, Kaşık 2,865.

**Inocybe rimosissima** (Bull.) P. Kumm.
Melikler Peninsula, on debris, 41°45′27″3′N, 36°31′09″8′E, 280 m 17.04.2011, Kaşık 2,915.

**LYOPHYLLACEAE**

**Rugosomyces onychinus** (Fr.) Raithelh.
Sığla forest, on debris, 41°37′40″3′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′41″9′N, 36°30′76″38′E, 330 m 22.10.2010, Kaşık 2,721.

**Omphalotus olearius** (DC.) Singer
Sığla forest, on debris, 41°37′40″3′N, 36°30′81″26E, 198 m, 16.04.2011, Kaşık 2,899.

**MYCENACEAE**

**Mycena amicta** (Fr.) Quel.
Çandır village, Boynuzu locality, on debris, 41°42′57″6′N, 36°31′39″4′E, 380 m 09.01.2011, Kaşık 2,833.

**Mycena epipterygia** (Scop.) Gray
Sığla forest, on debris, 41°37′40″3′N, 36°30′81″26E, 198 m, 22.10.2010, Kaşık 2,740.
Macromycetes of Karacaören Dam (Bucak-Burdur, TURKEY) and Its Surroundings

**Mycena pura** (Pers.) P. Kumm.
Çandır village, Karaguz locality, on debris, 41°42′57″N, 36°31′39″46E, 380 m, 09.01.2011, Kaşık 2,837.

**Mycena renati** Quel.
Sigla forest, on debris, 41°37′40″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′41″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′67″2′N, 36°31′36″71E, 305 m, 09.01.2011, Kaşık 2823.

**Xeromphalina cauticinalis** (With.) Kühner & Maire
Çandır village, Belentaşı locality, on debris, 41°37′40″N, 36°30′81″26E, 198 m, 09.01.2011, Kaşık 2,787.

**PAXILLACEAE**

**Paxillus involutus** (Batsch) Fr.
40 geçit, on debris, 41°34′11″55E, 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′89″N, 36°31′23″33E, 290 m, 08.01.2011, Kaşık 2,799, Çandır village, Boynuzlu locality, on branches, 41°44′67″2′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′17″55E, 36°31′31″55E, 283 m, 08.01.2011, Kaşık 2,796.

**PHYSALACRIACEAE**

**Armillaria mellea** (Vahl) P. Kumm.
Sigla forest, on debris, 41°37′40″N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,756.

**PLUTEACEAE**

**Pluteus cervinus** (Schaeff.) P. Kumm.
Melikler Peninsula, near stump, 41°45′27″N, 36°31′09″84E, 280 m, 17.04.2011, Kaşık 2,918.

**Volvopluteus gloiocephalus** (DC.) Justo
Melikler Peninsula, on debris, 41°45′27″N, 36°31′09″84E, 280 m, 16.05.2011, Kaşık 2,925.

**POLYPORACEAE**

**Daedaleopsis confragosa** (Bolton) J. Schröt.
Sigla forest, on stump, 41°37′40″N, 36°30′81″26E, 198 m, 16.05.2011, Kaşık 2,933.

**Fomes fomentarius** (L.) J. Kickx f.
Sigla forest, on stump, 41°37′40″N, 36°30′81″26E, 198 m, 22.10.2010, Kaşık 2,736, Sigla forest, on stump, 41°37′40″N, 36°30′81″26E, 198 m, 16.04.2011, Kaşık 2,895.

**Hexagonia nitida** Durieu & Mont.
Sigla forest, on branches, 41°37′40″N, 36°30′81″26E, 198 m, 16.04.2011, Kaşık 2,896.

**Lentinus tigrinus** (Bull.) Fr.
Sigla forest, on stump, 41°37′40″N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,756.

**Lentinus arcearius** (Batsch) Fr.
Sigla forest, on branches, 41°37′40″N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,762.

**Polyporus brumalis** (Pers.) Fr.
Sigla forest, on branches, 41°37′40″N, 36°30′81″26E, 198 m, 16.04.2011, Kaşık 2,903.

**Trametes hirsuta** (Wulfen) Lloyd
40 geçit, on debris, 41°34′11″55N, 36°31′21″55E, 449 m, 16.05.2011, Kaşık 2,922.

**Trametes versicolor** (L.) Lloyd
Sigla forest, on branches, 41°37′40″N, 36°30′81″26E, 198 m, 23.10.2010, Kaşık 2,767, Çandır village, Şahana locality, on branches, 41°43′17″55E, 36°31′31″55E, 283 m, 08.01.2011, Kaşık 2,798, Sigla forest, on branches, 41°37′40″N, 36°30′81″26E, 198 m, 08.01.2011, Kaşık 2,818.

**Trichaptum abietinum** (Dicks.) Ryvarden
Çandır village, Şahana locality, on branches, 41°43′17″55E, 36°31′31″55E, 283 m, 08.01.2011, Kaşık 2,799, Çandır village, Boynuzlu locality, on branches, 41°42′89″N, 36°31′23″33E, 290 m, 08.01.2011, Kaşık 2,784.

**PSATHYRELLACEAE**

**Coprinellus disseminatus** (Pers.) J. E. Lange
Sigla forest, on branches, 41°37′40″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′89″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′89″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′89″N, 36°31′23″33E, 290 m, 17.04.2011, Kaşık 2,906.

**Psathyrella tephrophylla** (Romagn.) M.M. Moser
Çandır village, Boynuzlu locality, on branches, 41°42′89″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.
Çandır village, Belentaşı locality, on debris, 41°44′672′′N, 36°31′39′′46E, 380 m, 09.01.2011, Kaşık 2,938.

**Russulaceae**

*Lactarius deliciosus* (L.) Gray
Çandır village, Belentaşı locality, on branches, 41°44′672′′N, 36°31′39′′46E, 380 m, 09.01.2011, Kaşık 2,938.

**Scleroderma bovista** (Fr.) Kühner
Çandır village, Boynuzlu locality, on debris, 41°42′896′′N, 36°31′23′′33E, 290 m, 17.04.2011, Kaşık 2,904.

**Scleroderma polyrhizum** (J. F. Gmel.) Pers.
Çandır village, Şahana locality, on debris, 41°43′178′′N, 36°31′31′′55E, 283 m, 08.01.2011, Kaşık 2,788.

**Stereaceae**

*Stereum hirsutum* (Willd.) Pers.
Çandır village, Belentaşı locality, on branches, 41°44′672′′N, 36°31′39′′46E, 380 m, 09.01.2011, Kaşık 2,904.

**Tricholomataceae**

*Clitocybe gibba* (Pers.) P. Kumm.
Çandır village, Belentaşı locality, on branches, 41°45′273′′N, 36°31′09′′84E, 280 m 04.02.2011, Kaşık 2,866.

**Agrocybe dura** (Bolton) Singer
Çandır village, Şahana locality, on debris, 41°43′178′′N, 36°31′31′′55E, 283 m, 08.01.2011, Kaşık 2,788.

**Galerina badipe** (Pers.) Kühner
Çandır village, Belentaşı locality, on debris, 41°44′672′′N, 36°31′39′′46E, 380 m, 09.01.2011, Kaşık 2,938.

**Resupinatus trichotis** (Pers.) Singer
Çandır village, Belentaşı locality, on debris, 41°44′672′′N, 36°31′39′′46E, 380 m, 09.01.2011, Kaşık 2,938.

**Tricholoma caligatum** (Viv.) Ricken
Çandır village, Belentaşı 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.

Acknowledgement
The current research, with project number (BAP-10401040), has financially been supported by Selçuk University, Scientific Research Project Coordinator. We would like to thank them for their financial support. Part of this study, with project number (BAP-12701585), has been presented at 4th Congress of Ecologists of The Republic of Macedonia with International Participation.

References
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 climate is typically Mediterranean.

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, anilin, 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 & Kränzl (1984-2005), Dennis (1981), Ellis & Ellis (1990), Pace (1998), 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.

Abstract


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.
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 476, Kara İsa village, on debris, 40°73′896′′N, 36°42′62′′72E, 945 m, 18.04.2011, Öztürk 478, Çayırözü, on debris, 40°73′896′′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 522.
Morchella esculenta (L.) Pers.
Kara İsa village, on debris, 40°75′990′′N, 36°40′33′′93E, 1032 m, 18.04.2011, Öztürk 479, 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, 14.05.2011, Öztürk 492.

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 539.

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
Amanita caesarea (Scop.) Pers.
Çürek, among debris, 40°23′722′′N, 36°39′79′′27E, 800 m, 22.10.2011, Öztürk 593.
Lycoperdon perlatum Pers.
Çürek, among debris, 40°23′722′′N, 36°39′79′′27E, 800 m, 22.10.2011, Öztürk 598.
Macrolepiota excoriata (Schaeff.) Wasser
Çürek, among debris, 40°23′722′′N, 36°39′79′′27E, 800 m, 22.10.2011, Öztürk 600.

AMANITACEAE
Amanita caesarea (Scop.) Pers.
Çürek, among debris, 40°23′722′′N, 36°39′79′′27E, 800 m, 22.10.2011, Öztürk 597.
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°75′990′′N, 36°40′72′′42E, 1032 m, 14.05.2011, Öztürk 509.
Exidia glandulosa (Bull.) Fr.
Çürek, 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.

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.
Cystodermella granulosa (Batsch) Harmaja
Soğukoluk, on debris, 40°79′649′′N, 36°41′17′′35E, 1487 m, 22.10.2011, Öztürk 627.
Exidia glandulosa (Bull.) Fr.
Çürek, on branches, 40°23′722′′N, 36°39′79′′27E, 800 m, 14.05.2011, Öztürk 498.

Geopora arenosa (Fuckel) S. Ahmad
Soğukoluk, on debris, 40°79′649′′N, 36°40′91′′26E, 1362 m, 10.05.2012, Öztürk 714.

Lycoperdon perlatum Pers.
Çürek, among debris, 40°23′722′′N, 36°39′79′′27E, 800 m, 22.10.2011, Öztürk 598.
Macropleiota excoriata (Schaeff.) Wasser
Çürek, among debris, 40°23′722′′N, 36°39′79′′27E, 800 m, 22.10.2011, Öztürk 599.
Macrolepiota procera var. procera (Scop.) Singer
Çürek, among debris, 40°23′722′′N, 36°39′79′′27E, 800 m, 22.10.2011, Öztürk 600.

Lycoperdon molle Pers.
Çürek, among debris, 40°23′722′′N, 36°39′79′′27E, 800 m, 22.10.2011, Öztürk 593.
Lycoperdon perlatum Pers.
Çürek, among debris, 40°23′722′′N, 36°39′79′′27E, 800 m, 22.10.2011, Öztürk 598.
Macropleiota excoriata (Schaeff.) Wasser
Çürek, among debris, 40°23′722′′N, 36°39′79′′27E, 800 m, 22.10.2011, Öztürk 599.
Macrolepiota procera var. procera (Scop.) Singer
Çürek, among debris, 40°23′722′′N, 36°39′79′′27E, 800 m, 22.10.2011, Öztürk 600.

Auricularia auricula-judae (Bull.) Quel.
Orta Alan plateau, on stump, 40°81′622′′N, 36°40′91′′26E, 1362 m, 23.10.2011, Öztürk 654.

Geopora arenosa (Fuckel) S. Ahmad
Soğukoluk, on debris, 40°79′649′′N, 36°41′17′′35E, 1487 m, 22.10.2011, Öztürk 621.

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.
Çürik, among debris, 40°23′722′′N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 609.

CANTHARELLACEAE
Cantharellus cibarius Fr.
Çürik, 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
Çürik, 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, 14.05.2011, Öztürk 505.

FOMITOPSIDACEAE
Antrodia juniperina (Murrill) Niemela & Ryvarden
Senirçalı, on branches, 40°75′990″N, 36°40′72″42E, 1032 m, 14.05.2011, Öztürk 510.
Antrodia rufescens (Murrill) Niemela & Ryvarden
Soğukoluk, on stump, 40°76′472″N, 36°42′44″69E, 921 m, 15.05.2011, Öztürk 563.

GEASTRACEAE
Geastrum fimbriatum Fr.
Soğukoluk, on debris, 40°76′204″N, 36°40′61″00E, 950 m, 23.10.2011, Öztürk 669.
Geastrum rufescens Pers.
Çürik, among debris, 40°23′722″N, 36°39′79″27E, 800 m, 22.10.2011, Öztürk 588.
Geastrum schmidelii Vittad.
Karadere, on branches, 40°76′204″N, 36°40′61″00E, 950 m, 23.10.2011, Öztürk 668.

GLOEOPHYLLACEAE
Gloeophyllum sepiarium (Wulfen) P. Karst.
Çürik, among debris, 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
Çürik, 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 650.
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
Seniçalı, on branches, 40°75′99″N, 36°40′51″61E, 1032 m, 14.05.2011, Öztürk 517, Çayırözü, on debris, 40°74′35″N, 36°42′62″72E, 1101 m, 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 692.

Mycena pura (Pers.) P. Kumm.
Karadere, on debris, 40°76′204″N, 36°40′61″00E, 950 m, 22.10.2011, Öztürk 672.

Mycena renati Quel.
Orta Alan plateau, on debris, 40°81′622″N, 36°40′91″26E, 1362 m, 23.10.2011, Öztürk 695.

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, among debris, 40°79′771″N, 36°40′51″61E, 786 m, 23.10.2011, Öztürk 665.

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 602.

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 672.

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.

Rhzopogon roseolus (Corda) Th. Fr.
Karadere, among debris, 40°79′771″N, 36°40′51″61E, 786 m, 23.10.2011, Öztürk 665.

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 Isa 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.
Çürükt, on branches, 40°23′722′′N, 36°39′79′′27E, 800 m, 14.05.2011, Öztürk 503,
Senirçalı, on branches, 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
Çürükt, among debris, 40°23′722′′N, 36°39′79′′27E, 800 m, 14.05.2011, 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,
GREENHOUSE GASEMISSIONS FROM LIVESTOCK IN THE REPUBLIC OF MACEDONIA, ENTERIC FERMENTATION AND MANURE MANAGEMENT, IN THE PERIOD 2006-2010

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Abstract


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 CO₂-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 26.41 Gg (2007), with lowest value in 2009 (25.49 Gg). Depending on the animal waste management system the highest value of nitrogen excretion (solid storage and drylot) was observed in 2010 (10.43 kt/N/yr). Lovest value for nitrogen excretion from pasture and paddock was observed in 2007 (9.54 and 9.53 kt/N/yr, respectively). Lowest value for nitrogen excretion from pasture and paddock was noted in 2006 (14.58 kt/N/yr) and the highest value in 2006 (3.33 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 CO₂-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 through higher emission of greenhouse gases (GHGs). Livestock sector generates 18% more greenhouse gases (converted into CO₂ 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 CO₂) 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 CO₂) 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

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

<table>
<thead>
<tr>
<th>Livestock</th>
<th>Emissions factor for enteric fermentation (kg/yr)</th>
<th>Emissions factor for manure management (kg/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy Cattle</td>
<td>81</td>
<td>6</td>
</tr>
<tr>
<td>Non-dairy Cattle</td>
<td>56</td>
<td>4</td>
</tr>
<tr>
<td>Buffalo</td>
<td>55</td>
<td>3</td>
</tr>
<tr>
<td>Sheep</td>
<td>5</td>
<td>0.1</td>
</tr>
<tr>
<td>Goats</td>
<td>5</td>
<td>0.11</td>
</tr>
<tr>
<td>Horses</td>
<td>18</td>
<td>1.1</td>
</tr>
<tr>
<td>Swine</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Poultry</td>
<td>0</td>
<td>0.012</td>
</tr>
</tbody>
</table>
illustrated through difference in period of degradation of methane and N\textsubscript{2}O compared with CO\textsubscript{2} (in 20 years period of time 1 kg of CH\textsubscript{4} will have same effect as 56 kg of CO\textsubscript{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\textsubscript{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 from 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\textsubscript{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\textsubscript{2}-eq from enteric fermentation were noted in 2006 while CO\textsubscript{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-

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**Table 3. Total annual emission of methane**

<table>
<thead>
<tr>
<th>Year</th>
<th>Emissions from enteric fermentation (t/yr)</th>
<th>Emissions from manure management (t/yr)</th>
<th>Total annual emissions from domestic livestock (Gg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>25.13</td>
<td>2.17</td>
<td>27.31</td>
</tr>
<tr>
<td>2007</td>
<td>23.90</td>
<td>2.51</td>
<td>26.41</td>
</tr>
<tr>
<td>2008</td>
<td>23.80</td>
<td>2.46</td>
<td>26.27</td>
</tr>
<tr>
<td>2009</td>
<td>23.23</td>
<td>2.24</td>
<td>25.49</td>
</tr>
<tr>
<td>2010</td>
<td>23.88</td>
<td>2.28</td>
<td>26.17</td>
</tr>
</tbody>
</table>

**Table 4. Total annual nitrogen excretion**

<table>
<thead>
<tr>
<th>Animal Waste Management System (AWMS)</th>
<th>Nitrogen Excretion Nex\textsubscript{(AWMS)} (kt /N/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2006</td>
</tr>
<tr>
<td>Solid storage &amp; drylot</td>
<td>10.06</td>
</tr>
<tr>
<td>Pasture range and paddock</td>
<td>14.5</td>
</tr>
<tr>
<td>Other</td>
<td>2.60</td>
</tr>
<tr>
<td>Total</td>
<td>27.28</td>
</tr>
</tbody>
</table>
Greenhouse gas emissions from livestock in the Republic of Macedonia, enteric fermentation and manure...

