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НА СОФИЙСКИЯ УНИВЕРСИТЕТ
«СВ. КЛИМЕНТ ОХРИДСКИ»

Биологически факултет

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ADDRESS OF ACKNOWLEDGEMENT TO PROF. DRSC PETYA YANEVA ON THE OCCASION OF HER 60TH BIRTHDAY

Photo: A. Kremenska

Prof. DrSc Petya Yaneva was born on 10th November, 1957 in Dolna Mitropoliya (a town in District of Pleven, North Bulgaria), which is the administrative center of the municipality of Dolna Mitropoliya. The fact that this prominent Bulgarian scientist took her first breath in the town with name translated as “Lower Bishopric” is quite symbolic - many of her scientific contributions reflect both language investigations and spiritual development.

Prof. Yaneva graduated from Sofia University in 1981 as a Master of Arts in Classical Philology with specialization in Modern Greek and Greek literature, followed by a number of specializations in Greece, Russia and Hungary. In 1983 she started teaching Greek at the department of Classical and Modern Philology, further developing from Assistant Professor to her current position of Professor and Doctor Habilitatus. She is a renowned lecturer of Greek Historical Grammar and Modern Greek Syntax, Ancient Greek for PhD candidates in Bulgarian Studies, Slavonic Studies and History, as well as Master’s Degree courses in Textual Studies, Critical Text Analysis and Editing Techniques, among others. She has delivered lectures at Sofia University "St. Kliment Ohridski", New Bulgarian University, American Research Center in Athens and in the SS. Cyril and

Methodius National Library.

Prof. Yaneva's scientific interests are in the field of medieval and paleoslavonic studies, which can be traced in her numerous publications and presentations in prestigious scientific forums on problems concerning the Greek language at the various stages of its historical development. In 2000 she defended her work on Textual and Linguistic Characteristics of the Greek Collections - Sources for the Simeon's Collection (according to the Svetoslav's copy from 1073). This work analyzed the Medieval Greek texts directly connected with the Simeon's collection. The logic of the study followed the logic of the creation and behavior of the text and combined different approaches - palaeographic, codicological, textual, linguistic, historical, and cultural. This broad methodological base allowed to clearly outline the relationship between the macro level (content and structure) and the micro level (graphical appearance and linguistic peculiarities), which made the text a complete symbolic system. It allowed tracing the history of the Greek text and its Old Bulgarian translation. This work is the foundation of the three volumes of the Simeon's Collection, a fundamental research cited more than 180 times worldwide. In addition, she is a translator and editor of a number of works and collections, among which are her brilliant translations of the works of ancient Greek and Byzantine authors.

Petya Yaneva's academic and lecturing development has been in parallel with her involvement in administrative and project work in the Faculty of Classical Philology, where she was elected as a respectful Dean (2003-2011). We would like to highlight specifically her unfailing efforts in supporting the idea and realization of a new direction of joint Bachelor's and Master's Degree education between the faculties of Biology and Classical and Modern Philology. This innovative thinking led to the creation of new binary specialties, such as *Biology and English Language*, through which a new generation of school teachers is created, empowering them with much higher employability. It is out of the scope of this tribute to describe the history of the establishment of this new line and to mention personally all its supporters among the visionary university lecturers. However, it must be stressed that this program, established six years ago, proved to be extremely successful and attracts more and more supporters among both academia and students.

Undoubtedly, Prof. Yaneva's contribution to science, education and innovation at Sofia University is significant. Yet, we would like to stress on her invaluable role in facilitating the training in foreign languages, innovative methodology and introducing technology in teaching, provided for young assistants and scientists from different faculties of Sofia University, including those from the Faculty of Biology. This was achieved through one of the projects she initiated: BG051PO001-3.3.06-0045 *Developing the capacity of specializing, postdoctoral and young scientist for teaching academic courses in and on a foreign language using current methodologies and ICT*, funded by the EC OP *Human Resources Development*. During the 27 month duration of the project, more than 42 assistant

professors and post-doctoral researchers (four of them from the Faculty of Biology) were trained in English and German languages, and were given the opportunity to increase and develop their knowledge in these languages via qualification courses at the University or abroad. Moreover, this project offered personalized tuition in applying state of art methodology and e-learning techniques in academic context, thus opening a totally new horizon of their teaching activities and academic careers. Upon the end of the project in 2015, for the Faculty of Biology alone, more than 26 electronic courses were designed in the University E-Learning System. Moreover, these have been administrated by one of the trainees, who is one of the authors of this tribute (B.U.). Last but not least, the project beneficiaries from the Faculty of Biology received additional funding for their impact factor publications.