Lose. Therefore, an integral component of the whole process of feed digestion is the formation of methane. Although during enteric fermentation CH₄ formation is inevitable, however certain foods and a properly balanced diet significantly affect the level of formation of CH₄ 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 CH₄ in terms of feeds with a lower level of crude fiber. Additional reduction in the formation of CH₄ 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 CH₄ production. Apart from the type of feed, correctly balanced feed and farming technology directly affects the production of CH₄. Breeding technology has particular impact in cattle breeding, where the formation and emission of CH₄ 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 CH₄ 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 CH₄ emissions from enteric fermentation. The high value of CH₄ 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 CH₄ 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 2009 (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

<table>
<thead>
<tr>
<th>Animal Waste Management System (AWMS)</th>
<th>Total Annual Emissions of N₂O (Gg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2006</td>
</tr>
<tr>
<td>Solid storage &amp; drylot</td>
<td>0.32</td>
</tr>
<tr>
<td>Pasture range and paddock</td>
<td>0.46</td>
</tr>
<tr>
<td>Other</td>
<td>0.20</td>
</tr>
<tr>
<td>Total</td>
<td>0.98</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annual CO₂-eq emission</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2006</td>
</tr>
<tr>
<td>Enteric fermentation (kt)</td>
<td>573.45</td>
</tr>
<tr>
<td>Animal Waste Management System AWMS (kt)</td>
<td>207.13</td>
</tr>
</tbody>
</table>
in CH₄ 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 N₂O production during the manure management process. Aerobic decomposition of manure is characterized with increased N₂O emissions, transformation of N₂O 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 RFNCC, 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 N₂O emissions (Gg) are primarily determined by the manure management system. Highest value (0.33 Gg) for the N₂O 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). N₂O 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 N₂O 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 N₂O 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 CO₂-eq that enables converting greenhouse gases into a common unit of measurement. Highest value for CO₂-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 CO₂-eq emission from enteric fermentation were observed in 2009 and 2010, 535.04 kt and 549.64 kt respectively. CO₂-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 CO₂-eq emissions from manure management is twice higher, as CO₂-eq from enteric fermentation shows approximately equal values with the exception of 2006. The obtained parameters for the CO₂-eq emissions (kt) is significantly lower compared to the values (600 to 700 kt) for emission of CO₂-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).

**References**


MANAGING POULTRY DIET COMPOSITION TO REDUCE PHOSPHORUS EXCRETION AND ENVIRONMENTAL POLLUTION

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Abstract


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 isocaloric 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/cm² 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, 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 матери за одржување на јајцепроизводството и квалитетот на жицовата средина. Зборник на трудови од 4 VI Конгрес на еколозите на Македонија со меѓународно учество, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 28, Скопје.

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Managing poultry diet composition to reduce phosphorus excretion and environmental pollution

**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 manure use as fertilizer.

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 al, (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 isocaloric 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

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

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 (1 million 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

<table>
<thead>
<tr>
<th></th>
<th>Control farmhouse</th>
<th>Phytase supplemented feed farmhouse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F -</td>
<td>F +</td>
</tr>
<tr>
<td>Feed consumption/hen housed</td>
<td>41.99</td>
<td>41.66</td>
</tr>
<tr>
<td>Number of egg produced/hen housed</td>
<td>297.96</td>
<td>297.99</td>
</tr>
<tr>
<td>Average production %</td>
<td>81.02</td>
<td>80.83</td>
</tr>
</tbody>
</table>

Tab. 3. Shell strength g/cm² (at different production phase and average)

<table>
<thead>
<tr>
<th>Diet</th>
<th>Diet</th>
<th>Diet</th>
<th>Diet</th>
<th>Diet</th>
<th>Diet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F0 -</td>
<td>F0 +</td>
<td>F1 -</td>
<td>F1 +</td>
<td>F2 -</td>
</tr>
<tr>
<td>Average</td>
<td>3731.40</td>
<td>3832.08</td>
<td>3898.26</td>
<td>4018.00</td>
<td>4041.60</td>
</tr>
<tr>
<td>Maximum</td>
<td>5352.00</td>
<td>5305.00</td>
<td>5269.00</td>
<td>5632.00</td>
<td>4820.00</td>
</tr>
<tr>
<td>Minimum</td>
<td>1748.00</td>
<td>1672.00</td>
<td>1791.00</td>
<td>1880.00</td>
<td>2750.00</td>
</tr>
<tr>
<td>STD</td>
<td>1075.87</td>
<td>896.81</td>
<td>769.02</td>
<td>983.55</td>
<td>692.78</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>DIETS</th>
<th>Dry matter</th>
<th>Humidity</th>
<th>P (total)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>F0 -</td>
<td>90.13</td>
<td>9.87</td>
<td>0.62</td>
<td>2.65</td>
</tr>
<tr>
<td>F0 +</td>
<td>89.47</td>
<td>10.53</td>
<td>0.98</td>
<td>3.35</td>
</tr>
<tr>
<td>F1 -</td>
<td>90.26</td>
<td>9.74</td>
<td>0.66</td>
<td>2.73</td>
</tr>
<tr>
<td>F1 +</td>
<td>89.89</td>
<td>10.11</td>
<td>0.75</td>
<td>3.16</td>
</tr>
<tr>
<td>F2 -</td>
<td>89.58</td>
<td>10.42</td>
<td>0.50</td>
<td>2.71</td>
</tr>
<tr>
<td>F2 +</td>
<td>90.22</td>
<td>9.78</td>
<td>0.76</td>
<td>2.69</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MANURE</th>
<th>Dry matter</th>
<th>Humidity</th>
<th>P (total)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>F0 -</td>
<td>77.38</td>
<td>22.62</td>
<td>0.41</td>
<td>0.69</td>
</tr>
<tr>
<td>F0 +</td>
<td>81.01</td>
<td>18.99</td>
<td>0.49</td>
<td>0.52</td>
</tr>
<tr>
<td>F1 -</td>
<td>70.52</td>
<td>29.48</td>
<td>0.63</td>
<td>0.94</td>
</tr>
<tr>
<td>F1 +</td>
<td>77.88</td>
<td>22.12</td>
<td>0.41</td>
<td>0.49</td>
</tr>
<tr>
<td>F2 -</td>
<td>72.03</td>
<td>27.97</td>
<td>0.50</td>
<td>0.82</td>
</tr>
<tr>
<td>F2 +</td>
<td>75.09</td>
<td>24.91</td>
<td>0.46</td>
<td>0.62</td>
</tr>
</tbody>
</table>
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 (1million 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.

**References**


Managing poultry diet composition to reduce phosphorus excretion and environmental pollution


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

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Abstract


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.

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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 overconsume on full-feeding programs. They suggested restriction at early age before peak of production of 12 to 13% 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-
Restrictive feeding as a management tool for reduced manure production and environmental pollution from...  

control birds fed *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.

**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 (1million 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-

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

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Diet F0</th>
<th>Diet F1</th>
<th>Diet F2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>43.00</td>
<td>44.55</td>
<td>44.07</td>
</tr>
<tr>
<td>Barley</td>
<td>5.00</td>
<td>9.00</td>
<td>11.00</td>
</tr>
<tr>
<td>Soya bean meal</td>
<td>34.13</td>
<td>29.61</td>
<td>28.65</td>
</tr>
<tr>
<td>Vegetable oil</td>
<td>5.70</td>
<td>5.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Limestone</td>
<td>9.50</td>
<td>9.53</td>
<td>10.00</td>
</tr>
<tr>
<td>Salt</td>
<td>0.25</td>
<td>0.28</td>
<td>0.24</td>
</tr>
<tr>
<td>Sodium bicarbonate</td>
<td>0.22</td>
<td>0.17</td>
<td>0.29</td>
</tr>
<tr>
<td>MCP</td>
<td>1.46</td>
<td>1.21</td>
<td>1.11</td>
</tr>
<tr>
<td>DL-Methionine 98%</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Betaine – Methionine</td>
<td>0.04</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>Cholin – Chloride</td>
<td>0.08</td>
<td>0.03</td>
<td>0.01</td>
</tr>
<tr>
<td>Vit.-Min. premix</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
<tr>
<td>ME KCal / kg</td>
<td>2750.00</td>
<td>2750.00</td>
<td>2720.00</td>
</tr>
<tr>
<td>Dry matter</td>
<td>88.90</td>
<td>88.90</td>
<td>88.80</td>
</tr>
<tr>
<td>Humidity</td>
<td>11.10</td>
<td>11.10</td>
<td>11.20</td>
</tr>
<tr>
<td>Crude ash</td>
<td>13.55</td>
<td>13.50</td>
<td>13.89</td>
</tr>
<tr>
<td>Crude fat</td>
<td>7.48</td>
<td>7.01</td>
<td>6.01</td>
</tr>
<tr>
<td>Crude proteins</td>
<td>17.99</td>
<td>16.45</td>
<td>16.01</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>4.10</td>
<td>4.10</td>
<td>4.20</td>
</tr>
<tr>
<td>Lysine</td>
<td>0.95</td>
<td>0.85</td>
<td>0.83</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.45</td>
<td>0.40</td>
<td>0.39</td>
</tr>
<tr>
<td>Met + Cystine</td>
<td>0.75</td>
<td>0.67</td>
<td>0.67</td>
</tr>
<tr>
<td>Ca</td>
<td>3.77</td>
<td>3.81</td>
<td>3.98</td>
</tr>
<tr>
<td>P (total)</td>
<td>0.68</td>
<td>0.61</td>
<td>0.60</td>
</tr>
<tr>
<td>P available</td>
<td>0.40</td>
<td>0.35</td>
<td>0.33</td>
</tr>
</tbody>
</table>

**Tab. 2.** Production parameters of two flocks

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

**Tab. 3.** Quantity of feed consumption during the trial

<table>
<thead>
<tr>
<th></th>
<th>Control flock</th>
<th>Trial flock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number of layers in the trial period</td>
<td>15016</td>
<td>15986</td>
</tr>
<tr>
<td>Total Quantity of feed consumed</td>
<td>720950kg</td>
<td>735990 kg</td>
</tr>
<tr>
<td>Quantity of feed spent / average number of layers</td>
<td>48kg</td>
<td>46.01 kg</td>
</tr>
<tr>
<td>Quantity of feed spent / housed number of layers</td>
<td>42.87</td>
<td>41.85</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Feces (fresh)</th>
<th>Manure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average body weight kg</td>
<td>1.850</td>
<td>1.850</td>
</tr>
<tr>
<td>Period of exploitation (days)</td>
<td>365</td>
<td>365</td>
</tr>
<tr>
<td>Specific weight kg/m³</td>
<td>993.000</td>
<td>993.000</td>
</tr>
<tr>
<td>Humidity %</td>
<td>85.000</td>
<td>65.000</td>
</tr>
<tr>
<td>Total Nitrogen Content %</td>
<td>1.350</td>
<td>1.400</td>
</tr>
<tr>
<td>NH₃-N Ammonia Nitrogen %</td>
<td>0.330</td>
<td>0.700</td>
</tr>
<tr>
<td>P₂O₅ %</td>
<td>1.050</td>
<td>1.600</td>
</tr>
<tr>
<td>Pure Phosphorus (P)</td>
<td>0.462</td>
<td>0.704</td>
</tr>
<tr>
<td>K₂O %</td>
<td>0.600</td>
<td>1.000</td>
</tr>
<tr>
<td>Ca %</td>
<td>2.050</td>
<td>2.050</td>
</tr>
<tr>
<td>Mg %</td>
<td>0.210</td>
<td>0.270</td>
</tr>
<tr>
<td>S %</td>
<td>0.210</td>
<td>0.350</td>
</tr>
<tr>
<td>Na %</td>
<td>0.180</td>
<td>0.140</td>
</tr>
<tr>
<td>Cl %</td>
<td>1.000</td>
<td>0.200</td>
</tr>
<tr>
<td>Mn %</td>
<td>0.008</td>
<td>0.014</td>
</tr>
<tr>
<td>B %</td>
<td>0.002</td>
<td>0.001</td>
</tr>
<tr>
<td>Zn %</td>
<td>0.007</td>
<td>0.015</td>
</tr>
<tr>
<td>Cu %</td>
<td>0.001</td>
<td>0.002</td>
</tr>
</tbody>
</table>

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.

References

СОДРЖИНА НА ТЕШКИ МЕТАЛИ ВО ПОЧВИ ОД НЕГОТИНСКО

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Извод


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 (Неготино) на локалитетот Цуцка, на површина од 11 ha е ископан еден почвен профил на регосол (профил 1) и еден профил на рендзина (профил 2). Растворенето на почвените проби е извршено со концентриран HCl и HNO₃ во однос 3:1, а определувањето на тешките метали е извршено со атомски емисионен спектрометар со индуктивно спрегнато плазма Varian 715ES. Достапните форми на тешки метали се екстрахирани со DTPA методот а определувањето е извршено на електротермички атомски апсорбционен спектрометар Varian SpectrAA 614Z. Во испитуваните почви, содржината на вкупен бакар е нешто повисока од референтните вредности, (освен хор.С 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.

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

Abstract


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 HNO₃ 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 механичниот состав, некои хемиски својства и содржината на вкупните и достапни форми на бакар, железо, манган и цинк во регосол и рендзина од Неоготинско. Податоци за содржината на вкупни форми на бакар, железо, манган и цинк во почви од Тиквешкиот регион се сретнале во трудовите на Savić et al. (1968); Савиќ и др. (1970); Кекиќ 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 извршиле од страна на Stafilov et al. (2008, 2010). Овие истражувања извршени биле испитувања на 31 хемиски елементи, на површина од 360 km², при што се земени почвени проби од 172 локации на длабочина од 0-5 cm и од 20-30 cm. Од погоре изнесеното може да се констатира дека во однос на содржината на вкупни форми на тешки метали, Тиквешкиот регион е еден од најпроучувани во Република Македонија.


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 влијанието на педогенетските процеси и апсолутната и релативната старост на почвите врз дистрибуцијата на тешките метали по длабочина на профилот.

Материјал и методи


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

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

Истражувано подрачје

Во атарот на с. Тимјаник (Неготинско) на локалитетот Цуцка (Слика 1) на површина од 11 hа е ископан еден почвен профил на регосол (профил 1) и еден профил на рендзина (профил 2). Регосолот и рендзината се образуваат од ис-тата матична стена - лапорец. Испитуваните почви се копани во прелог, а во поблиското минато се одгледувале поледелски култури. Испитуваните почви се распространети на надморска височина од около 210 до 220 m. Резултат на испитуваните почви е брановидно-брдски со инклина-ција 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 Табли 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 i Zn во испитува-
ните почви. За споредба на добиените резултати ке 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 почви е повисока од референтните вредности (освен Хор.C 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 смолниците 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 72,0 mg kg⁻¹ почва (Савиќ и др.1970). 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 127 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 таа 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 највиока 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 почва (Јекиќ и др. 1970) и во циметна шумска почва од неготинско од 24,8 до 48,8 mg kg⁻¹ почва (Јекиќ и др. 1972). Содржина на вкупен манган (344 почвени проби) од 22 до 3100 mg kg⁻¹ почва е констатирана од Stafilov et al. (2010). Содржината на вкупен цинк варира во грацији од 21,37 до 67,77 mg kg⁻¹ почва и е значително пониска од интервентните вредности. Во испитуваните почви содржина на вкупен цинк во вкупот се движи помеѓу 10 и 300 mg kg⁻¹, просечно 50 mg kg⁻¹. Смолниците од Тиквеш соодветно 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), од 24,8 до 32,0 mg kg⁻¹ почва (Савиќ и др.1970), од 24,8 до 32,0 mg kg⁻¹ почва (Савиќ и др.1970), од 682 до 728 mg kg⁻¹ почва (Јекиќ и др. 1970) и во циметна шумска почва од неготинско од 580 до 628 mg kg⁻¹ почва (Савиќ и др.1970). Содржина на вкупен цинк (344 почвени проби) од 28 до 3100 mg kg⁻¹ почва е констатирана од Stafilov et al. (2010). 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

<table>
<thead>
<tr>
<th>Број на профил</th>
<th>Профил длаб. во cm</th>
<th>Вкупна содржина во mg/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Horizon and depth in cm</td>
<td>Cu</td>
</tr>
<tr>
<td>1 (A)p 0-30</td>
<td></td>
<td>38.0</td>
</tr>
<tr>
<td>1 C 30-60</td>
<td></td>
<td>38.7</td>
</tr>
<tr>
<td>1 C 60-74</td>
<td></td>
<td>45.4</td>
</tr>
<tr>
<td>2 Ap 0-35</td>
<td></td>
<td>62.8</td>
</tr>
<tr>
<td>2 C 35-62</td>
<td></td>
<td>18.0</td>
</tr>
<tr>
<td>C/R</td>
<td></td>
<td>36</td>
</tr>
<tr>
<td>Референтни вредности</td>
<td>Referent value</td>
<td>190</td>
</tr>
</tbody>
</table>

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

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<tr>
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<tr>
<td></td>
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<td>36</td>
</tr>
<tr>
<td>Референтни вредности</td>
<td>Referent value</td>
<td>190</td>
</tr>
</tbody>
</table>
Содржината на вкупен бакар и цинк во проф. 1 (регосол) е повисока од хоризонтот Ар 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 Ар на профил 2 е по-висока од хоризонтот Ар на профил 1 што значи дека нема антропогена контаминација. Од Таб. 3 може да се види дека содржината на вкупен бакар и цинк во хоризонтот Ар на профил 2 е повисока од хоризонтот (А)р на профил 1 што се должи на повисоката содржина на хумус и биолошка акумулација во овие тешки метали. Рендината (профил 2) е по-старе по споредба со матичниот супстрат, што значи дека нема антропогена контаминација. Во резултат на тоа, содржината на бакар и цинк во хоризонтот Ар на профил 2 е повисока од хоризонтот (А)р на профил 1 што може да се расцртат кај овие два профила.