In recognition of her dedicated teaching, influential research and effective and innovative administrative activities, Prof. Petya Yaneva was awarded the prestigious Sofia University Grand Award for Science and Research and Sofia University Honorary Blue Ribbon Insignia. We are honored to add our humble voice in warmest cordial and highly respectful recognition of her merits and great personality by this address of acknowledgement for her 60th jubilee.

Vive, valeque, Prof. Yaneva! Ad multos annos!

Prof. DrSc Maya P. Stoyneva-Gärtner,
Assoc. Prof. Dr Blagoy A. Uzunov &
Assoc. Prof Dr Anelly I. Kremenska, Dipl. Eng.,
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CONGRATULATION NOTE TO PROF. RNDR. FRANTIŠEK HINDÁK, DRSC. ON THE OCCASION OF HIS 80TH BIRTHDAY

Photo: M. Horecká

This congratulation tribute is dedicated to Prof. František Hindák – the world renowned phycologist with influential contributions on microscopic algae, which include descriptions of many new for science genera and species. He is a strong supporter and friend of Bulgarian algologists from Sofia University “St Kliment Ohridski”.

Prof. František Hindák was born on 25 March, 1937 in the Slovakian town Trnava. In 1959 he graduated the Faculty of Biology of the Charles University in Prague and almost immediately started his career as a Research Associate in the Institute of Fishery Research and Hydrobiology in Bratislava. Thus starting his professional career, he went through all steps from PhD student in the Institute of Microbiology, Třeboň (1962), Research Associate in the same institute (1966) and Research Associate in the Institute of Botany, Bratislava (1968) to the position of the Head of the Department of Lower Plants in the Institute of Botany, Bratislava (1990-1991), followed by his respectful election as a Member of the Presidium of the Slovak Academy of Sciences, Bratislava (1992-1998). He was also a member and/or chairman of scientific committees of the Slovak Academy of Sciences (1992-2007).

In 1966, F. Hindák defended his PhD thesis in the Czechoslovak Academy of Sciences, Institute of Microbiology, Prague/Třeboň and then successfully became a *Rerum naturalium doctor* (RnDr, or Doctor of Natural Sciences) in the Faculty of Sciences of the Charles University in Prague (1970) and *Scientiae Doctor* (DrSc, or Doctor of Science) in the Institute of Botany of the Slovak Academy of Sciences in Bratislava (1979). In 1992, he became Associated Professor in the Faculty of Sciences of Comenius University, Bratislava and in 2004 he was elected as a University Professor in the Technical University, Faculty of Ecology and Environment in Zvolen. Behind this simple enlistment of all educational steps and positions occupied by Prof. Hindák, there are many years of in-deep research in the microscopic world of algae, which often remained "hidden" for those who look with "naked eyes". Only scholars, who have spent time for numerous field trips followed by hours after hours on the microscopes, surrounded by heaps of taxonomic books, papers, photos and notes, could understand the enormous work, which is behind the brief enlistment of the fields of interests, provided in his autobiographies: "*Field of Specialization*: Phycology, Hydrobiology, Ecology, Algal laboratory and outdoor cultures; *Research Interests*: Cyanobacterial and algal ecology and taxonomy, cyanophyte water blooms, biodiversity, floras, phytoplankton of rivers and lakes, laboratory cultures of cyanobacteria and green algae". Knowledge gained through his lifetime experience was distributed through about 500 publications on microalgal taxonomy and ecology in prestigious journals and issues, among which are 24 books. Some of these publications were prepared in cooperation with his daughter, respected follower and strong supporter in science and life – Mgr. Alica Hindaková, PhD. The series of five monographic books, published by F. Hindák as *Studies of Chlorococcal algae,* are every algologist's best-known *desktop books* and are widely used together with the invaluable two Atlases on cyanoprokaryotes, Atlas on Euglenophytes (published in co-authorship with K. Wołowski) and keys for identification of filamentous green algae (published in co-authorship with M. Pliński). Last but not least, there have to be mentioned his numerous book reviews, bibliographic notes, symposia reports, *etc.* in different journals and many scientific popular articles related to both the value of cryptogams' investigations and nature conservation, including creation of algal Red Lists. Nature conservation and algological studies in the protected areas and different localities of Slovakia comprise a significant part of Prof. Hindák's scientific work, but his scientific interests are much wider and concern different taxonomic and ecological groups of algae in various habitats of Europe, Asia, Africa and America.