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

Во табела 4 е прикажана содржината на достапни форми на бакар, цинк, манган и цинк в одделните почви. Овие тешки метали се неопходни микроелементи во исхраната на растенијата и недостаток може да предизвика пореметување во растот и развојот на растенијата. Спротивно на ова, достапното железо може да живее во течанија на почвата и може да се сеќесе со други микроелементи. Според Savić et al. (1968) смолниците од неколку региони во Република Македонија, корисно 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 обезбеден (Јекиќ и др. 1972).

Според податоците од табелата може да се констатира дека испитуваните почви се средно до многу хидрогенизирани почви.

<table>
<thead>
<tr>
<th>Таб. 4. Содржина на достапни форми тешки метали во некои почви од Неготиноско area</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Број на профил</strong></td>
</tr>
<tr>
<td><strong>Profile No.</strong></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>

Изводи


Марјан Андреевски и сор.


Заклучок

При давање на оценка за антропогена контаминација на почва, поредни се вредностите за содржината на тешки метали во апсолутно и релативно помлади почви. Испитаните почви се одликуваат со висока содржина на глина, високи рН вредности и голема содржина на CaCO₃, што влијае на намалување на достапноста на испитуваните тешки метали.

Литература

Андреевски, М., Цветковиќ, Ј., Попоска, Х., Мукаетов, Д., Петковски, Д., Василевски, К. (2008). Содржина на тешки метали (Fe, Cr и Ni) во ригосолите распространети во околната на металуршкиот регион ФЕ-НИ. Зборник на трудови од III Конгрес на екологите на Македонија со меѓународно учество. Струга, 06-09.10.2007. Македонско еколошко друштво, Скопје, 375-380.


Савиќ, Б., Јекиќ М. (1970): Содржина на манган,
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 CaCO₃ 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 pedogenetically older soil than regosols) in comparison to the cultivated top soil of regosols as a result of the biological accumulation of heavy metals.
THE BIOACCUMULATION OF SOME METALS IN SOIL AND SPECIES *Stachys recta* L. AND *Stachys scardica* (Griseb.) Hayek ON ONE SERPENTINE LOCALITY (SERBIA)

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¹University of Kragujevac, Faculty of Science, Institute of Biology and Ecology, 34000 Kragujevac, Serbia; ²Agriculture Research Institute Serbia, Small Grains Research Center, 34000 Kragujevac, Serbia

Abstract


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 serpinophilous.

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 provides a more comprehensive knowledge of the systematics, distribution, ecology and environmental adaptations, and
The bioaccumulation of some metals in soil and species Stachys recta L. and Stachys scardica (Griseb.)...

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 105°C 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.).
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 3427.435-5261.595 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 5261.595 to 35709.918 mgkg⁻¹ d.m. The mean concentrations of Mn in plant samples varied from 113.494 to 140.813 mgkg⁻¹ d.m. and in soil it 288.863 mgkg⁻¹ d.m. The content of Cu varied from 1.407 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 11.600-39.542 mgkg⁻¹ d.m. in plant samples and in soil the concentration of Ni was 23.124 mg Zn kg⁻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.

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 comparison 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≤0.001) existed in the content of metals between soil samples and investigated species, as well as between investigated species.

### Table 1. The mean concentrations 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*

<table>
<thead>
<tr>
<th></th>
<th>Ca</th>
<th>Mg</th>
<th>Fe</th>
<th>Mn</th>
<th>Cu</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOIL</td>
<td>1109.08±6.139</td>
<td>59603.58±312.001</td>
<td>35709.91±320.899</td>
<td>288.86±3.678</td>
<td>6.10±0.295</td>
</tr>
<tr>
<td>STREC</td>
<td>3427.43±17.711</td>
<td>5261.59±29.486</td>
<td>113.49±1.290</td>
<td>14.06±0.105</td>
<td>3.50±0.018</td>
</tr>
<tr>
<td>STSCA</td>
<td>4610.41±23.099</td>
<td>2889.16±27.734</td>
<td>140.81±1.459</td>
<td>34.31±0.465</td>
<td>4.14±0.108</td>
</tr>
<tr>
<td></td>
<td>Zn</td>
<td>Ni</td>
<td>Pb</td>
<td>Cd</td>
<td>Co</td>
</tr>
<tr>
<td>SOIL</td>
<td>23.12±0.147</td>
<td>931.49±23.773</td>
<td>13.20±0.085</td>
<td>1.407±0.006</td>
<td>33.64±0.085</td>
</tr>
<tr>
<td>STREC</td>
<td>11.81±0.112</td>
<td>39.54±0.297</td>
<td>3.69±0.277</td>
<td>0.02±0.002</td>
<td>0.18±0.004</td>
</tr>
<tr>
<td>STSCA</td>
<td>17.94±0.135</td>
<td>11.60±0.090</td>
<td>0.20±0.012</td>
<td>0.01±0.001</td>
<td>0.31±0.004</td>
</tr>
</tbody>
</table>

Tab. 1. The mean value (n=6) ± standard deviation; SOIL – soil; STREC – *S. recta*; STSCA – *S. scardica*
The bioaccumulation of some metals in soil and species *Stachys recta* L. and *Stachys scardica* (Griseb.)...

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 indicating that 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 is very 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)
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 localit 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 Fe3+ 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 (Ghaderi 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;
various soils ranged 2-200 mgkg⁻¹. Our results are 
Kabata-Pendias (2001) reported that Pb levels of 
tributing to the natural content (Bech et al. 2008).

and also from species to species within a genus. 
accumulation of pollutants vary from plant to plant 
lower parts of the trichome pedicle. The uptake and 
leaves (Ghaderian et al. 2007). Nickel is mainly 
ment of Ni in their above-ground parts, especially in 
of Ni in their above-ground parts, especially in the 
(Ghaderian et al. 2007). Nickel is mainly 
stored in the leaves, and is particularly concentrated 
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-Álvarez 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 toxicity, 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 cadmi- um 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 re-
results were described by some authors (Robinson et al. 1997; Reeves et al. 2007). Cobalt frequently in-
teracts antagonistically with Ni, Fe and Mn in plants, and antagonistic interaction between Ni and Co are 
observed for some species under specific experimen-
tal conditions (Tappero et al. 2007). These fac-
tors 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 ob-
tained 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% (Za-
yed 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 miner-
al, 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 up-
take of essential metals for plants metabolism. Ac-
cording to Reeves and Baker (2000), the normal val-
cues of Cr in plants is 2-5 mgkg⁻¹. However, our find-
ings showed that Cr concentrations in plants ranged 
from 1.346 to 1.879 mgkg⁻¹, which are in accord-
ance 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 bioavaila-
bility of plants is influenced by various factors, such 
as pH, temperature, redox potential, chemical speci-
ation, 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 spa-
tial and temporal contamination (Keshav et al. 2011). 
The content of metals in the soil depends on numer-
ous factors, such as: specific ability of some plants 
to over-accumulate various toxic metals, chemical 
and physical characteristics of soil and metal inter-
actions.

An organism is expected to reflect environmental 
pollution if it has the ability to take up elements proportionally to their concentration in the environ-
ment (Ravera et al. 2003). This study exhibited dif-
ferent metal concentration in investigated plant spe-
cies, depending on kind of metals and plant spe-
cies. 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 environment with 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 content of eleven metals in species S. recta and S. scardica 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 showed 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.

Acknowledgements

This investigation was supported by the Ministry of Science and Technological Development of the Republic of Serbia (BTR 31054). The authors are thankful to colleagues from the Institute of Public Health Division of Hygiene and Medical Ecology in Kragujevac for help in chemical analysis of soil and plant samples, as well as and to colleagues from Geological Institute of Serbia.

References


Chaney, R.L., Chen, K.Y., Li, Y.M., Angle, J.S.,


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

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Апстракт


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 одговорни 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.

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

Abstract


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.
Нивото на еколошкото образование кај учениците од средните училишта во Република Македонија

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 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 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.

Резултати и дискусија

На тествот 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 одговара на следниве прашања: Кој предизвикува глобално затоплување на биосферата (56.46%), Преку кои процеси се произведуваат органски материја во природата (54.33%). Што е популација (53.40%). Како ги делиме организмите според начинот на исхрана во природата (52.85%) 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, 2005 в итн.).
Миле Србиновски и сор.

Според резултатите од скалата на вреднос-
tи можеме да констатираме дека испитаници-
te се позитивно еколошки определени. Карак-
tеристично е дека ниту за едно тврдење испита-
ниците немаа просечен 5 боди, а од друга страна-
pак, за 6 тврдења просечните бодови се под-
4. Најголем број испитаници главно и сосема се-
служуваат со тврдењето “Заштитувајќи ја при-
родата, се заштитуваме самите себе си и нашите-
pоколенија” (аритметичка средина 4,15) што збо-
рува за високо вреднување на еколошката рам-
нотежка како предуслов за опстанок на човекот.
Најголем дел од ученицито воцувот го сметаа за-
најдоговорен фактор за заштита на животнота-
средина, а тоа се забележува од аритметичка-
tа средина за предпоследното тврдење “Човекот е
најдоговорен фактор за заштита на животната
средина” која изнесува 3.91. Така би го издвоиле
високот проценат на испитаници кои сосема или
оглавно со тврдењето “Природата е наше заедничко
богатство и затоа треба да се грижиме за неа” чија
аритметичка средина изнесува 3.79. Радува податокот дека поголем дел од
ученицито сметаат дека развојот на општеството
е поврзан и зависен од тоа како ние се однесува-
ме кон животната средина. Тоа имплицитно збо-
рува дека младите го респектираат и прифаќаат
концепот за одржлив развој. Затоа тие го оцениле
високиот процент на испитаници кои сосема или
воглавно се сложуваат со тврдењето “Не треба да се штедат сред-
ствата кога е во прашање заштитата на околината” со аритметичка средина 3.73.

Загрижува малиот проценат на ученици кои
правилно го вреднуваат тврдењето “Напредокот на
човештвото се огледа во тоа колку човекот ја
искористил природата”. Според резултатите од скалата на задовол-
ство, ученицито најмалку се задоволни од одно-
сот на надлежните органи и институции (аритме-
tичка средина 2.23), чистотата на реките (воопш-
то не задоволни – 46.49%, главно незадоволни
29.96%, аритметичка средина 2.25). Потоа следу-
ваат грижата на државата за природата во прак-
сата (воопшто не задоволни – 36.78%, главно неза-
dоволни 20.66%, аритметичка средина 2.28).) и
чистотата на воздухот (воопшто не задоволни –
29.34%, главно незадоволни 31.20%, аритме-
tичка средина 2.34).

Испитаницито најмногу се задоволни од
квалитетот на храната (воопшто незадоволни–
12.19%, главно незадоволни 22.52%, аритме-
tичка средина 2.51). Потоа, од уреденоста на
туристичките места (воопшто не задоволни –
15.91%, главно незадоволни 17.98%, аритметич-
ка средина 2.88), чистотата на училиштето и учи-
лишкиот двор (воопшто не задоволни – 27.07%,
главно незадоволни 29.96%, аритметичка среди-
на 2.25), квалитетот на водата за пиене (воопш-
то не задоволни – 28.31%, главно незадоволни
24.79%, аритметичка средина е 2.49) итн.

Врз база на добиените резултати од Скалата на
активи-нација можеме да констатираме дека по-
големиот дел од ученицито се подготвени актив-
но да учествуваат во заштитата и унапредување-
то на животната средина во која живеат. Повеќе-
tо од половината испитаници (56%) се изјасниле
дека се подготвени колективно да се ангажира-
ат во активностите за заштитата и унапредување на нивната
животна средина. Од друга страна пак, не е мал
и проценат на ученици кои имаа индиферен-
tан однос (12.85%). Тоа значи дека ове ученици
не сакаат да учествуваат во заштитата, бидејќи се
бара одредена активност. Со други зборови, нив-
nата акциона подготвеност е пониска од она што
општеството го бара.

На Слика 1 е прикажана еколошката едуци-
раност на ученицито во поглед на сите 4 испиту-
вани параметри.

Сл. 1. Нивото на еколошката едуцираност на
ученицито.

Fig. 1. Students’ level of environmental
education.
Забележуваме дека ки испитаниците нај- силио се развени вредносната и конативната компонента, а најслабо се развени 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 компаративата на добиените вредности со оните добени 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 оните добени од предходното истражување. Најголем пад забележуваме кај вредносната и когнитивната компонента на еколошката едуцираност. Од друга страна, незначително пониски вредности добивме во поглед на афективната и конативната компонента.

На следната слика е прикажана просечната еколошка коспособност на учениците во испитуванот 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 освоија 34.71% од максималниот број можни поени. Според субјективна проценка на испитаниците, знаењата на учениците од областа на екологијата се на ниво “се секавам дека нив сум ги учел” и “имам чувство дека нив ги зnam но не можам да ги искажам”, односно истите ги усвојуваат до степен на препознавање.

Средното ниво на задоволство од качествот на животната средина изнесува 2.46. Учениците најмалку се задоволни од подобро 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 гржитата на државата за природата во прокаса (воопшто не задоволни – 36.78%, главно незадоволни 20.66%, аритметичка средина 2.28). Тие се најмногу задоволни од квалитетот на храната (воопшто не задоволни– 12.19%, главно незадоволни 22.52%, аритметичка средина 2.51) и од уредноста на туристичките места (воопшто не задоволни – 15.91%, главно незадоволни 17.98%, аритметичка средина 2.88).

Поголемиот дел од учениците се подготвели активно да учествуваат во заштитата и унапредувањето на животната средина во која живеат. По-веќето од половината (56%) испитаници се подготвили колективно да се ангажираат во активностите за унапредување на нивната животна сердина. Процентот на ученици кои имаат индиферентен однос изнесува 12.85%.

Кај наште ученици најсилно се развени вредносната и конативната компонента, а најслабо се развени 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 оните добени 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.
Референции


Донуши, И., Исмаили, М., Србиновски, М. & Зенки, В. (2009). Когнитивната еколошка компонента кај учениците од средното образование, Реафировање на воспитната функција на училиштата, Зборник на трудови од тематска расправа, Дом на просветните Работници, Педагошки факултет Св. Климент Охридски и Филозофски факултет (Институт за педагогија), Скопје, 159-162.

Донуши, И. (2009). Еколошката едуцираност на средношколците во Република Македонија, Магистерска работа, Универзитет на Југоисточна Европа, Тетово.


Србиновски, М., Исмаили, М. & Абази, А. (2009b). Проблемите и дилемите на воспитанието за животна средина, Реафирира-ција на воспитната функција на училиштата, Зборник на трудови од тематска расправа, Дом на просветните Работници, Педагошки факултет Св. Климент Охридски и Филозофски факултет (Институт за педагогија), Скопје, стр. 64-69.


Srbínovski, Mile, Murtezan Ismaili & Alajdin Abazi (2011). The trend of the High School Students' Level of the Environmental Knowledge in the Republic of Macedonia, 3rd World Conference on Educational Sciences, Abst-

ЕКОЛОШКИ СОДРЖИНИ ВО УЧЕБНИЦИТЕ ЗА СРЕДНО ОБРАЗОВАНИЕ ЗА РЕПУБЛИКА МАКЕДОНИЈА

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Извод


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. Без 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.

Ключни зборови: еколошко образование, еколошки содржини, учебници, средно образование, Република Македонија.

Abstract


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, основан извор на знаење наменет за учениците (Вилотијевиќ, 1999). Развојот на егзактната проблематизација на современиот учебник од една страна укажува на евидентнатата 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).

Главната 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. Важното потребно треба да овозможи т.н. оперативно знаење и способност за самообразование.

Учебникот мораме и понатаму да го разгледаме 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 самото претставува изразит променлив фактор (Erceg 1982).

За нас беше значајно да утврдиме колку денешните учебници придонесуваат на полето на еколошкото образование и воспитание. Исто тоа беше установлено во истражувањето на анализираните 43 учебници од средното гимназиско образование во Република Македонија (Таб. 1).

Таб. 1. Анализирани учебници по наставни години.

<table>
<thead>
<tr>
<th>Наставна година</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>11</td>
<td>25.58</td>
</tr>
<tr>
<td>II</td>
<td>12</td>
<td>27.91</td>
</tr>
<tr>
<td>III</td>
<td>9</td>
<td>20.93</td>
</tr>
<tr>
<td>IV</td>
<td>11</td>
<td>25.58</td>
</tr>
<tr>
<td>Вкупно/Total</td>
<td>43</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Забележуваме дека процентот на анализирани учебници по класови скоро е издаден и се движи во границите од 20.93% до 27.91%.

Резултати и дискусија

Од вкупни 11 анализирани учебници за прва година, еколошки содржини проназадове само во учебниците по биологија и географија. Во следната табела се прикажани еколошките поними и содржини кои се обработуваат во овие учебници.

Еколошки содржини не проназадуван в учебниците по следните наставни предмети: хе-

Таб. 2. Еколошки поними и содржини во учебниците за прва година.

<table>
<thead>
<tr>
<th>Наставен предмет Subject</th>
<th>Поними/Содржини Terms/Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Биологија Biology</td>
<td>- еколошки фактори; користење на електричната енергија и обновливи извори на енергија.</td>
</tr>
<tr>
<td>Географија Geography</td>
<td>- еколошки фактори; користење на електричната енергија и обновливи извори на енергија.</td>
</tr>
</tbody>
</table>
мија, француски јазик, информатика, физика, англиски јазик, спорт и спортски активности, македонски јазик и литература, математика и историја.

Еколошки содржини пронајдени во учебниците по следниве предмети за втора наставна година: географија, биологија, физика, хемија, социологија, англиски јазик, германски јазик и литература (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 пронајдени еколошки содржини во учебниците по следниве предмети: социологија, англиски јазик, француски јазик, информатика, физика, хемија, социологија, англиски јазик, германски јазик и литература.

Во следната табела се прикажани учебниците за трета наставна година во кои пронајдени еколошки содржини.