We shall not even make an attempt to count and generalize the numerous citations of Hindák's works, but would like to note that he generously shared his knowledge and provided collegial support to many authors during his work as Editor-in-Chief of both journals *Biologia, Bratislava* and *Bulletin of the Slovak Botanical Society*, as well as in the Editorial boards of *Algological Studies* (Stuttgart), *Annales de limnologie* (Toulouse) and *Algologia* (Kiev). The same

words are relevant to his noble work as President of the Slovak Botanical Society (1999-2005) and as President of the Foundation Ján Futák (1995-2007).

The *algological acknowledgements* for his contribution to the knowledge on the taxonomy and ecology of microscopic algae find best expression in the decisions of authors from all over the world to name genera and species of algae after him. Two genera and nine species refer to his name with expressed gratitude by the authors: *Hindakia* Bock, Pröschold et Krienitz, *Hindakochloris* Comas, *Characiopodium hindakii* (Lee et Bold) Floyd et Shin Watanabe (Syn. *Characium hindakii* Lee et Bold), *Chlamydomonas hindakii* Ettl, *Choricystis hindakii* Tell, *Coenochloris hindakii* Komárek, *Gloeothece hindakii* Stoyneva, Gärtner et Vyverman, *Komvophoron hindakii* Hasler et Poulícková, *Lagerheimia hindakii* Hegewald et Schmidt, *Scenedesmus hindakii* Hegewald et Hanagata and *Trachelomonas hindakii* Duangjan et Wołowski.

The high recognition of Prof. F. Hindák's professionalism and experience led to invitations for work abroad and foreign study visits in different algological and limnological centers around the world, with longer stay in Cuba (1965, 1979-1980), Switzerland (1991-1992) and U.S.A (1994), as well as to the long list of honor and distinctions: Holuby Prize of the Slovak Botanical Society (1985), Prize of the Slovak Academy of Sciences (1987, 1997, 2002, 2003, 2004), Comenius University Prize (1987), Honorary Member of the Slovak Botanical Society (1987), Honorary Member of the Hungarian Algological Society (1995), Slovak Agricultural University Prize (1997), Water Research Institute Prize (2001), Honorary Member of the Czech Botanical Society (2002), Honorary Member of the Polish Botanical Society (2004), Member of the Learned Society of SAS (2004) with the most recent election as a Honorary Member of the Bulgarian Society for Mycological and Algological Innovations on occasion of his 80th jubilee this year.

However, no award and no prize can fully reflect the respect and admiration that this person evokes due to his contribution for building bridges between the algologists around the world. Doubtlessly, here we mean the organization of the Symposia on taxonomy of algae (mainly green algae) commonly known as *Smolenice meetings*: International Symposium *Progress in algal taxonomy* (15-19 June 1987), International Symposium *Biology and Taxonomy of Green Algae* (25-29 June 1990), 2nd International Symposium *Biology and Taxonomy of Green Algae* (Stará Lesná, 12-19 September 1993), 3rd International Symposium *Biology and Taxonomy of Green Algae* (6-10 October 1997), International Symposium *Biology and Taxonomy of Green Algae IV* (20-24 June 2002), 5th International Symposium *Biology and Taxonomy of Green Algae* (25–29 June 2007). Most probably, nowadays the young algologists can hardly imagine the role which these meetings played in establishing contacts between western and eastern scholars during the socialist period of the development of Eastern countries. At that time, Bratislava, situated so close to Vienna, was perhaps the most western point, which most of Eastern-European algologists (including Bulgarian) could dream to reach.