Еколошки содржини не пронајдени во учебниците по Македонски јазик и литература, Историја и Латински јазик за трета наставна година.

Во истражувањето анализирано вкупно 11 учебници за четврта наставна година од средно-то гимназиско образование. Од аспект на застаненост на еколошки содржини би издвоиле следниве наставни предмети: биологија, физика и филозофија (Таб. 5). Кога сме кеј биологија, сакаме да истакнеме дека содржините од овој наставен предмет се во основа повторување на оние од предходните години, со одредени измени и дополнувања. Оттука, еколошките содржини во голема мера се исти со оние од прва наставна година.

Во учебниците по следниве наставни предмети не пронајдени еколошки содржини: македонски јазик и литература, математика, логика, научност, алгебра, математички анализ, програмски јазици и економија.


Заклучоци

Од вкупно 43 анализирани учебници, еколошки содржини/елементи пронајдени во 18 учебници или 41.86%. Не постои рамномерна дистрибуција на еколошките теми по предмети и класови, ниту хоризонтална и вертикална повзаоност, 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%) наставна година.

Таб. 3. Еколошки поими и содржини во учебниците за втора година.

<table>
<thead>
<tr>
<th>Наставен предмет</th>
<th>Поими/Содржини</th>
</tr>
</thead>
<tbody>
<tr>
<td>Биологија Biology</td>
<td>- фотосинтезата и еколошките фактори; реакција на дразбите од животната средина.</td>
</tr>
<tr>
<td>Географија Geography</td>
<td>- 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 шумското фонд; значењето на пошумувањето ; заштита на шумите.</td>
</tr>
<tr>
<td>Физика Physics</td>
<td>- защита 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.</td>
</tr>
<tr>
<td>Хемија Chemistry</td>
<td>-значењето на фотосинтезата за животот свет; ефект на стаклената градина; озонски слој и озонски дупки; мерки за заштита.</td>
</tr>
<tr>
<td>Социологија Sociology</td>
<td>демографска структура; развој на техниката и технологијата; експлоатација на природни ресурси; пренаселеност; човечка негрижа; нарушување на еколошките системи; хумана екологија; подигање на еколошката свет; загрозени видови; животната средина (природна и социјална); урбан живот; општествена организација.</td>
</tr>
<tr>
<td>Англиски јазик English</td>
<td>употреба на велосипед; сообраќајот и животната средина; ефектите од загадувањето врз климата и здравјето; озон; начини за подобрување на животната средина; претрпени акоци; контрола на туристичко подрачје.</td>
</tr>
<tr>
<td>Германски јазик German</td>
<td>шума; пожар; уништување; жив свет.</td>
</tr>
<tr>
<td>Наставен предмет</td>
<td>Subject</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Биология Biology</td>
<td>- ефектот и загаѓувањето на воздухот врз здравјето; ефектот на бучавата.</td>
</tr>
<tr>
<td>Физика Physics</td>
<td>- дејството на бучавата врз човековит организам и заштита на човековата околнина од бучава; ултравиолетно зрачење; озон; &quot;чиста енергија&quot;; нуклечен отпад; апсорбирана доза на зрачење и нејзино биолошко дејство; критериуми за заштита од изворите на јонизирачкото зрачење; гранични вредности на дозволени дози; заштита на паметниот ризик; фон; организирање акција за собирање на пластични отпад; ефектот на полимерите врз животната средина; енергетски ефикасна градба.</td>
</tr>
<tr>
<td>Хемија Chemistry</td>
<td>- предностите на земнатот гас од еколошка гледна точка.</td>
</tr>
<tr>
<td>Педагогија Pedagogy</td>
<td>- техника и технологија; производство; односот кон природата; социјална средина и конфлиkti; катализма; еколошки фактори (абиотички; биотички и антропогени); демографски карактеристики; разградување на дивите екосистеми; уништување на шумите; загаѓување на светскиот океан; засолување и ерозија на почвите; загрозување на атмосферата; климатски промени; карактеристики на екосистемите; биохемиски циклуси; кисели дождови; природни ресурси.</td>
</tr>
<tr>
<td>Филозофија Philosophy</td>
<td>судир со природата- нерационално користење на ресурсите; загаѓување; енергија; демографски прираст; сечење на шумите; сообраќај; губре; пластика; нуклена енергија; генетски модификациона храна; биоверзеритет; последници од загаѓувањето врз здравјето (психички растројства); свет; одговорност; (одговорно) однесување; етика на здравјето; етика на исхраната; етика на употребата на животните; етика на наука; етика на староста; етика на природата; бучава; генетски инжењеринг; клонирање; емпатија; разбирање; загриженост и грижа; етика на еколошката средина; еколошка философија или екософија; норми на екоетика итн.</td>
</tr>
<tr>
<td>Физика Physics</td>
<td>животна средина; природна сфера (екосфера; геосфера); техносфера; биосфера; демографски прираст; индустриско и земјоделско производство; прекумерно користење на ресурси; деградација; рамнотежа во биосферата; сообраќај; загаѓување на животната средина; исчезнување на видовите; биоверзеритет; загаѓување на здравјето.</td>
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<td>фотосинтеза (значење); организација на Земјата; општи услови за живот; нива на еколошката интеграција; еколошки фактори (абиотички; биотички и антропогени); демографски карактеристики; разградување на дивите екосистеми; уништување на шумите; загаѓување на светскиот океан; засолување и ерозија на почвите; загрозување на атмосферата; климатски промени; карактеристики на екосистемите; биохемиски циклуси; кисели дождови; природни ресурси.</td>
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| 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; загаѓување на животната средина; исчезнување на видовите; биоверзеритет; загаѓување на здравјето; етичка на сообраќајот; етичка на неизјаснетото; етичка на природата; бучава; генетски инжењеринг; клонирање; емпатија; разбирање; загриженост и грижа; етика на еколошката средина; еколошка философија или екософија; норми на екоетика итн.
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 географија, педагогија, социологија и филозофија. Од природни науки, најмалку еколошки содржини пронајдоме во учебниците по хемија. Иако во мала количина, еколошки елементи пронајдоме и во учебниците по англиски и германски јазик.

Од аспект на сегментите на животната средина, доминираат содржини за природната животна средина, организацијата на живата матерija, 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), резултira со констатациjата дека во нив се проучува и општествениот аспект на животната средина.

Литература


РУДНИЧКИ ДРЕНАЗИ И ПОСТАПКИ ЗА НИВНО ТРЕТИРАЊЕ

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Апстракт


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 алкали 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 пасивното третирање 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.

Ключни зборови: руднички дренажи, тешки метали, пасивен третман, активен третман

Abstract


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, соодветно, може да се формира ширум области каде што постојат рударски активности или пак од карпести области богати со пирит (FeS2). Рудничката дренажа, која најчесто е кисела, доаѓа од области каде што постоеле рударски активности или пак од карпести области богати со пирит (FeS2). Како резултат на реакцијата помеѓу пиритот, водата и воздухот се добива сулфурна киселина и растворено железо. Ова железо, целосно или делумно, може да се истапи 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, живе, 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, рН < 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 се содржат водите со рН < 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 фера железо (Fe2+) и Mn, без или со ниска содржина на кислород и рН > 6,0. Пораснетите вредности на рН потенцијалот на овие води значително опаѓаат 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 фера железо (Fe2+) и Mn е ниска до средна, без или со ниска содржина на кислород, рН > 6,0 и алкалноста е повисока од киселоста. Пораснетите вредности на рН потенцијалот на овие води значително опаѓаат и преминуваат во кисели руднички дренажи од Тип 1;
- Тип 4 - Неутрализирани кисели руднички дренажи со рН > 6,0 и високи концентрации на вкупно суспендирани цврсти честички. Таложењето на металните хидроксиди во водата има лаком период на престој во таложникот, честичките се исталожуваат и се формираат води од Тип 5;
- Тип 5 – Неутрализирани кисели руднички дренажи со рН > 6,0 и високи концентрации на вкупно растворени цврсти честички. Откако повеќето метали метални хидроксиди ќе преципитираат во таложникот, главни катаони кои што остануваат во водата со високи концентрации вообичаено се растворени Ca и Mg. Типот 5 е претпоставен за водите кои се формираат од рудни дренажи со биокатализам без или со ниска количина на карбонати. Вообичаено имаат неутрална вредност на рН 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 рН вредноста, состојбата со киселоста и концентрацијата на карбонатите и фера железо (Fe2+). (Kimmel, 1983). Алкалните руднички дренажи со ниска концентрација на метали имаат слабо забележителен ефект врз водениот свет. Вкупниот ефект зависи од концентрацијата на растворените метални хидроксиди, вкупната концентрација, рН и количината на дренажата, како и од протокот, рН и алкалноста на преминатата вода. Пораснетите вредности на рН и алкалноста на преминатата вода значително преминуваат во кисели руднички дренажи од Тип 1;
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 руднички дренажи, кој вклучува додавање на хемикалии – неутирализирачки агенси (Coulton et al., 2003).

Типичниот активен третман вклучува оксидација на киселата рудничка дренажа, неутрализација (додавање на алкали) и седиментација (додавање на коагуланти и флокуланти). Оксидацијата е важна бидејки со неа се внесува кислород во дренажата, кој е неопходен за таложење на металите при нiska 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 тина која поброи се таложи во таложникот. Големата густина на тината е поволна бидејки 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 около 10 mg/l O2 може да се раствори 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 усвоене во системите за третман на водите, ефикасноста на хемискот 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

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Сл. 1. Шема на активен третман
Fig. 1. Scheme of active treatment
што растворените метали во водата ќе образуваат нерастворливи метални хидроксиди и ќе преципитираат од водата потребно е додавање на дополнителна 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.

<table>
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<th>Хемиска формула</th>
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<td></td>
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<td>Калциум хипохлорит</td>
<td>Ca(ClO)₂</td>
<td>Јак оксидант</td>
</tr>
<tr>
<td>Натриум хипохлорит</td>
<td>NaClO</td>
<td>Исто е Јак оксидант</td>
</tr>
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<td>Калциум пероксид</td>
<td>CaO₂</td>
<td>Трапзен, неутрализатор на киселоста</td>
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<td>Водороден пероксид</td>
<td>H₂O₂</td>
<td>Јак оксидант</td>
</tr>
<tr>
<td>Калциум перманганат</td>
<td>KMnO₄</td>
<td>Многу ефикасен, општо употребуван</td>
</tr>
<tr>
<td>Неутрализатори на киселоста</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Баровнички канали</td>
<td>CaCO₃</td>
<td>Се користат каде безкиселородните баровнички дренажи и каде отворените баровнички канали.</td>
</tr>
<tr>
<td>Водороден пероксид</td>
<td>H₂O₂</td>
<td>Рентабилен реагент, но потребно е мешање.</td>
</tr>
<tr>
<td>Негасена вар (калциев оксид)</td>
<td>CaO</td>
<td>Многу реактивен, потребна мerna опрема.</td>
</tr>
<tr>
<td>Натриум карбонат</td>
<td>Na₂CO₃</td>
<td>Систем за оддалечени локации, но е скап.</td>
</tr>
<tr>
<td>Натриума оксид</td>
<td>NaOH</td>
<td>Многу раборовлив, може да биде во цврста и течна форма. Поета е во течна форма.</td>
</tr>
<tr>
<td>Амониак</td>
<td>NH₃ или NH₄OH</td>
<td>Многу раборовлив и растворлив.</td>
</tr>
<tr>
<td>Летечка пепел</td>
<td>CaCO₃, Ca(OH)₂</td>
<td>Вредноста на неутрализацијата варира со секој производ.</td>
</tr>
</tbody>
</table>

Таб. 1. Хемикалии за оксидација, неутрализација и коагулација/флокулација

(извор: Skousen et al., 1998)

- **Флокуланти / коауланти**

Коаулантите и флокулантите се користат за зголемување ефикасноста на таложење на честичките на површината. Промовирајќи ја коонсолидацијата на малите честички во пополнени честички. Флокулацијата ги агрира или комбинира честичките со премостување на просторот помеѓу честичките со хемикалии. Премостувањето се јавува кога таа сепак сегменти од линицата на плочката ги ампунираат сусепедираните честички, формирајќи пополни честици.

- **Технологија за пасивен третман**

Моделирањето на пасивните системи е зачувано според природните мочуришта и други природни процеси, примена коаулантите и флокулантите за пречистување на продукциите на лацети на плочката ги ампунираат сусепедираните честички, формирајќи пополни честици.
темот за третирање, а не кај приемот на водата.

Основните пасивни технологии се поделени на: конструиран мочуришта (аеробни и анаеробни), системи со вертикален проток (системи за производство на сукцисивна алкалност и системи за редукција и производство на алкалност), безкислородни варовнички дренажи, варовнички базени и отворени варовнички канали.

- Конструиран мочуришта

Начинот на кој што се конструиран мочуриштата влијае на начинот на третман на водата. Доминираат два вида на конструкција: 1) “аеробни” мочуришта кои што содржат Turha (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 Turha (барски трски) и друга мочуришна вегетација засадена во длабоките (>30cm), порозни седименти кои што опфаќаат почви, тресет, компост во кој што имало печурки, дрвени стротогити, слама, губриво, сено или други органски смеси, над подлога или измешиени 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. Примерната функција на овие системи е да се овомогнат аерација на рудничките води кои течат низ вегетацијата, оксидација на раствореното железо и да обезбедат време за задржување, каде што водата се забавува за да преципитираат железните оксиди. Бидејќи преципитацијата на Fe генерира Н⁺, 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 кисели води и значителна преципитација на растворените метали. Ова вклучува додавање на подлога од варовник и органска материја која го поттикнува генерирањето на алкалност како бикарбонат (HCO₃⁻). Редукцијата на сулфатите е микробиолошки процес кој се јавува во безкислородни услови, кога се присутни сулфати и биоразградливи организми. Сулфато-редуцирачките бактерии го користат кислород-
дот кой навлегол во безкислородната околина ка-ко компонента на сулфатот (SO₄²⁻) за метаболич-ките процеси на биоразградливите организми, то го трансформираат сулфурот или до гасна фаза (H₂S) или до сулфид во цврста фаза.

- Анаеробните моучуришта се во состојба да ги отстранат металите кои што се растворени во киселина (посебно Fe и Al), како и да гене-рираат алкалност. Нивната ефикасност е ограни-чена од бавното мешање на водите од алкални-от супстрат со киселите води близу површина-та. За овие системи често пати е потребна голе-ма површина и долго време на задржување. Како и кај другите системи за пасивен третман нивна-та ефикасност за отстранувањето на Mn е огра-ничена, 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 кисло-род. На тој начин е оновможена оксидацијата на металите и образувањето на варовнички нас-лаги. Варовникот се растворува 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 киселите води. PVC мембраната најчесто се поставува над варовни-кот за да го ограничи пристапот на киселите руднички дренажи и аерированата вода.. Целта на долниот дел на безкислородните варовнички дренажи е да обез-беди алкалност и на тој начин киселата вода да ја трансформира во алкална. Задржувки се ја-гледородниот диоксид во водите се подобруваат разтворливоста и производство на варовникот. Задржувки ја притискаат водата под влијание на варовникот. Задржувањето на варовникот се постави над варовникот за да се ограничи пристапот на киселите води. Основните делови на системот се: варовничкиот слој и органскиот слој. Органскиот слој е поставен во водопропуско-басен, а во варовничкиот слој е поставен хидрант за контрола на нивото на водата, за да се обезбеди поплавеност со варовникот. Системот е конструиран за филтрирање од страна на аеробни-те бактерии кои ги користат бикарбонатите за производство на алкалност. За овој тип на системи е потребна специјална таложница, за да се задржуваат разтворувањата на металите.
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лоност, количината на проток, специфичните видови и концентрацијата на метали во водата, стапката и степенот на потребниот хемиски третман и посакуваното формално квалитет на водата. Економскиот фактор ги вклучува цената на реагенците, работната рака, механизацијата и опремата, потребниот период (години) за кој ќе биде неопходен третманот, отстранување и одложување на опаднатото тало, каматната стапка и факторите на ризик.

За да изврши селекција на систем за активен третман, операторот мора да го одреди протокот на опаднатите води, pH, вкупно суспендираните цврсти честички (TSS), киселост/ алкалност во mg/l како CaCO₃, концентрациите на тежките 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 воолуменот 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 альтернативните системи за активен третман.

При дизајнирањето на пасивниот третман потребно е да се окарактеризираат водите кои ќе се третираат, односно треба да се направи мереже 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 предnost во однос на активните системи.

Почетните трошоци кај пасивниот третман може да бидат повисоки одколку кај активниот, но бидејќи користат процеси кои не се оперативно интензивни, вкупните трошоци за нив се помали (Fripp et al., 2000). Активниот третман е поскак процес како резултат на трошоците за опрема, хемикалиите кои се применуваат и учестото на работната сила (Skousen et al. 1998). Освен тоа овој процес е долгорочен и претставува тројца обврска.

Референции


ИЗВОД


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 лимнологски методи. Истражувањата показаа дека концентрацијата на азотните форми во акумулацијата „Стрежево“ во двегодишниот циклус значајно варираат како резултат на различни концентрации на влезот во акумулацијата, ефектот на фотосинтетската активност, како и од разложувањето на белковинските материји од растително и животинско потекло. Констатирани се 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.

Ключни зборови: Акумулација „Стрежево“, нутриенти, еутрофикација, вкупен фосфор.

Abstract


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
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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 оните наменети за водоснабдување, долго се центар на интересињето на голем броj 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 матери во акумулациите и површинските води, е важен лимитирачки фактор за појавата 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 матери, се основан предуслов за правилно и успешно управување со повеќето водења кои по својот тек минуваат низ подрека со комунални и промишлени води, рурални подреци кои се оптеретени со современи средства за заштита на растенијата. Дел од тие опадни контаминенти дотекуваат во реката р. Шемница, 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 1 со сезонска динамика од седум места од три профили; влив на р. Шемница, централен дел и дел во близина на кула зафаат.