The opportunities to meet colleagues from all countries of Western Europe, USA, Canada, Japan, *etc*., provided by F. Hindák through organizing these meetings, practically influenced and shaped the development of modern algology in many different aspects. Clearly, the *vice versa* statement is also valid – the western colleagues and colleagues from Far East could contact and meet their eastern partners, and in this way, behind the science stood not only names, books and papers but real people, scholars who sometimes had contradictive scientific opinions, but always remained friends in life. It is really difficult to keep away from great emotions when writing and remembering about the wonderful time of these meetings, hold in the beautiful castle of the Slovak Academy of Sciences on the eastern slope of the Little Carpathians, near the town of Smolenice. Not only the authors of this tribute, but all those who participated in these algological meetings, kept pleasant and thankful memories of these days, which ran under the motto *Friendship and co-operatin as the principle of scientific progress on phycology,* as it was formulated by Polish professor J. Sieminska. Practically, there is no participant, who will not agree that the very special atmosphere of *Smolenice meetings* was always due to the *good spirit* of the castle – F. Hindák. We write here his full name, but we have to mention that he never allowed anyone to call him Prof. Hindák or František, but simply Fero. We are sure that Fero leaves a memorable part in the hearts not only of the algologists who visited Smolenice symposia, but in the heart of everyone, who was blessed to be in touch with him at least once, with his admirable broad knowledge combined with sense of humour and friendly disposition with people. This is fully valid also for his students, PhD students and followers, who comprise an important group among the modern Slovakian phycological school.

We hope that this small tribute could express our cordial and deeply grateful acknowledgment of the personality and scientific traces of the preeminent phycologist Prof. F. Hindák, of our friend and colleague Fero.

Felix natalis dies, Prof. Hindák! Ad multos annos!

Prof. DrSc Maya P. Stoyneva-Gärtner,
Sofia University "St. Kliment Ohridski" &
tit. Univ.-Prof. DrSc Georg Gärtner
Innsbruck University, Dr.h.c. of Sofia University

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COASTAL ZONES – VULNERABLE BIODIVERSITY REPOSITORIES: TOPICS AND CONTRIBUTIONS OF THE FIRST EUROPEAN SYMPOSIUM *RESEARCH, CONSERVATION AND MANAGEMENT OF THE BIODIVERSITY OF EUROPEAN SEASHORES/RCMBES*

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Abstract. This paper aims to summarize the work, topics and contributions of the First European Symposium *Research, conservation and management of biodiversity of European seashores/RCMBES*, 8-12 May 2017, Primorsko, Bulgaria. The symposium was organized by OPIMOS and ECOPAN in cooperation with the Bulgarian Academy of Sciences, Faculty of Biology of Sofia University “St. Kliment Ohridski” and Primorsko Club Ltd. The symposium aimed to: 1) Present the status of scientific approaches within the European coastal areas; 2) Discuss the role of biodiversity research in trans-border issues; 3) Bring together scientists, academics, practitioners with a view to strengthening and promoting the trans-border cooperation and this with municipalities; 4) Define the priorities concerning various aspects of conservation research and good practices. In accordance, thirteen more detailed symposium topics were announced and later on discussed at the scientific sessions, during the field trip along the southern Bulgarian Black Sea coast and Strandzha Mt, and at the Symposium Round Table. In total, 65 scientific reports (5 plenary lectures, 26 oral presentations and 34 posters), prepared by 146 contributors from 11 countries were presented. The main topics of the contributions and studied

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regions, described briefly in the paper, helped to outline different problems related to the studies and conservation of the coastal areas, to share some good practices and new methodological approaches, as well as to define priorities and discuss the future design of studies and activities in these exceptionally rich in biodiversity, but also severely threatened areas.

Key words: ecotone, fauna, flora, natural habitats, protected areas, threatened species, vegetation, wetlands, zoocoenoses

INTRODUCTION

This paper aims to summarize the work, topics and contributions of the First European Symposium *Research, conservation and management of biodiversity of European seashores/RCMBES*, hold from 8 to 12th May 2017 in Primorsko town, Bulgaria. The symposium was organized by OPIMOS and ECOPAN in cooperation with the Bulgarian Academy of Sciences, Faculty of Biology of Sofia University "St. Kliment Ohridski" and Primorsko Club Ltd.