Вкупниот фосфор е одредуван како ортофосфат (Strickland & Parsons, 1972), после кисела дигестија со персулфат и спекулар настрои 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. Основните ортофосфати се отчитуваат спектрофотометрично на 885 нм 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 амониак, а по тоа како амониак се одредува спектрофотометрично на 640 нм бранова должина (Strickland & Parsons, 1972). Резултатите се отчитувани на спектрофотометар марка Perkin-Elmer, модел

Сл. 1. Акумулација „Стрежево“
Fig. 1. Reservoir “Strezevo”
Соња Георгиевска и Елизабета Велјаноска-Сарафилоска

Зборник на трудови од IV Конгрес на еколозите од Македонија

Colleman. Вкупниот азот претставува збир од редуцирачки форми (органски + амонијачки) и оксидирачки форми (нитритни + нитратни). При тоа органскиот и амонијачниот азот се одредуваат со спомнатата Kjeldahl метода, а нитратниот азот со сулфанил амид и нафтил етилен диамин дихидрохлорид, при што се добива обогатен комплекс чиј интензитет (во зависност од концентрацијата) се отчитува спектрофотометрички на веќе спомнатото спектрофотометар. Овој нитратен азот прво се редукува преку Cd-колоноана до нитритни, а потоа се одредува како нитритна форма.

Резултати и дискусија

Голем број хемиски елементи ги потпомага-ат или потиснуваат биохемиските реакции било по некои од ендоконтролни карактеристики на клетките или во медиумите во кои опстануваат. Еден таков незаменилив хемиски елемент кој често е ограничуваач во оживувањето на примарната продукција на акватичните екосистеми е фосфорот. Зависно од степенот на загадување, фосфатните можат да бидат присутни во значително високи концентрации кои потекнуваат од употребените средства за перење, детергенти или ѓубри во земјоделството. Не е ништо невообичаено да притоките кои минуваат низ неколку населби да донесуваат толку само органски материја и неколку животни, кои се евоцираат во земјоделството. 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 се донесуваат." За примарните продукенти, 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 ги графичките прикази на содржината на вкупниот фосфор, може да се заклучи дека концентрацијата на фосфорот е регистрирана во летниот период од 2011 година и изнесува 3,43 μg/l (површинската вода кај зафатна кула). Највисоката концентрација на вкупен фосфор е регистрирана во летниот период од 2011 година и изнесува 26,16 μg/l во истиот дел на длабочина од 8 m.


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 мешањата се извршило.

Споредувајќи ги сезонските концентрации на вкупен фосфор сезонски, може да се констатира дека тие се значително повисоки во зимскиот период, што најверојатно резултира со процесот на микирење, т.е. мешање на водната маса, при што доаѓа до збогатување и на погорните слоеви со нутриенти.
Нутриентен режим во водата од акумулацијата „Стрежево“

Сите овие вредности укажуваат на фактот дека одлеко 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 општинот аналитички интерес ги содржи растворениот и партикуларниот азот, кои се во различни редуцирани форми раниграани од обични амино киселини до комплексни протени, во живите и во мртвите ткива и продукти на ткивата; амонијакот кој е најмногу во редуцирана форма и е продукт на органско-то распадање, па нитритите и нитритите кои се оксидирани од нитрификацијата (бактериската оксидација на амонијакот)“. Изворите на азот се многуброjni. Во сировата вода неговиот состав е варијабилен во облик на вкупен N, NH₄, NO₃, NO₂ и органски азот. Со разградувањето на органсите матери 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 не биле во доменот за „азотниот метаболизам во водата“ (Yasushi et al., 1990). И Goldman (1993), истакнува дека во акуватичните системи, главните форми на азот доступни 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 слика 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 вливател на река Шемница во акумулацијата (лето 2010 година; 25,54 μg/l). Тоа е разбирливо со оглед на големото присуство на аллохтонни матери во акумулацијата од краварските формации кои се наоѓаат во непосредна близина на вливателот. Но ваквото големо количество на амонијачен азот значително се намалува одејќи кон следниот профил, површинската вода во централниот дел кога концентрацијата 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 летото 2010 година се издвои голем пик во концентрацијата на амонијачен азот (73,09 μg/l) во површинската вода во централниот дел. Сето ова е резултат на минерализацијата на органсите матери во летниот период при висока температура како на водата, така и в воздухот.

Како помалку застапени форми на неоргански азотни соединенија, нитритите, како нитритен азот во акумулацијата „Стрежево“ се претставени на Слика 4. Нитритите воовсепо не се евидирани и во голем број примероци во различни сезони. Нитритот содржи NO₂⁻ - N е измерен во летото 2010 година (6,222 μg/l на 20 m деб-
Соња Георгиевска и Елизабета Велјаноска-Сарафилоска

Зборник на трудови од IV Конгрес на еколозите од Македонија

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 го-лем 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 - крајни оксидациони produkти на азотните соединенија, се претставени како примарна форма на неоргански 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 искушени). 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


Fig. 4. Nitrite-nitrogen content in the water of “Strezevo” reservoir (2009-2011)

Слика 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)
Нутриентен режим во водата од акумулацијата „Стрежево”

на што се и високите кислородни концентрации, а во трофолитичниот слој е максимумот поради процесите на интензивна минерализација во водата и седиментите.

Вкупниот азот во водата од Стрежевската акумулација е претставен на Слика 6. Највисока вредност за вкупен азот во целниот истражувачки период (19,57 μg/l) е измерена на дебелини од 8 m (есен 2009 година) во централниот дел од акумулацијата (Слика 6).

Највисоката концентрација на вкупен азот во целниот истражувачки период е измерена во зима 2009/10 година, и изнесува 1057,13 μg/l во површинската вода кај зафатната кула. Забележили во 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 организмотите во водените средињи. Тие претставуваат и главни лимитиращи 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 тропфија и еутрофикација“ (Martinović - Vitanović, 1996).

Заклучок

Анализата на параметрите за оценка на нутриентниот режим во водата од акумулацијата „Стрежево” во двегодишниот период на искусствено тражување, укажува на сезонска и просторна динамика на нутриентните 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. Нитритите се јавуваат во погостите количини, но исто така се далеку под дозволените граници. Присутното на амонијак е констатирано само во летниот период и тоа само на две мери места. Главно квалитетот на водата во Стрежевската акумулација во периодот август 2009 – август 2011 година, ги задоволува критериумите за бараниот квалитет на водата за повекенаменските акумулации, со акцент кон тенденција на континуира но зголемување на средната просечна концентрација на вкупен фосфор за секоја сезона. Тоа укажува на зголеменото влијание на антропогенот 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 аковатичен екосистем.

Литература


Summary

The analysis of parameters for assessment 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.
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 Pitois et al. (2001) indicate the opposite.

Recent studies show a connection between periphyton development and tufa deposition in karst streams (Pitois et al. 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 cm². 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 Kaluderovac](image)
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 *Cratoneuru 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/dm², 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

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**Tab. 1. Environmental parameters of water during sampling in 2010**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>May</th>
<th>June</th>
<th>October</th>
<th>November</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>16.4</td>
<td>24.0</td>
<td>16.2</td>
<td>10.1</td>
</tr>
<tr>
<td>Dissolved Oxygen (mgO₂/L)</td>
<td>8.3</td>
<td>8.2</td>
<td>11.0</td>
<td>17.1</td>
</tr>
<tr>
<td>Oxygen saturation (%)</td>
<td>86</td>
<td>101</td>
<td>119</td>
<td>152</td>
</tr>
<tr>
<td>pH</td>
<td>8.10</td>
<td>8.20</td>
<td>8.33</td>
<td>8.35</td>
</tr>
<tr>
<td>Conductivity (µS/cm)</td>
<td>383</td>
<td>392</td>
<td>388</td>
<td>381</td>
</tr>
<tr>
<td>Alkalinity (mg CaCO₃/L)</td>
<td>210.0</td>
<td>202.5</td>
<td>220.0</td>
<td>201.0</td>
</tr>
<tr>
<td>Total hardness (mg CaCO₃/L)</td>
<td>215.4</td>
<td>227.8</td>
<td>218.9</td>
<td>213.6</td>
</tr>
<tr>
<td>COD&lt;sub&gt;ₗₗ₉₉&lt;/sub&gt; (mg O₂/L)</td>
<td>1.58</td>
<td>1.46</td>
<td>0.50</td>
<td>0.39</td>
</tr>
<tr>
<td>Orthophosphates (mg P/L)</td>
<td>0.119</td>
<td>0.011</td>
<td>0.0025</td>
<td>0.007</td>
</tr>
<tr>
<td>Total phosphorus (mg P/L)</td>
<td>0.246</td>
<td>0.018</td>
<td>0.019</td>
<td>0.017</td>
</tr>
<tr>
<td>Nitrites (mg N/L)</td>
<td>0.0030</td>
<td>0.0000</td>
<td>0.0025</td>
<td>0.0025</td>
</tr>
<tr>
<td>Nitrates (mg N/L)</td>
<td>0.57</td>
<td>0.78</td>
<td>0.39</td>
<td>0.43</td>
</tr>
</tbody>
</table>

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![Fig. 2. Chlorophyll a concentrations on different microhabitats through months of sampling](image-url)
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-metazoa. Ciliates dominated in number of taxa (73 taxa) and abundance. In G microhabitats, ciliates contributed with an average of 65% in total abundance, rotifers with 25.3%, and nematods with 10.9%. In D microhabitats ciliates contributed with 62.5% in total abundance followed by rotifers (15.8%) and nematods (8.7%). Diptera, Gymnoamoebae and Heliiozoa 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 (Chlidonella, Chlamydonellopsis, Dysteria, Odontochlamys, Pseudochlidononopsis, Trithigmotoma, Trochilia), Gymnastomatida (Dileptus, Lacrymaria, Lagynophrya), Nassulida (Leptopharynx), Protostomatida (Placus), Suctoria (Heliophrya, Metacineta, Acinetra), Hymenostomatida (Cyclidium, Frontonia, Glaucoma, Paramecium), Peritrichia (Carchesium, Vaginicola, Platycolia), Pleurostomatida (Acineria, Ligonotus), Prostomatida (Urotricha), Oligotrichida (Halleria), Heterotrichida (Stenot, Lagotia), Hypotrichia (Aspidisca, Balladyna, Diaxonella, Euplotes, Holoichia, Oxyrichia, Stylochnia, 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./cm² and 410.1 ind./cm², while on D microhabitats values were between 6.6 ind./cm² and 258.8 ind./cm². D microhabitats sustained only 38 taxa, with Ds having only 8 taxa (mainly Heterotrichida and Peritrichida), 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., Platycolia decumbens, Carchesium sp., Heliophrya rotunda, Lagynophrya acuminata, Urotichia 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, F3, 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, F3, 60 = 39.915, p<0.001). Posthoc 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

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**Fig. 3.** A dendrogram 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), Srđoč 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 (Prime-Habdia 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 (Habdić 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.

**References**


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Foissner, W., Berger, H., Kohmann, F. (1996). A user-friendly guide to the ciliates (Protozoa, Ciliophora) commonly used by hydrobiologists as bioindicators in rivers, lakes, and waste waters, with notes on their ecology. Freshwater Biology 35: 375-482


Summary

During a four months period (May-November 2010.) artificial substrates have been placed on the barrier between lakes Kaluderovac 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.
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 km², average height 828 m and multi-annual average flow rate 32.5 m³/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

Keywords: Phytoplankton, composition, seasonal variation, Osumi River
## Tab. 1. List of phytoplankton species recorded at three stations upstream of the Osumi River (*+* indicates the presence of species)

<table>
<thead>
<tr>
<th>Name of Species</th>
<th>Station</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Cyanophyceae</strong></td>
<td></td>
</tr>
<tr>
<td><em>Anabaena</em> sp.</td>
<td>+</td>
</tr>
<tr>
<td><em>Chroococcus</em> sp.</td>
<td>+</td>
</tr>
<tr>
<td><em>Merismopedia glauca</em> (Ehrenberg) Kützing</td>
<td>+</td>
</tr>
<tr>
<td><em>Microcystis</em> sp.</td>
<td></td>
</tr>
<tr>
<td><em>Oscillatoria limosa</em> C. Agardh</td>
<td>+</td>
</tr>
<tr>
<td><em>Oscillatoria</em> sp.</td>
<td>+</td>
</tr>
<tr>
<td><em>Spirulina major</em> Kützing</td>
<td>+</td>
</tr>
<tr>
<td><strong>Bacillariophyceae: Centrales</strong></td>
<td></td>
</tr>
<tr>
<td><em>Aulacoseira italica</em> (Grunow) Simonsen</td>
<td>+</td>
</tr>
<tr>
<td><em>Cyclotella cyclopuncta</em> Håkansson</td>
<td>+</td>
</tr>
<tr>
<td><em>Cyclotella commonensis</em> Hustedt</td>
<td>+</td>
</tr>
<tr>
<td><em>Cyclotella meneghiniana</em> Kützing</td>
<td>+</td>
</tr>
<tr>
<td><em>Cyclotella radiosa</em> (Grunow) Lemmermann</td>
<td></td>
</tr>
<tr>
<td><em>Melosira varians</em> Agardh</td>
<td>+</td>
</tr>
<tr>
<td><em>Stephanodiscus medius</em> Håkansson</td>
<td>+</td>
</tr>
<tr>
<td><strong>Bacillariophyceae: Pennales</strong></td>
<td></td>
</tr>
<tr>
<td><em>Achnanthidium minutissimum</em> (Kützing) Czarnecki</td>
<td>+</td>
</tr>
<tr>
<td><em>Achnanthes lanceolata</em> (Brebisson) Grunow</td>
<td>+</td>
</tr>
<tr>
<td><em>Amphora coffeaeformis</em> (C.Agardh) Kützing</td>
<td>+</td>
</tr>
<tr>
<td><em>Amphora pediculus</em> (Kützing) Grunow</td>
<td>+</td>
</tr>
<tr>
<td><em>Amphora ovalis</em> (Kützing) Kützing</td>
<td>+</td>
</tr>
<tr>
<td><em>Brachysira neoexilis</em> Lange-Bertalot</td>
<td>+</td>
</tr>
<tr>
<td><em>Brachysira vitrea</em> (Grunow) Ross</td>
<td>+</td>
</tr>
<tr>
<td><em>Caloneis bacillum</em> (Grunow) Cleve</td>
<td>+</td>
</tr>
<tr>
<td><em>Cocconeis pediculus</em> Ehrenberg</td>
<td>+</td>
</tr>
<tr>
<td><em>Cocconeis placenta</em> Ehrenberg var. <em>placentula</em></td>
<td>+</td>
</tr>
<tr>
<td><em>Cocconeis placenta</em> Ehrenberg var. <em>lineata</em> (Ehrenberg) Van Heurck</td>
<td>+</td>
</tr>
<tr>
<td><em>Craticula cuspidata</em> (Kützing) D.G. Mann</td>
<td>+</td>
</tr>
<tr>
<td><em>Cymatopleura solea</em> (Brebisson) W. Smith</td>
<td>+</td>
</tr>
<tr>
<td><em>Cymbella affinis</em> Kützing</td>
<td>+</td>
</tr>
<tr>
<td><em>Cymbella caespitosa</em> (Kützing) Brun</td>
<td>+</td>
</tr>
<tr>
<td><em>Cymbella cistula</em> (Ehrenberg) Kirchner</td>
<td>+</td>
</tr>
<tr>
<td><em>Cymbella helvetica</em> Kützing</td>
<td>+</td>
</tr>
<tr>
<td><em>Cymbella microcephala</em> Grunow</td>
<td>+</td>
</tr>
<tr>
<td><em>Cymbella lanceolata</em> (Ehrenberg) Van Heurck</td>
<td>+</td>
</tr>
<tr>
<td><em>Cymbella prostrata</em> (Berk.) Cleve</td>
<td>+</td>
</tr>
<tr>
<td><em>Cymbella silesiaca</em> Bleisch</td>
<td>+</td>
</tr>
<tr>
<td><em>Dictama ehrenbergii</em> Kützing</td>
<td>+</td>
</tr>
<tr>
<td><em>Dictama vulgaris</em> Bory</td>
<td>+</td>
</tr>
<tr>
<td><em>Diploneis elliptica</em> (Kützing) Cleve</td>
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</tr>
<tr>
<td><em>Diploneis marginiatrix</em> Hustedt</td>
<td>+</td>
</tr>
<tr>
<td><em>Fallacia lenzii</em> (Hustedt) Lange-Bertalot</td>
<td>+</td>
</tr>
<tr>
<td><em>Fragilaria construens</em> (Ehrenberg) Gunow</td>
<td>+</td>
</tr>
<tr>
<td><em>Fragilaria capucina</em> var. <em>vaucheriae</em> (Kützing) Lange-Bertalot</td>
<td>+</td>
</tr>
<tr>
<td><em>Fragilaria crotonensis</em> Kitton</td>
<td>+</td>
</tr>
<tr>
<td><em>Geissleria acceptata</em> (Hustedt) Lange-Bertalot &amp; Metzeltin</td>
<td>+</td>
</tr>
<tr>
<td><em>Geissleria decussis</em> (Østrup) Lange-Bertalot &amp; Metzeltin</td>
<td>+</td>
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<tr>
<td><em>Gomphonema minutum</em> (Agardh) Agardh</td>
<td>+</td>
</tr>
<tr>
<td><em>Gomphonema olivaceum</em> (Hornemann) Brebisson</td>
<td>+</td>
</tr>
<tr>
<td><em>Gomphonema parvulum</em> Kützing</td>
<td>+</td>
</tr>
<tr>
<td><em>Gomphonema tergestinum</em> Fricke</td>
<td>+</td>
</tr>
<tr>
<td><em>Gomphonema truncatum</em> Ehrenberg</td>
<td>+</td>
</tr>
<tr>
<td><em>Gyrosigma scalpoides</em> (Rabenhorst) Cleve</td>
<td>+</td>
</tr>
<tr>
<td><em>Hantzschia amphyoxys</em> (Ehrenberg) Grunow</td>
<td>+</td>
</tr>
<tr>
<td><em>Luticola kotschiyi</em> (Grunow) Mann</td>
<td>+</td>
</tr>
<tr>
<td><em>Luticola matica</em> (Kützing) Mann</td>
<td>+</td>
</tr>
<tr>
<td><em>Mastogloia smithii</em> Thwaites</td>
<td>+</td>
</tr>
<tr>
<td><em>Meridion circulare</em> (Grewille) Agardh</td>
<td>+</td>
</tr>
<tr>
<td><em>Navicula capitatoradata</em> Germain</td>
<td>+</td>
</tr>
<tr>
<td><em>Navicula cryptcephala</em> Kützing</td>
<td>+</td>
</tr>
<tr>
<td>Name of Species</td>
<td>Station</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Navicula cryptotenella Lange-Bertalot</td>
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</tr>
<tr>
<td>Navicula cryptocenelloides Lange-Bertalot</td>
<td>+ +</td>
</tr>
<tr>
<td>Navicula digitoradata</td>
<td>+ +</td>
</tr>
<tr>
<td>Navicula gregaria Donkin</td>
<td>+</td>
</tr>
<tr>
<td>Navicula halophila (Grunow) Cleve</td>
<td>+ +</td>
</tr>
<tr>
<td>Navicula leistikowii Lange-Bertalot</td>
<td>+</td>
</tr>
<tr>
<td>Navicula meniscus Schumann</td>
<td>+</td>
</tr>
<tr>
<td>Navicula oligotraphenta Lange-Bertalot &amp; Hofmann</td>
<td>+ +</td>
</tr>
<tr>
<td>Navicula radiosa Kützing</td>
<td>+</td>
</tr>
<tr>
<td>Navicula reichardiana Lange-Bertalot</td>
<td>+</td>
</tr>
<tr>
<td>Navicula rostellata Kützing</td>
<td>+</td>
</tr>
<tr>
<td>Navicula saprophila Lange-Bertalot</td>
<td>+ +</td>
</tr>
<tr>
<td>Navicula tripunctata (O. F. Müller) Bory</td>
<td>+ +</td>
</tr>
<tr>
<td>Nitzschia acicularis W. Smith</td>
<td>+</td>
</tr>
<tr>
<td>Nitzschia amphibia Grunow</td>
<td>+ +</td>
</tr>
<tr>
<td>Nitzschia angustata (W. Smith.) Grunow</td>
<td>+ +</td>
</tr>
<tr>
<td>Nitzschia brunoi Lange-Bertalot</td>
<td>+</td>
</tr>
<tr>
<td>Nitzschia constricta (Kützing) Ralfs</td>
<td>+ +</td>
</tr>
<tr>
<td>Nitzschia dissipata (Kützing) Grunow</td>
<td>+</td>
</tr>
<tr>
<td>Nitzschia hungarica Grunow</td>
<td>+ +</td>
</tr>
<tr>
<td>Nitzschia fonticola Grunow</td>
<td>+</td>
</tr>
<tr>
<td>Nitzschia incospicua Grunow</td>
<td>+</td>
</tr>
<tr>
<td>Nitzschia lacuum Lange-Bertalot</td>
<td>+</td>
</tr>
<tr>
<td>Nitzschia longissima (Baum) Ralfs</td>
<td>+ +</td>
</tr>
<tr>
<td>Nitzschia linearis (Agarth) W. Smith var. linearis</td>
<td>+ +</td>
</tr>
<tr>
<td>Nitzschia palea (Kützing) W. Smith</td>
<td>+</td>
</tr>
<tr>
<td>Nitzschia recta Hantzsch</td>
<td>+</td>
</tr>
<tr>
<td>Nitzschia signoides (Nitzsch) W. Smith</td>
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</tr>
<tr>
<td>Nitzschia sinuata var. tabellaria (Grunow) Grunow</td>
<td>+</td>
</tr>
<tr>
<td>Nitzschia vermicularis (Kützing) Hantzsch</td>
<td>+</td>
</tr>
<tr>
<td>Pinnularia microstauron var. brebissonii (Kützing) Mayer</td>
<td>+ +</td>
</tr>
<tr>
<td>Rhoicosphenia abbreviata (Agardh) Lange-Bertalot</td>
<td>+ +</td>
</tr>
<tr>
<td>Rhopalodia gibba (Ehrenberg) O. Müller</td>
<td>+ +</td>
</tr>
<tr>
<td>Sellaphora bacillum (Ehrenberg) D.G.Mann</td>
<td>+</td>
</tr>
<tr>
<td>Sellaphora pupula (Kützing) Mereschkovsky</td>
<td>+</td>
</tr>
<tr>
<td>Šturillia brebissoni Krammer, Lange-Bertalot</td>
<td>+</td>
</tr>
<tr>
<td>Synedra ulna (Nitzsch) Ehrenberg</td>
<td>+ +</td>
</tr>
</tbody>
</table>