The Organizing Committee of the symposium consisted of six members: Academic Nikola Sabotinov, long-standing Chairman of the Bulgarian Academy of Sciences, Prof. DrSc Dimitar Peev – IBER – Bulgarian Academy of Sciences, Mag. Elena Georgieva, chair of the NGO OPIMOS, Dr Stefan Peykov from ECOPAN, Prof. DrSc Maya Stoyneva-Gärtner – Faculty of Biology, Sofia University „St. Kliment Ohridski" and tit. Univ.-Prof. DrSc, Dr h. c. Georg Gärtner from the Institute of Botany of Innsbruck University. Their work was supported by the help of 16 members of the Symposium Advisory Board: Prof. Dr Francesko Maria Raimondo – University of Palermo, Italy, Prof. Dr Neriman Ozhatay – Istanbul University, Turkey, Prof. Dr Emilio Laguna – Administrative region of Valencia, Spain, Assoc. Prof. Dr Anna Ganeva – IBER - Bulgarian Academy of Sciences, Prof. Dr Valko Biserkov – IBER - Bulgarian Academy of Sciences, Prof. Dr Rumiana Mecheva – IBER - Bulgarian Academy of Sciences, Assoc. Prof. Tanyo Michev – IBER - Bulgarian Academy of Sciences, Prof. DrSc Boyko Georgiev – IBER - Bulgarian Academy of Sciences, Prof. Dr Svetlana Banceva – IBER - Bulgarian Academy of Sciences, Prof. Dr Mincho Anchev – IBER - Bulgarian Academy of Sciences, Prof. Dr Ekaterina Pavlova – University of Forestry – Sofia, Bulgaria, Prof. Dr Dimitar Pavlov – University of Forestry – Sofia, Bulgaria, Prof. Dr Aleksandar Tashev – University of Forestry – Sofia, Bulgaria, Prof. DrSc Vesela Bankova – Institute of Organic Chemistry – Bulgarian Academy of Sciences and Assoc. Prof. Dr Simeon Simeonov – Bioinform Consult LTD, Bulgaria. Acad. N. Sabotinov delivered the first speech at the official opening of the Symposium, outlined its aims and expected results, and cordially greeted all the participants.

RESULTS AND DISCUSSION

The main idea which served as a prelude to RCMBES, was to provide an opportunity to exchange important information in the field of the nature conservation of species and habitats from the coastal regions, which represent broad ecotones between land and water. In fact, the initial idea related the Symposium to the threatened dune habitats only. However, during the discussions among the members of the Organizing Committee, it became clear that such an approach will be quite one-sided, although theoretically these habitats could be discussed separately. In this way the idea was *born* for a wide-spectrum scientific event, which would allow to create a more complex view of the biological systems. This idea found the full support from the members of the Advisory Board and it was decided that the Symposium should aim to: 1) Present the status of scientific approaches within the European coastal areas; 2) Discuss the role of biodiversity research in trans-border issues; 3) Bring together scientists, academics, practitioners with a view to strengthening and promoting the trans-border cooperation and this with municipalities; 4) Define the priorities concerning various aspects of conservation research and good practices. Logically, the following Symposium topics were announced: 1) Coastal area monitoring and assessment; 2) Coastal biodiversity impact and risk assessment; 3) GIS and remote sensing; 4) Flora and vegetation diversity; 5) Fauna and zoocoenoses diversity; 6) Natural habitats diversity; 7) Coastal area management; 8) Coastal natural resources; 9) Coastal biodiversity conservation; 10) Good practices (legislative, managerial, application, *etc*.); 11) Environmentally friendly municipalities practices; 12) Coastal environment; 13) Oceanology.

Almost all of these topics were discussed at the scientific sessions, during the field trip along the southern Bulgarian Black Sea coast and Strandzha Mt, and at the Symposium Round Table. The *Book of Abstracts*, supervised by N. Sabotinov as Editor-in-Chief with E. Georgieva and D. Peev as Editors, contained the main information presented in 65 scientific reports (5 plenary lectures, 26 oral presentations and 34 posters) prepared by 146 contributors from 11 countries (enlisted in the alphabetical order of their family names):

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The fundamental importance of the coastal regions for the research, conservation and management of the biodiversity has been world-wide recognized. Therefore, it was not surprising that the symposium was attended also by scholars who worked far away from the European borders, and far away from seashores as well (on reservoir banks, in mountains or fields and arable regions), and by researchers who went deep in the history of coastal structure and biodiversity through palynological-palynostratigraphical or paleontological studies (*e.g.* Boev 2017; Filipova-Marinova 2017).