**Euglenophyceae**

<table>
<thead>
<tr>
<th>Species</th>
<th>Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euglena sp.</td>
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</tr>
<tr>
<td>Peranema sp.</td>
<td>+</td>
</tr>
<tr>
<td>Phyacys sp.</td>
<td>+ +</td>
</tr>
<tr>
<td>Trachelomonas sp.</td>
<td>+</td>
</tr>
</tbody>
</table>

**Chlorophyceae**

<table>
<thead>
<tr>
<th>Species</th>
<th>Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actinastrum hantziicii Lagerheim</td>
<td>+ +</td>
</tr>
<tr>
<td>Ankistrodesmus falcatus (Corda) Ralfs</td>
<td>+ +</td>
</tr>
<tr>
<td>Chlamydomonas sp.</td>
<td>+ + +</td>
</tr>
<tr>
<td>Chlorella vulgaris Beyerinck</td>
<td>+ +</td>
</tr>
<tr>
<td>Closterium sp.</td>
<td>+</td>
</tr>
<tr>
<td>Cosmarium hammeri Reisch</td>
<td>+</td>
</tr>
<tr>
<td>Dictyosphaerium pulchellum H.C.Wood</td>
<td>+</td>
</tr>
<tr>
<td>Golenkinia paucispina W. &amp; G.S. West</td>
<td>+ +</td>
</tr>
<tr>
<td>Mougeotia sp.</td>
<td>+ + +</td>
</tr>
<tr>
<td>Oocystis sp.</td>
<td>+ +</td>
</tr>
<tr>
<td>Pediasastrum boryanum (Turpin) Meneghini</td>
<td>+ +</td>
</tr>
<tr>
<td>Pediasastrum duplex Meyen</td>
<td>+</td>
</tr>
<tr>
<td>Pediasastrum simplex Meyen</td>
<td>+</td>
</tr>
<tr>
<td>Pediasastrum tetras (Ehrenberg) Ralfs</td>
<td>+ +</td>
</tr>
<tr>
<td>Scenedesmus acutus Meyen</td>
<td>+ +</td>
</tr>
<tr>
<td>Scenedesmus longus var. carpetana P.González</td>
<td>+ +</td>
</tr>
<tr>
<td>Scenedesmus quadricauda (Turpin) Brébisson</td>
<td>+ +</td>
</tr>
<tr>
<td>Scenedesmus subspicatus Chodat</td>
<td>+</td>
</tr>
<tr>
<td>Scenedesmus sp.</td>
<td>+</td>
</tr>
</tbody>
</table>
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 due 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 vegetation 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). Dinoflagellates 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-
fied, followed by the blue-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/l. 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 blue-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. Achnanthes 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 Pediasastrum (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. Achnanthes minutissimum (Kützing) Czarnecki, Cyclotella meneghiniana Kützing, Fragilaria crotonensis Kütton, Gomphonema olivaceum (Hornemann) Brebisson, Rhicosphenia 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.

References

of Central and Northern Canada (in two parts). Winnipeg: Fisheries & Marine Service.


Sertoli cells as somatic component of seminiferous lobules of Salmonid species from Ohrid Lake during the reproduction

Abstract

Electron microscopic analysis of degenerative changes of Sertoli cells as somatic component of seminiferous lobules of Salmonid species from Ohrid Lake during the 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, Salmonid species, Ohrid Lake, degenerative changes, electron microscopic analysis.

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; Tavchiovskaja-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 & Tavčiovsk-Vasileva 2010; Tavčiovsk-Vasileva 1999, 2000, 2003; Tavčiovsk-Vasileva & Dimovska 1997; Tavčiovsk-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. Sma 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 submitted to postfixation in 1% osmium tetroxid (OsO4). 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 nm thickness have been prepared, with the help of glass knives, on Reichert-Yung “Ultracut” ultramicrotome, installed on copper nets, contrasted with uranil acetate and lead citrate. 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 transferral 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 emphasised 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, chyloplasm 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 comparison 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.
Electron microscopic analysis of degenerative changes of Sertoli cells as somatic component of seminiferous...

Fig. 4  Part of cytoplasm of Sertoli cell (SK) with well seen nucleus (N) and lipid vacuoles (LV) of different size. Presence of transversally 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 different 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.
Electron microscopic analysis of degenerative changes of Sertoli cells as somatic component of seminiferous...

important 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., involu- tion 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 & Tavčiovska-Vasileva 2010; Tavčiovska-Vasileva 1999, 2000, 2003; Tavčiovska-Vasileva & Dimovska 1997; Tavčiovska-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, etc. This process was also noted in other Teleostei (Tavčiovska-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 degenerative 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 Tavčiovska-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, finally are resorbed (Nagahama et al., 1978). The degeneration of Sertoli cells in some species of Atheriniformes, as *Poeckilia 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; Nichols & 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; Tavčiovska-Vasileva 1992; Tavčiovska-Vasileva & Dimovska 1997). Our investigation in Salmonidae from Ohrid Lake pointed out that directly 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 cytomorphical appearance. Namely, in the prespawning period Sertoli 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 favor of this fact was the presence of transversally and longitudinally cut fragments of flagellumes of sperm residues in the cytoplasm of these cells, later its lysis, which indicated the phagocytic 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 phagocytic 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 structural changes point out the degeneration of these somatic cells, i.e., these changes cause 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 cells as an integral part of seminiferous lobules suffered considerable changes, changing their cytomorphical aspect. Namely, 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 crystals and thickened 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.

**References**


LAND USE CHANGES ON GALICICA MOUNTAIN

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Abstract


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.

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 the 1950s, 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 km². 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 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 inhabitants. 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.
Land use changes on Galicica Mountain

Results

Fig. 1. Land condition of Galichica mountain in 1950’s, 1970’s and 2007

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 Ljubaništa 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, Petrično, 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 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 specifically 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 (Markoski, 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 inacrities 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, 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.

**References**

Municipal solid waste disposal site “Duplja” Novi Vinodolski (Croatia): heavy metals case study

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Abstract


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

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.
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.

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
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 (HNO3), 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 (HNO3) 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) HNO3 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.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Gaus-Krüger coordinates</th>
<th>Type of sample</th>
<th>Sampling site</th>
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<tr>
<td>IB-1</td>
<td>5478126 5001048</td>
<td>seawater</td>
<td>gravel beach in Selce</td>
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<tr>
<td>IB-2</td>
<td>5484908 5000337</td>
<td>landfill leachate</td>
<td>leachate lagoon at MSW disposal site &quot;Duplja&quot;</td>
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<td>5488366 4996867</td>
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<td>water source &quot;Nova kaptaha&quot;</td>
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<tr>
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<td>5488364 4996893</td>
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<td>water source &quot;Stara kaptaha&quot;</td>
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<tr>
<td>IB-6</td>
<td>5488387 4996775</td>
<td>fresh water</td>
<td>water source &quot;Čardak&quot;</td>
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<td>IB-7</td>
<td>5518688 4969171</td>
<td>fresh water</td>
<td>river Gacka</td>
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</table>

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.

<table>
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<th>Eh</th>
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<td>IB-2</td>
<td>11,2</td>
<td>8,64</td>
<td>-144,5</td>
<td>0,24</td>
<td>15,98</td>
<td>3</td>
<td>770</td>
<td>561</td>
<td>202</td>
<td>45</td>
<td>345</td>
</tr>
<tr>
<td>IB-4</td>
<td>8,6</td>
<td>7,83</td>
<td>238,4</td>
<td>11,33</td>
<td>0,242</td>
<td>0,07</td>
<td>8,4</td>
<td>0,6</td>
<td>6</td>
<td>0,6</td>
<td>&lt;0,2</td>
</tr>
<tr>
<td>IB-5</td>
<td>9,4</td>
<td>7,86</td>
<td>219,4</td>
<td>11,44</td>
<td>0,243</td>
<td>&lt;0,05</td>
<td>15,8</td>
<td>&lt;0,5</td>
<td>1,3</td>
<td>0,3</td>
<td>&lt;0,2</td>
</tr>
<tr>
<td>IB-6</td>
<td>8,6</td>
<td>7,95</td>
<td>248,2</td>
<td>11,84</td>
<td>0,242</td>
<td>&lt;0,05</td>
<td>15,2</td>
<td>&lt;0,5</td>
<td>1,3</td>
<td>0,2</td>
<td>&lt;0,2</td>
</tr>
<tr>
<td>IB-7</td>
<td>10,4</td>
<td>7,59</td>
<td>157,9</td>
<td>10,09</td>
<td>0,465</td>
<td>&lt;0,05</td>
<td>16,3</td>
<td>&lt;0,5</td>
<td>1,5</td>
<td>0,2</td>
<td>&lt;0,2</td>
</tr>
</tbody>
</table>

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-
Geochemical impact of the municipal solid waste (MSW) disposal site “Duplja” Novi Vinodolski (Croatia)... 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 than 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 kapaža” 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 (Grimi 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 measurable 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 kapaža” (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 kapaža” (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 kapaža” (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 layer has been slowly rinsing, but it is necessary to carry out further research in order to determine the real situation.

References

Geochemical impact of the municipal solid waste (MSW) disposal site “Duplja” Novi Vinodolski (Croatia)...


IPZ Uniprojekt MCF (2002): Studija o utjecaju na okoliš pogona za obradu biorazgradljivog otpada (kompostiranje), odlagališta ostatnog otpada te reciklažnog dvorišta na lokaciji „Duplje“ Novi Vinodolski. IPZ Uniprojekt MCF, Zagreb.

IPZ Uniprojekt MCF (2002): Studija o utjecaju na okoliš pogona za obradu biorazgradljivog otpada (kompostiranje), odlagališta ostatnog otpada te reciklažnog dvorišta na lokaciji „Duplje“ Novi Vinodolski. IPZ Uniprojekt MCF, Zagreb.

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.
**DETERMINING THE EFFECTIVENESS OF REMOVING HEAVY METALS FROM MODIFIED WASTEWATER BY COPRECIPITATION AND ADSORPTION WITH CaCO$_3$**

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**Abstract**


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 (Namasiyayam 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,
Determining the effectiveness of removing heavy metals from modified wastewater by coprecipitation and...
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)

<table>
<thead>
<tr>
<th>Metals</th>
<th>c (mol/L)</th>
<th>γ (g/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu</td>
<td>$1.574 \times 10^{-3}$</td>
<td>0.1</td>
</tr>
<tr>
<td>Ni</td>
<td>$1.704 \times 10^{-3}$</td>
<td>0.1</td>
</tr>
<tr>
<td>Pb</td>
<td>$4.815 \times 10^{-4}$</td>
<td>0.1</td>
</tr>
<tr>
<td>Hg</td>
<td>$4.985 \times 10^{-4}$</td>
<td>0.1</td>
</tr>
<tr>
<td>Mn</td>
<td>$1.820 \times 10^{-3}$</td>
<td>0.1</td>
</tr>
<tr>
<td>Fe</td>
<td>$1.791 \times 10^{-3}$</td>
<td>0.1</td>
</tr>
<tr>
<td>Zn</td>
<td>$1.529 \times 10^{-3}$</td>
<td>0.1</td>
</tr>
</tbody>
</table>

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$_2$CO$_3$) and in those conditions lead is mobile (Figure 3). Method should 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.

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**Tab. 5.** Concentrations of heavy metals in sediments of ideal solution AG-4.

<table>
<thead>
<tr>
<th></th>
<th>Ni (ppm)</th>
<th>Cu (ppm)</th>
<th>Zn (ppm)</th>
<th>Hg (ppm)</th>
<th>Pb (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-precipitation with CaCO$_3$</td>
<td>1526</td>
<td>3516</td>
<td>5626</td>
<td>1974</td>
<td>0</td>
</tr>
<tr>
<td>Adsorption to CaCO$_3$</td>
<td>89.7</td>
<td>1319</td>
<td>154</td>
<td>35251</td>
<td>2870</td>
</tr>
</tbody>
</table>

---

**Tab. 6.** Concentrations of heavy metals in sediments of realistic solution AG-6.

<table>
<thead>
<tr>
<th></th>
<th>Ni (ppm)</th>
<th>Cu (ppm)</th>
<th>Zn (ppm)</th>
<th>Hg (ppm)</th>
<th>Pb (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-precipitation with CaCO$_3$</td>
<td>131.14</td>
<td>121.68</td>
<td>217.70</td>
<td>46.65</td>
<td>0</td>
</tr>
<tr>
<td>Adsorption to CaCO$_3$</td>
<td>9.39</td>
<td>35.26</td>
<td>35.10</td>
<td>17.71</td>
<td>143.80</td>
</tr>
</tbody>
</table>
Conclusions

From the results we see that the co-precipitation with CaCO₃ is a better method for removing all heavy metals, except lead. For the co-precipitation with CaCO₃ 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 CaCO₃ 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, nitrates, ammonium 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.