A brief summary of the topics and regions discussed in the presentations could be traced in the text below. In accordance to the studied regions, starting from Europe in eastern direction, the contributions can be ordered in the following way: from the European Russian Arctic at White and Barents Seas (Kolesnikova 2017; Kolesnikova et al. 2017; Konakova & Kolesnikova 2017; Markovskaya et al. 2017; Sergienko et al. 2017), Northern Sea (Gulyaeva & Starodubtseva 2017) and Baltic Sea region (Andreev et al. 2017) to the Mediterranean European coasts (Asenov 2017; Domina et al. 2017; Laguna et al. 2017), then through the Black Sea coastal region (Abramova et al. 2017; Agafonova 2017; Bancheva 2017; Bancheva & Delcheva 2017; Boev 2017; Bogdan 2017; Broshtilova et al. 2017; Bryantseva 2017; Descy et al. 2017; Dimitrov & Vutov 2017; Doycheva et al. 2017a, b; Filipova-Marinova 2017; Gärtner et al. 2017; Kozhuharova 2017; Maximilian et al. 2017; Michev et al. 2017; Nikolova et al. 2017; Pavlova et al. 2017; Petrova & Vladimirov 2017; Petrova et al. 2017; Sadogurska 2017; Stoyneva-Gärtner et al. 2017; Strat & Holobiuc 2017; Strat et al. 2017; Tashev et al. 2017a, b; Vinogradova & Bryantseva 2017; Vitkova et al. 2017; Yankova-Tsvetkova 2017; Zhelev & Aneva 2017), Caspian Sea coast (Dimeeva et al. 2017), Aral Sea (Bekniyaz et al. 2017), Persian Gulf and Gulf of Oman of the Indian Ocean (Alhaj 2017) to the Pacific Ocean shores of the Russian Far East (Kuzmina 2017), and studies in more distant from the shores regions (Angelov et al. 2017; Aneva et al. 2017; Doğu et al. 2017a, b; Gagarina 2017; Holobiuc et al. 2017; Inelova et al. 2017a, b; Kostadinova et al. 2017; Nashar et al. 2017; Optasyuk & Lutska 2017; Pasheva et al. 2017; Vassilev et al. 2017).

Modern geomorphological terminology related to coastal regions and their development was presented by Zhelezov (2017), the necessity to assess the ecosystems and ecosystems services was outlined by Chipev (2017) and the concept of block organization of a water-terrestrial ecotone system, created to study the influence of the sea on the shore, was discussed by Novikova & Volkova (2017).

Mapping of ecosystems using this concept and its role in assessment of the structure and dynamics of the ecosystems was exemplified on the basis of littoral ecotones of the Ural River delta and the Caspian Sea by Dimeeva et al. (2017). The peculiarity of the nature conservation through organization of micro-reserves was presented by Laguna et al. (2017) and exemplified by the positive pioneer experience of the Valencian Community in proposing and setting-up a network of Plant Micro-Reserves (PMR) to protect small sites holding relevant rare, endemic or threatened wild plants. The environmental legislation as an example of *best practice* protected areas was discussed by Bogdan (2017) with the aim to protect the area where the Danube River flows into the Black Sea. The validation of multidisciplinary approach based on the common studies of flora, vegetation and fauna and updated with the help of advanced GIS technologies in assessment of coastal regions was presented by Domina et al. (2017) on the example of the Sicilian coast. The results of over 50 years of experience and practice offered differentiated forestry practices (the most appropriate types and technologies) to improve sustainability, adaptation capabilities and field protection forests efficiency, shown in the contribution by Broshtilova et al. (2017). The complex environmental monitoring related to the global climate change, natural hazards and technological risks was exemplified by Angelov et al. (2017). The state of excellence management systems in the United Arab Emirates, providing insights into the quality management systems in the Arab world, was presented by Alhaj (2017).

Flora and vegetation comprised an important focus in the coastal investigations and were presented from different points of view – starting from historical reviews (*e.g.* Bancheva 2017; Descy et al. 2017; Gärtner et al. 2017; Stoyneva-Gärtner et al. 2017; Zhelev & Aneva 2017), running through descriptions of recent biodiversity of given regions and protected areas of both shores and seas (Bancheva & Delcheva 2017; Bryantseva 2017; Dimitrov & Vutov 2017; Gulyaeva & Starodubtseva 2017; Kozhuharova 2017; Kuzmina 2017; Markovskaya et al. 2017; Petrova & Vladimirov 2017; Sadogurska 2017; Sergienko et al. 2017; Tashev et al. 2017a, b; Vinogradova & Bryantseva 2017; Vitkova et al. 2017), to studies and conservation of certain species (Asenov 2017; Doycheva et al. 2017a, b; Maximilian et al. 2017; Nikolova et al. 2017; Petrova et al. 2017; Strat & Holobiuc 2017; Yankova-Tsvetkova 2017) and description of natural habitats in protected areas (Dimitrov & Vutov 2017; Pavlova et al. 2017; Tashev et al. 2017a, b).