References


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 CaCO₃ is more effective method for removing heavy metals than method of adsorption to CaCO₃, but the best results are achieved by combining both methods.
INFLUENCE OF INCREASED SALINITY ON PROTOZOA IN ACTIVATED SLUDGE

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Abstract


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* 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](image-url)
Influence of increased salinity on protozoa 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-
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*, *Euplotes 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 consallaria*, *Vorticella microstoma*, *Tetrahy-

![Fig. 4. Distribution of ciliate salinity tolerance groups (share in abundance) in activated sludge](image)

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 Martin-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 will 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.
Influence of increased salinity on protozoa in activated sludge

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 species were dominant in the control.

Most sensitive species proved to be: *Aspidisca cicada*, *Aspidisca lynceus*, *Chilodonella uncinta*, *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.

Acknowledgements

Authors wish to thank prof. dr. sc. Jasna Hrenović for valuable suggestions, as well as to Svjetlana Vidović for the assistance in the laboratory. Thank LUVETI d.o.o. for financing participation on the 4th Congress of the Ecologists of Macedonia, especially the director, Mr. Tino Herceg.

References


Papadimitriou, C., Palaska, G., Samaras, P., Lazari-


**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 holoeuryhaline species of ciliates, namely *Cyclidium glaucum* 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 flocules. 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.
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 land-cover 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-

Abstract


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


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 на визионерите 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 долга на истражуванот коридор се забележани кај брдските пасишта, потоа кај земјоделските површини и населениите места и шумите. Резултатите можат да бидат искрстени во насока на креирање на планови за управување и одржување на практиките на искрштување на земјиштето кои имаат најголемо значење во обликувањето на пределот во подржавањето.

Ключни зборови: покровност на земјиште, искрштивање на земјиште, станишта, промени, североисточна Македонија
The environment has resulted in specific appearance over the years. The long lasting extensive human impact on the territory, it has been populated for thousands of years. 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 between Kumanovo and Kriva Palanka results in low-continental climate, with Mediterranean climate related according to the equation given by Mas et al. 2004.

Administratively the corridor falls 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 (Lazarevska 1993).

Administratively the corridor falls in the northeastern 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

Smaller changes to 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).

<table>
<thead>
<tr>
<th>1995 LULC types</th>
<th>2011 LULC types</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abandoned arable land</strong></td>
<td><strong>Abandoned arable land</strong></td>
</tr>
<tr>
<td>Abandoned fields or meadows; Abandoned fields overgrown with shrubs and meadows</td>
<td>Abandoned arable land</td>
</tr>
<tr>
<td><strong>Agricultural land</strong></td>
<td><strong>Agricultural land-fields and acres</strong></td>
</tr>
<tr>
<td>Acres; Acres with fruit and wild trees</td>
<td>Acres; Acres with fruit and wild trees</td>
</tr>
<tr>
<td><strong>Heterogeneous agriculture</strong></td>
<td><strong>Orchards; Vineyards</strong></td>
</tr>
<tr>
<td>Orchards; Vineyards</td>
<td>Orchard; Vineyards</td>
</tr>
<tr>
<td>Dry meadows; Grasslands with planted non fruit trees</td>
<td>Meadow</td>
</tr>
<tr>
<td><strong>Arranged areas</strong></td>
<td><strong>Anthropogenic tree belt; Small broadleaf tree plantation</strong></td>
</tr>
<tr>
<td>Arranged areas</td>
<td>Arranged areas</td>
</tr>
<tr>
<td><strong>Pastures and dry grasslands</strong></td>
<td><strong>Unmanaged mesic grasslands</strong></td>
</tr>
<tr>
<td>Grassylands in beech forest</td>
<td>Hill pasture (dry grasslands)</td>
</tr>
<tr>
<td>Hill pastures (dry grasslands)</td>
<td>Hill pasture on stony ground (dry grasslands)</td>
</tr>
<tr>
<td>Hill pastures on stony ground (dry grasslands)</td>
<td></td>
</tr>
<tr>
<td><strong>Forests</strong></td>
<td><strong>Hill pasture with sparse shrubs (dry grasslands)</strong></td>
</tr>
<tr>
<td>Hill pastures with sparse shrubs (dry grasslands)</td>
<td>Hill pasture with sparse shrubs (dry grasslands)</td>
</tr>
<tr>
<td>Mixed thermophylous forests with different stages of degradation</td>
<td>Degraded mesic forest; Degraded thermophilous oak forest; Degraded xerothermophilous oak forest</td>
</tr>
<tr>
<td>Mixed mesophylous forests; Mixed mesophylous forests, north slopes</td>
<td>Mesophillous oak forest; Thermophilous oak forest; Xerothermophilous oak forest</td>
</tr>
<tr>
<td>Beech forests</td>
<td>Beech forests</td>
</tr>
<tr>
<td>Shrub-grassland terrain in shallow dales; Woodlands in shallow dales</td>
<td>Forest ravines and dails</td>
</tr>
<tr>
<td><strong>Forest plantations</strong></td>
<td><strong>Forest ravines and dails</strong></td>
</tr>
<tr>
<td>Black locust’s forests</td>
<td>Black locust plantation</td>
</tr>
<tr>
<td>Forests of Pinus nigra</td>
<td>Conifer tree plantation</td>
</tr>
<tr>
<td>Mixed conifer-black locust plantation with oak</td>
<td>Mixed conifer-black locust plantation with oak</td>
</tr>
<tr>
<td><strong>Riverine/riparian</strong></td>
<td><strong>Riparian shrub communities; Riparian willow-poplar belt; Riparian willow-poplar woodland</strong></td>
</tr>
<tr>
<td>Willow grows, forests and scrublands along the rivers and springs</td>
<td>Riparian shrub communities; Riparian willow-poplar belt; Riparian willow-poplar woodland</td>
</tr>
<tr>
<td>Grasslands along the rivers and springs; Wet meadows</td>
<td>Riparian shrub communities; Riparian willow-poplar belt; Riparian willow-poplar woodland</td>
</tr>
<tr>
<td><strong>Barren areas</strong></td>
<td><strong>Epiapotamal stream; Hiporhithral stream; River gravel bank</strong></td>
</tr>
<tr>
<td>Rocky/sandy areas with almost no vegetation</td>
<td>Rocky sites;</td>
</tr>
<tr>
<td><strong>Rural areas</strong></td>
<td><strong>Rural settlements</strong></td>
</tr>
<tr>
<td>Rural areas and settlements; Gardens</td>
<td>Rural settlements</td>
</tr>
<tr>
<td>Urban area</td>
<td><strong>Urban area; Park</strong></td>
</tr>
<tr>
<td>Industrial objects; Cattle breeding areas; Pond</td>
<td><strong>Man-made structure; Artificial pond; Road</strong></td>
</tr>
</tbody>
</table>
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-Heterogenous 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-Урбан/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-

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**Fig. 3.** Overview of LULC change in the area of Rankovce. (Legend as in Fig. 1).

**Fig. 4.** Overview of LULC change in the area of Kratovo. (Legend as in Fig. 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 registered.

<table>
<thead>
<tr>
<th>LULC Types/categories</th>
<th>Along the survey corridor</th>
<th>Kumanovo</th>
<th>Rankovce</th>
<th>Kratovo</th>
<th>Kriva Palanka</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abandoned arable land</td>
<td>4.12%</td>
<td>6.75%</td>
<td>3.14</td>
<td>5.55%</td>
<td>6.61%</td>
</tr>
<tr>
<td>Agricultural land</td>
<td>18.76%</td>
<td>21.84%</td>
<td>0.96</td>
<td>40.51%</td>
<td>46.50%</td>
</tr>
<tr>
<td>Heterogenous agriculture</td>
<td>7.48%</td>
<td>4.84%</td>
<td>2.69</td>
<td>8.69%</td>
<td>5.20%</td>
</tr>
<tr>
<td>Pastures and grasslands</td>
<td>22.33%</td>
<td>13.29%</td>
<td>3.19</td>
<td>15.60%</td>
<td>11.13%</td>
</tr>
<tr>
<td>Forests</td>
<td>20.03%</td>
<td>25.05%</td>
<td>1.41</td>
<td>2.58%</td>
<td>1.37%</td>
</tr>
<tr>
<td>Forest plantations</td>
<td>6.38%</td>
<td>6.92%</td>
<td>0.50</td>
<td>n.r.</td>
<td>n.r.</td>
</tr>
<tr>
<td>Riverine/riparian</td>
<td>9.28%</td>
<td>5.03%</td>
<td>3.75</td>
<td>11.03%</td>
<td>6.24%</td>
</tr>
<tr>
<td>Barren areas</td>
<td>0.74%</td>
<td>0.83%</td>
<td>0.71</td>
<td>0.07%</td>
<td>0.08%</td>
</tr>
<tr>
<td>Rural areas</td>
<td>5.69%</td>
<td>7.58%</td>
<td>1.80</td>
<td>8.07%</td>
<td>10.86%</td>
</tr>
<tr>
<td>Urban/artificial areas</td>
<td>5.19%</td>
<td>7.88%</td>
<td>2.64</td>
<td>7.91%</td>
<td>12.01%</td>
</tr>
</tbody>
</table>
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 while 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 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...
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).

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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 office 1999; PE “Macedonian Forest” personal communication).
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-thermophilous 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)

Land cover succession as a result of changing land use practices in Northeast Macedonia

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.

References


Lazarevski, A. (1993). Climate in Macedonia. Kul-
Daniela Jovanovska & Ljupcho Melovski


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 премистување 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. Доцништето статистички податоци за населението и земјоделските стопанства во тој период послужи за да се идентификуваат причините кои ги иницирале тие промени.

Изразено во апсолутни вредности, најзначајни промени по должина на целниот коридор беа забележани кај брдските пасишта, потоа кај земјоделските површини, населените места и шумите (Сл. 1; Таб. 2). Следејќи ја пределната структура на подрачјето, понатамошна 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 обликуване на пределот.

Трендот на пораст на бројноста на населението во урбаните подрачја и интензивирање на практиките на искористување на земјиштето се особено забележителен во Куманово и делумно во Крива Паланка (Сл. 6; Сл. 7). Трендет 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 под пасишта, сокцисечно обраснување со грмушки и пораст на површините под шуми. Во Кратово и Ранковци, каде коридорот поминува низ целосно рурални средини, набљудуванот тренд на напуштање на површините под пасишта, сукцисечно обраснување со грмушки и следствено пораст на површините под шуми е индиректен одраз на негативниот миграционски тренд на населението проследено со значително занемарување на сточарските практики.
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 колкува 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 одржив 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 кое антропогененот фактор врз шумите, како природен ресурс, во Скопскиот Регион.

Ключни зборови: еколошка стапка, биолошки капацитет, природни ресурси, животна средина

Abstract


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 одржливото развој: Колку од регенеративниот капацитет на планетата е потребен 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).


Оваа техника е адаптирана и применета од многу организации вклучувајќи го и Светскиот фонд за диви животни (World Wildlife Fund) кој ги 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 антропогенит фактор врз природните ресурси во однос на нивниот регенеративен капацитет, конкретно во Скопскиот Регион, преку анализа на антропогенит 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 et al., 2012).

Еколошката стапка ги одредува биолошки продуктивното земјиште и водните површини кои се неопходни на популацијата за да ги произведе обновливите ресурси и екосистемски услуги што ги користи. Од друга страна, биолошкият 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 кон човештвото има потреба да се дефинират како еколошки средства (Galli et al. 2012). Се изразуваат во вообичаената единица глобални хектари (gha), или биолошки продуктивни хектари со просечно 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,
- Земјиштето ко го абсорбира создадениот отпад (емисии на CO2) и
- Изградени земјиштета на кои се локираат објектите за домување, индустриски капацитети и урбана инфраструктура.

Побарувачката на една нација за ресурси и екосистемски услуги се пресметува преку додање на увезените и одземање на извезените производи на вкупното производство на истите на национално ниво. Овие пресметки ја покажуваат побарувачката на биолошки капацитет на една нација (Kitzes at al. 2007).

При пресметување на регионалната еколошка стапка, се користат податоци за просечната еколошка стапка на Република Македонија и нејзиниот биолошки капацитет (Galli at al., 2012). Еколошката стапка ги одредува биолошки продуктивното земјиште и водните површини кои се неопходни за потребите на дадената популација.
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 ги абсорбира емитиранот CO₂, како отпад, од друга страна.

Анализата на можностите за пресметување на еколошката стапка на регионално ниво 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 ги абсорбира емитиранот CO₂, 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.

Истражување 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 Република Македонија (ДЗС, 2009). Иако зафаќа најмалата 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 km² (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 потресено да ги задоволи потребите на населението 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 стапка по жител, потребна да го абсорбира емитиранот CO₂, кој се создава како резултат на антропогените активности, во 2008 година, на национално ниво, изнесува 3,87 gha/жител (Galli et al. 2012). Одтука, биолошки продуктивната површина под шуми во Скопскиот Регион, истата година изнесува 0,2 милиони gha.

Резултатите посочуваат дека регионалната биолошка продуктивна површина под шуми по жител, неопходна за задоволување на потребите на населението на национално ниво во 2008 година изнесува 0,38 gha/жител, или 8,03 милиони gha. Во споредба со површината под шуми во 2008 година, биолошки продуктивната површина под шуми во Скопскиот Регион изнесува 0,4 милиони gha.

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Резултатите посочуваат дека абсолютно биолошки продуктивната стапка по жител, потребна да го абсорбира емитиранот CO₂, кој се создава како резултат на антропогените активности, во 2008 година, на национално ниво, изнесува 3,87 gha/жител (Galli et al. 2012). Одтука, биолошки продуктивната површина потресено да ги абсорбира емисиите на CO₂, во Скопскиот Регион, во текот на 2008 година изнесува 2,31 милиони gha. Оваа површина е приближно 6 пати поголема од располагањата со биолошки продуктивната површина под шуми во регионот, како абсорбент на емисиите на CO₂.
Потенцијалот на еколошката стапка како индикатор за следење на антропогеното влијание врз ...

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 CO₂, посебно во секекторот згради, него кое подобрување на енергетската ефикасност во постојните и запазување на прописите за енергетска ефикасност при изградба на новите објекти. Според проекците за намалување на емисиите на CO₂ за градот Скопје, долгорочната стратегија би се превземала за 43,3% а во секекторот згради за 19,9% или вкупната емисија на CO₂ 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 CO₂ на национално ниво, Скопскиот Регион има голем удел во вредноста на стапката на јаглерод по жител, односно еколошката стапка 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 CO₂.

Пресметување на еколошката стапка за Скопје Регион е повеќе од потребно 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 CO₂ што секако инициираат и промени во вредноста на еколошката стапка. Вклучувањето на повеќе варијабли при утврдување на еколошката стапка и биолошкото капацитет на регионално ниво ос тава простор за понатамошни научни истражувања и прецизирање на добиените податоци.

Литература


Актиски план за одржив енергетски развој на град Скопје (SEAP), 2011. Скопје, Република Македонија

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 CO₂ 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 CO₂ 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 CO₂ 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.
CALCULATION OF SUPPORTING RATES FOR AUTOCHTHONOUS BUSHA CATTLE BREED AS A METHOD IN IMPLEMENTING AGRI-ENVIRONMENTAL MEASURES

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Abstract


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 between different farms which 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.
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 an alternative course of action be given up.
ly require a large amount of money spread in defferent 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-Friesian 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 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 per head at the meat only oriented farm). 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-
Calculation of supporting rates for autochthonous busha cattle breed as a method in implementing agri-environment measures. The busha 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 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 subsidies 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.

**References**


Council Regulation (EC) No. 1257/1999


**Tab. 2.** Calculated partial differences corrected with the coefficients of endangerment and geographical distribution

<table>
<thead>
<tr>
<th>Case farm</th>
<th>FDF</th>
<th>FCF</th>
<th>FBF</th>
<th>CBF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial difference without financial support/subsidies (1269 MKD=0)</td>
<td>23245</td>
<td>14668</td>
<td>3526</td>
<td>0</td>
</tr>
<tr>
<td>Partial difference without financial support/subsidies (4760 MKD=0)</td>
<td>19719</td>
<td>11142</td>
<td>0</td>
<td>-3526</td>
</tr>
</tbody>
</table>

* coefficient of endangerment (CE) = 1.01, coefficient of geographical distribution(GD) = 1.00
Penn State, Agriculture Alternatives (cooperative extension). (2012).
ji. Domzale. 55-73.
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 лија (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. Коцилари, посебно во стебленцата е резултат на повисоката снабденост на почвата со калиум (68,20 mg/100 g) кој го успорува усвојувањето на магнезиум. По-добрата застапеност на изменливо 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 лија и 0,42% во стебленца е значително пониска поради високата концентрација на калиум во почвата. Во фаза на цветање е измерена значително пониска содржина на MgO во сува маса на луцерката, за разлика од лијата каде има тенденција на зголемување.

Прихранувањето на луцерка со NPK (15:30:15) + микроелементи во опитот со вегетациони садови по-кажа депресивен ефект врз усвојувањето на Mg, посебно изразено во стебленцата поради антагонистичко- то делување на калиумот.

Ключни зборови: луцерка, почва, фази на развиток, сува маса, антагонизам, макроелементи

Abstract

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 there 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; Zlateva & 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 metabollic 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 + microelements (ME) was done.