Flora and habitat diversity in river watersheds, mountain areas and other inland parts of Europe and Asia were in the focus of the studies presented by Aneva et al. (2017), Doğu et al. (2017a, b), Gagarina (2017), Inelova et al. (2017a, b), Kostadinova et al. (2017), Optasyuk & Lutska (2017), Vassilev et al. (2017), in some of which ethnobotanical and medical aspects (Nashar et al. 2017; Pasheva et al. 2017) or conservation of threatened plant species (Holobiuc et al. 2017) were outlined.

From taxonomic point of view the abovementioned studies concerned algae (Bryantseva 2017; Descy et al. 2017; Gärtner et al. 2017; Sadogurska 2017; Stoyneva-Gärtner et al. 2017; Vinogradova & Bryantseva 2017), mosses (Kuzmina 2017), vascular plants (Abramova et al. 2017; Asenov 2017; Bancheva 2017; Bancheva & Delcheva 2017; Dimitrov & Vutov 2017; Doğu et al. 2017a, b; Gagarina 2017; Gulyaeva & Starodubtseva 2017; Holobiuc et al. 2017; Inelova et al. 2017a, b; Markovskaya et al. 2017; Nashar et al. 2017; Optasyuk & Lutska 2017; Pasheva et al. 2017; Pavlova et al. 2017; Petrova & Vladimirov 2017; Petrova et al. 2017; Sadogurska 2017; Sergienko et al. 2017; Strat & Holobiuc 2017; Tashev et al. 2017a, b; Yankova-Tsvetkova 2017; Zhelev & Aneva 2017) with special attention to medicinal plants (Doycheva et al. 2017a, b; Kozhuharova 2017; Nikolova et al. 2017; Vitkova et al. 2017). Rare and threatened species were subjects in the contributions by Descy et al. 2017; Doğu et al. 2017a, b; Gärtner et al. 2017; Holobiuc et al. 2017; Maximilian et al. 2017; Petrova et al. 2017; Sadogurska 2017; Stoyneva-Gärtner et al. 2017; Strat & Holobiuc 2017; Tashev et al. 2017a, b; Vinogradova & Bryantseva 2017; Vitkova et al. 2017). Alien, invasive, harmful and toxic species were discussed in the reports by Abramova et al. (2017), Descy et al. (2017), Petrova & Vladimirov (2017), Stoyneva-Gärtner et al. (2017) and Vinogradova & Bryantseva (2017).

The biodiversity of lichens in coastal regions was reflected in the contributions of Andreev et al. (2017) and Markovskaya et al. (2017)

Fauna and zoocoenoses of coastal areas were topics in the contributions by Boev (2017), Kolesnikova (2017), Kolesnikova et al. (2017), Konakova & Kolesnikova (2017), Strat et al. (2017). From taxonomic point of view these studies concerned both invertebrates (Kolesnikova 2017; Kolesnikova et al. 2017; Konakova & Kolesnikova 2017) and different vertebrates (Boev 2017; Strat et al. 2017). The conservation of species and habitats of community importance, including flagship species was presented in particular by Strat et al. (2017).

Assessment of general biodiversity (of plants, fungi and animals) and monitoring of wetlands were described in the contributions by Bekniyaz et al. (2017) and Michev et al. (2017), and the contribution of Agafonova (2017) provided important for monitoring data on hydro-chemical studies on a coastal lake and its main inflowing rivers.

The presented broadness of views, opinions and topics logically led to the recognition of the importance of the RCMBES symposium by different Bulgarian media, who reflected its work in more than 70 issues and by local people and non-governmental organizations, who visited the scientific sessions and actively participated in the discussions. This joint work of local people and scientists was among the main peculiarities of the Symposium, since it has never been a common practice of big scientific events organized in Bulgaria. Most likely, this high public

awareness was recognized early enough by the Symposium sponsors (enlisted in the Acknowledgments below), who, from the beginning, supported the idea of its organization in addition to the financing provided by OPIMOS.