### 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-

### Table 1. Agro-chemical soil composition

<table>
<thead>
<tr>
<th>Location</th>
<th>NH₄N</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saray</td>
<td>0,49</td>
<td>3,33</td>
<td>526.0</td>
<td>19,0</td>
</tr>
<tr>
<td>Yegunovce</td>
<td>0,77</td>
<td>4,87</td>
<td>622.5</td>
<td>29,3</td>
</tr>
<tr>
<td>Raduša</td>
<td>2,01</td>
<td>9,89</td>
<td>582.5</td>
<td>195.5</td>
</tr>
<tr>
<td>Kodzilari</td>
<td>2,21</td>
<td>68,2</td>
<td>815.0</td>
<td>63,7</td>
</tr>
</tbody>
</table>

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 HNO₃, HClO₄, H₂SO₄ (10 : 1.0 : 0.25), whereas the reading was done by an atomic absorption spectro-photometer (A.A.C.).
Tab. 2. The content of magnesium in the dry matter of leaves and stems

<table>
<thead>
<tr>
<th>Location</th>
<th>Leaves % MgO</th>
<th>Stems % MgO</th>
<th>stems/leaves %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>before blooming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saray</td>
<td>0.59 ± 0.02</td>
<td>100.0</td>
<td>0.51 ± 0.06</td>
</tr>
<tr>
<td>Yegunovce</td>
<td>0.53 ± 0.07</td>
<td>88.8</td>
<td>0.44 ± 0.08</td>
</tr>
<tr>
<td>Raduša</td>
<td>1.73 ± 0.12</td>
<td>292.7</td>
<td>1.11 ± 0.12</td>
</tr>
<tr>
<td>Kodzilari</td>
<td>0.60 ± 0.01</td>
<td>101.9</td>
<td>0.39 ± 0.03</td>
</tr>
<tr>
<td></td>
<td>Blooming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saray</td>
<td>0.62 ± 0.04</td>
<td>100.0</td>
<td>0.42 ± 0.10</td>
</tr>
<tr>
<td>Yegunovce</td>
<td>0.57 ± 0.02</td>
<td>92.2</td>
<td>0.40 ± 0.09</td>
</tr>
<tr>
<td>Raduša</td>
<td>1.92 ± 0.11</td>
<td>308.2</td>
<td>0.81 ± 0.04</td>
</tr>
<tr>
<td>Kodzilari</td>
<td>0.65 ± 0.02</td>
<td>103.7</td>
<td>0.31 ± 0.03</td>
</tr>
</tbody>
</table>

Tab. 3. The content of Mg in dry matter of alfalfa leaves and stems

<table>
<thead>
<tr>
<th>Location</th>
<th>v. phase</th>
<th>Leaves % MgO</th>
<th>stems % MgO</th>
<th>Unfertilized</th>
<th>Fertilized</th>
</tr>
</thead>
<tbody>
<tr>
<td>v.Saray</td>
<td>before blooming</td>
<td>0.75 ± 0.03</td>
<td>100.0</td>
<td>0.67 ± 0.04</td>
<td>100.0</td>
</tr>
<tr>
<td>v.Yegunovce</td>
<td>before blooming</td>
<td>0.71 ± 0.02</td>
<td>94.7</td>
<td>0.63 ± 0.02</td>
<td>94.0</td>
</tr>
<tr>
<td>v.Raduša</td>
<td>before blooming</td>
<td>1.70 ± 0.03</td>
<td>226.7</td>
<td>1.18 ± 0.10</td>
<td>176.1</td>
</tr>
<tr>
<td>v.Kodzilari</td>
<td>before blooming</td>
<td>0.60 ± 0.02</td>
<td>80.0</td>
<td>0.42 ± 0.03</td>
<td>62.7</td>
</tr>
<tr>
<td>v.Saray</td>
<td>blooming</td>
<td>0.78 ± 0.03</td>
<td>100.0</td>
<td>0.65 ± 0.02</td>
<td>100.0</td>
</tr>
<tr>
<td>v.Yegunovce</td>
<td>blooming</td>
<td>0.75 ± 0.02</td>
<td>96.2</td>
<td>0.60 ± 0.03</td>
<td>92.3</td>
</tr>
<tr>
<td>v.Raduša</td>
<td>blooming</td>
<td>1.79 ± 0.03</td>
<td>229.5</td>
<td>0.81 ± 0.03</td>
<td>124.6</td>
</tr>
<tr>
<td>v.Kodzilari</td>
<td>blooming</td>
<td>0.62 ± 0.03</td>
<td>79.5</td>
<td>0.33 ± 0.04</td>
<td>50.8</td>
</tr>
<tr>
<td>v.Saray</td>
<td>before blooming</td>
<td>0.72 ± 0.02</td>
<td>100.0</td>
<td>0.48 ± 0.02</td>
<td>100.0</td>
</tr>
<tr>
<td>v.Yegunovce</td>
<td>before blooming</td>
<td>0.69 ± 0.03</td>
<td>95.8</td>
<td>0.46 ± 0.02</td>
<td>95.8</td>
</tr>
<tr>
<td>v.Raduša</td>
<td>before blooming</td>
<td>1.69 ± 0.03</td>
<td>234.7</td>
<td>0.74 ± 0.03</td>
<td>154.2</td>
</tr>
<tr>
<td>v.Kodzilari</td>
<td>before blooming</td>
<td>0.62 ± 0.02</td>
<td>86.1</td>
<td>0.36 ± 0.02</td>
<td>75.0</td>
</tr>
<tr>
<td>v.Saray</td>
<td>blooming</td>
<td>0.75 ± 0.03</td>
<td>100.0</td>
<td>0.32 ± 0.03</td>
<td>100.0</td>
</tr>
<tr>
<td>v.Yegunovce</td>
<td>blooming</td>
<td>0.73 ± 0.04</td>
<td>97.3</td>
<td>0.30 ± 0.03</td>
<td>93.7</td>
</tr>
<tr>
<td>v.Raduša</td>
<td>blooming</td>
<td>1.72 ± 0.03</td>
<td>229.3</td>
<td>0.56 ± 0.04</td>
<td>175.0</td>
</tr>
<tr>
<td>v.Kodzilari</td>
<td>blooming</td>
<td>0.63 ± 0.01</td>
<td>84.0</td>
<td>0.28 ± 0.02</td>
<td>87.5</td>
</tr>
</tbody>
</table>
Kodzilari is 21.4% (0.33% Mg) and Radusa is 31.4% (0.81% Mg) (Table 3). In the dry matter of the stems from Yegunovce and 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-fertilized 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; Bošnjak & 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; Gagachev & Jekić, 1989.. The lower Mg contents in the leaves and the stalks from Kodzilari, besides the good soil richness with Mg, showed a negative influence on the degree of absorbed Mg. According to the values obtained for Mg in the dry matter of 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).

- Alfalfa’s dry matter has shown significantly higher Mg contents in the before-blooming phase, compared to the one in the blooming phase.
- In the blooming phase 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.

**References**


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.
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

Danica Andreevska, Dobre Andov, Emilija Simeonovska

Abstract


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


Во трудот се претставени резултатите од испитувањето на рандманот, приносот на бел ориз и масата на 1000 зрна кај две новоинтродуирани италијански сорти ориз: Bianca и Galileo. Истите параметри се испитани паралелно и на две стандардни сорти: Prima riska (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
**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 broken, removing small stones, assorting the grains according to their colour, packing and storing. De-hulling 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 suitable to specific environmental conditions would provide full expression of their productive and quality traits.


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.
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 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.

Tab. 1. Some chemical properties of the soil from the locality “Bosevica”

<table>
<thead>
<tr>
<th>Depth [cm]</th>
<th>CaCO₃ [%]</th>
<th>Humus [%]</th>
<th>Total [%]</th>
<th>pH H₂O nKCl</th>
<th>P₂O₅</th>
<th>K₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>-</td>
<td>2.16</td>
<td>0.09</td>
<td>5.79</td>
<td>4.92</td>
<td>17.85</td>
</tr>
<tr>
<td>20-40</td>
<td>-</td>
<td>1.50</td>
<td>0.06</td>
<td>5.88</td>
<td>5.07</td>
<td>11.57</td>
</tr>
</tbody>
</table>

Tab. 2. Data on meteorological elements during the rice vegetation period in Kocani

<table>
<thead>
<tr>
<th>Year</th>
<th>Months</th>
<th>Average monthly temperature [°C]</th>
<th>Average monthly max.temperature [°C]</th>
<th>Average monthly min.temperature [°C]</th>
<th>Monthly rainfalls [mm]</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IV</td>
<td>V</td>
<td>VI</td>
<td>VII</td>
<td>VIII</td>
<td>IX</td>
</tr>
<tr>
<td>2009</td>
<td>14.0</td>
<td>18.7</td>
<td>22.4</td>
<td>24.9</td>
<td>24.9</td>
<td>21.2</td>
</tr>
<tr>
<td>2010</td>
<td>13.7</td>
<td>18.5</td>
<td>22.1</td>
<td>24.9</td>
<td>26.9</td>
<td>19.3</td>
</tr>
<tr>
<td>Average</td>
<td>13.9</td>
<td>18.6</td>
<td>22.3</td>
<td>24.9</td>
<td>25.9</td>
<td>20.3</td>
</tr>
<tr>
<td>2009</td>
<td>19.6</td>
<td>25.0</td>
<td>28.5</td>
<td>31.7</td>
<td>30.8</td>
<td>26.6</td>
</tr>
<tr>
<td>2010</td>
<td>19.0</td>
<td>23.9</td>
<td>26.9</td>
<td>29.9</td>
<td>32.7</td>
<td>25.6</td>
</tr>
<tr>
<td>Average</td>
<td>19.3</td>
<td>24.5</td>
<td>27.7</td>
<td>30.8</td>
<td>31.8</td>
<td>26.1</td>
</tr>
<tr>
<td>2009</td>
<td>6.4</td>
<td>9.0</td>
<td>13.0</td>
<td>15.8</td>
<td>15.4</td>
<td>12.1</td>
</tr>
<tr>
<td>2010</td>
<td>8.3</td>
<td>11.8</td>
<td>15.2</td>
<td>17.0</td>
<td>18.7</td>
<td>12.4</td>
</tr>
<tr>
<td>Average</td>
<td>7.4</td>
<td>10.4</td>
<td>14.1</td>
<td>16.4</td>
<td>17.1</td>
<td>12.3</td>
</tr>
<tr>
<td>2009</td>
<td>36.0</td>
<td>59.7</td>
<td>96.7</td>
<td>11.0</td>
<td>33.0</td>
<td>34.5</td>
</tr>
<tr>
<td>2010</td>
<td>63.3</td>
<td>20.5</td>
<td>86.0</td>
<td>19.5</td>
<td>6.5</td>
<td>33.0</td>
</tr>
<tr>
<td>Average</td>
<td>49.7</td>
<td>40.1</td>
<td>91.4</td>
<td>15.3</td>
<td>19.8</td>
<td>33.8</td>
</tr>
</tbody>
</table>
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).

### Table 3. Dressing percentage [%]

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Year</th>
<th>Whole grains</th>
<th>Brokens</th>
<th>Total whole grains+brokens</th>
<th>Chalky grains</th>
<th>Rice bran</th>
<th>Hulls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1/3</td>
<td>2/3</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prima riska (st.)</td>
<td>2009</td>
<td>44.51</td>
<td>1.98</td>
<td>18.02</td>
<td>20.00</td>
<td>64.51</td>
<td>1.09</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>53.12</td>
<td>2.04</td>
<td>10.90</td>
<td>12.94</td>
<td>66.06</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>2009/10</td>
<td>48.82</td>
<td>2.01</td>
<td>14.46</td>
<td>16.47</td>
<td>65.29</td>
<td>0.80</td>
</tr>
<tr>
<td>R-76/6 (st.)</td>
<td>2009</td>
<td>53.23</td>
<td>1.99</td>
<td>11.26</td>
<td>13.25</td>
<td>66.48</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>57.05</td>
<td>1.65</td>
<td>10.47</td>
<td>12.12</td>
<td>69.17</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>2009/10</td>
<td>55.14</td>
<td>1.82</td>
<td>10.87</td>
<td>12.69</td>
<td>67.83</td>
<td>0.58</td>
</tr>
<tr>
<td>Bianca</td>
<td>2009</td>
<td>52.92</td>
<td>1.45</td>
<td>13.00</td>
<td>14.45</td>
<td>67.37</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>47.70</td>
<td>2.88</td>
<td>16.41</td>
<td>19.29</td>
<td>66.99</td>
<td>1.40</td>
</tr>
<tr>
<td></td>
<td>2009/10</td>
<td>50.31</td>
<td>2.17</td>
<td>14.71</td>
<td>16.87</td>
<td>67.18</td>
<td>0.86</td>
</tr>
<tr>
<td>Galileo</td>
<td>2009</td>
<td>37.14</td>
<td>4.70</td>
<td>22.92</td>
<td>27.62</td>
<td>64.76</td>
<td>1.20</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>33.66</td>
<td>7.94</td>
<td>24.60</td>
<td>32.54</td>
<td>66.20</td>
<td>1.20</td>
</tr>
<tr>
<td></td>
<td>2009/10</td>
<td>35.40</td>
<td>6.32</td>
<td>23.76</td>
<td>30.08</td>
<td>65.48</td>
<td>1.20</td>
</tr>
</tbody>
</table>

**LSD**

| LSD _α0.05_ | 2.17 | 3.86 |
| LSD _α0.01_ | 3.16 | 5.62 |
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 milling quality parameters of rice (dressing percentage and yield of white rice) are genetically determined, but their values also depend on envi-

### Tab. 4. Yield of white rice [kg ha⁻¹]

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Year</th>
<th>Average</th>
<th>Index from</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2009</td>
<td>2010</td>
<td>Prima riska</td>
</tr>
<tr>
<td>Prima riska (st.)</td>
<td>3028.00</td>
<td>5290.67</td>
<td>4159.34</td>
</tr>
<tr>
<td>R-76/6 (st.)</td>
<td>3471.67</td>
<td>5106.33</td>
<td>4289.00</td>
</tr>
<tr>
<td>Bianca</td>
<td>3922.67</td>
<td>4215.00</td>
<td>4068.84</td>
</tr>
<tr>
<td>Galileo</td>
<td>2810.67</td>
<td>3206.67</td>
<td>3008.67</td>
</tr>
<tr>
<td>Average</td>
<td>3308.253</td>
<td>4454.668</td>
<td>3881.46</td>
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<tr>
<td>LSD_0.05</td>
<td>226.95</td>
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### Tab. 5. Mass of 1000 grains [g]

<table>
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<tr>
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<td>Average</td>
</tr>
<tr>
<td></td>
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<td>2010</td>
</tr>
<tr>
<td>Prima riska (st.)</td>
<td>40.77</td>
<td>39.96</td>
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<td>R-76/6 (st.)</td>
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<tr>
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<td>Galileo</td>
<td>41.78</td>
<td>40.65</td>
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Dressing percentage and yield of white rice in *Bianca* and *Galileo* - two newly introduced rice varieties...

environmental growing conditions that differ in different years of investigation.

References


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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Institute of Agriculture, 1000 Skopje, Republic of Macedonia
(corresponding author: dr_andov@yahoo.com)

Abstract


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 °С, average maximum temperature was 25.4 °С, 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 новоинтродуириани италијански сорти ориз одгледувани во агроеколошките услови на Македонија. Зборник на трудови од IV Конгрес на еколоците на Македонија со меѓународно учење, Охрид, 12-15 октомври 2012 година. Македонско еколошко друштво, посебно издание 21, Скопје.

Рандманот, приносот на бел ориз и споредните производи добиени при белението на сушевното ориз-арпа, како и масата на 1000 зрна ориз се испитуван состав како и три новоинтродуириани италијански сорти ориз: брио, елеби и опале. Истите својства се испитани и кај две стандардни сорти: прима риска и Р-76/6, со цел да се споредат добиените резултати. Истражувачката се проведени 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 белниот ориз - цели зрна и споредните производи при белението на арпата (кршен
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., 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
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 (36.46%), significantly higher compared to both standards.

The lowest dressing percentage of white rice was determined in in the variety Opale (36.46%) 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

<table>
<thead>
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<th>Year</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
<th>IX</th>
<th>X</th>
<th>Average months (ºC)</th>
<th>Years</th>
<th>Veg.</th>
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<td>18.5</td>
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<td>19.3</td>
<td>12.2</td>
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<tr>
<td>2011</td>
<td>13.1</td>
<td>17.2</td>
<td>22.1</td>
<td>26.2</td>
<td>26.3</td>
<td>23.1</td>
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<td>13.9</td>
<td>20.1</td>
<td></td>
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<tr>
<td>Average</td>
<td>13.4</td>
<td>17.9</td>
<td>22.1</td>
<td>25.6</td>
<td>26.6</td>
<td>21.2</td>
<td>12.4</td>
<td>14.1</td>
<td>19.9</td>
<td></td>
</tr>
</tbody>
</table>

| Year | Average monthly min. temperature (ºС) | | | | | | | | |
|------|--------------------------------------| | | | | | | | |
| 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 |

| Year | 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 |
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
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. 4.** Yield of white rice [kg ha$^{-1}$]

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Year</th>
<th>Average</th>
<th>Index from</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2010</td>
<td>2011</td>
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<tr>
<td>$Prima riska$(st.)</td>
<td>5290</td>
<td>3986</td>
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<td>$R$-$76/6$ (st.)</td>
<td>5106</td>
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<td>4671.00</td>
</tr>
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<td>$-Brio$</td>
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<td>4969</td>
<td>5138.00</td>
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<td>$Ellebi$</td>
<td>5241</td>
<td>4603</td>
<td>4922.00</td>
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<tr>
<td>$Opale$</td>
<td>3259</td>
<td>3619</td>
<td>3439.00</td>
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<td>Average</td>
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**Tab. 5.** Mass of 1000 grains [g]

<table>
<thead>
<tr>
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<th>White rice</th>
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<th>Average</th>
<th>Year</th>
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<tr>
<td>$Prima riska$(st.)</td>
<td>39.96</td>
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The yield of white rice and byproducts of rice milling in some newly introduced Italian rice varieties grown...

- 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.

**References**


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