It is not common to write scientific reports in an emotional style, but it is not possible to avoid mentioning of the friendly, non-formal collegial atmosphere during the whole event, starting with the welcome cocktail and the social dinner at the closure party. Frank discussions, sometimes with strong contradictive opinions, ran after the sessions in the hotel lobby or restaurant. The field trip provoked many spontaneous *wow* reactions by the symposium guests regarding the natural beauty of southern Bulgarian Black Sea coast and of Strandzha Mt, where many interesting plant species (incl. endemics) and habitats were seen. Most probably, the wonderful combination of scientific events and collegial exchange of experiences and ideas, provoked the participants to ask for *speeding-up* the work and time for the next meeting. In this regard, the delivery of the symbolical scientific relay from the Doyen of the Symposium - Assoc. Prof. Tanyo Michev to the youngest participant – the Ukrainian PhD student Sofia Sadogurska, should be taken as a symbol of the temporal scientific sustainability of RCMBES.

CONCLUSION

The main topics of the contributions and studied regions, described briefly in the paper, proved the rich biodiversity of the coastal areas, when regarded as broad ecotones between land and water. They helped to outline different problems related with their research and conservation, but also to share some good practices and new methodological approaches, as well as to define priorities and discuss the future design of studies and activities in these exceptionally rich in biodiversity, but severely threatened areas.

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HYPOGEOUS MACROFUNGI ON THE TERRITORY OF THE SOFIA AND PLOVDIV CITY PARKS, BULGARIA

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Abstract. Data on the distribution of eight hypogeous macrofungi found in the city parks of Sofia and Plovdiv are presented in the paper. Seven species are new records from urban green areas in Bulgaria. Three of them are true truffles from genus *Tuber*. Four species are of high conservation value, included in the Red List of fungi in Bulgaria and also in the Red Data Book of the Republic of Bulgaria.

Key words: ascomycetes, basidiomycetes, fungal conservation, truffles, urban green areas

INTRODUCTION

Data on the fungal diversity in the Sofia city parks (*Borisova gradina, Vrana, Zapaden park*) have been reported by Barzakow (1926a,b), Barsakoff (1929, 1933, 1936), Atanasov & Martinov (1933), Hinkova (1950, 1955, 1961),

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Dimitrova et al. (2007), Pencheva et al. (2009), Assyov et al. (2010), Alexov et al (2012), Bencheva (2014), Gyosheva & Nedelin (2016), Stoyneva & Uzunov (2016), Georgiev et al. (2017), *etc.* The published information about fungal diversity in the Sofia city parks and especially in the city park *Borisova gradina* was summarized in the paper by Stoyneva & Uzunov (2016), where a checklist of 115 macrofungi recorded by the first author in the south-eastern part of the park was presented. Data on the macrofungal diversity of the Plovdiv city parks *Bunardzhika*, *Lauta* and *Ostrova* were reported by Stoichev (1981, 1982, 1995), Stoichev & Dimcheva (1982), Stoichev & Anastasov (1988), Hinkova & Stoychev (1983), Lacheva (2010), *etc*. About 140 macrofungal species were recorded so far from the city parks of Sofia and Plovdiv and only one of them (*Hymenogaster verrucosus* Bucholtz) was a hypogeous fungus. Wood-destroying fungi (saprotrophs and parasites) prevailed among all published species.

The present work provides new chorological information for eight hypogeous macrofungi (ascomycetes and basidiomycetes), collected by the authors on the territory of the Sofia and Plovdiv city parks.

MATERIAL AND METHODS

Hypogeous fungi were found by the first author in the Sofia city parks *Borisova gradina*, *Loven park* and *Yuzhen park* and by the third author in the Plovdiv city parks *Bunardzhika* and *Lauta*. The fruit bodies of hypogeous fungi in the Sofia city parks were collected by a truffle dog (**Plate I, Fig. 2**). For some species, we provide information about the period when they were recorded. The identification was confirmed by the use of the works by Dennis (1968), Pegler et al. (1993), Montecchi & Sarasini (2000). The Latin and author names follow Index Fungorum.

The studied specimens are kept at the Mycological Collection of the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Sofia (SOMF) and Mycological Collection of the Agricultural University, Plovdiv (SOA).

The threat status follows the Red List of fungi in Bulgaria (Gyosheva et al. 2006).

RESULTS

List of hypogeous fungi, found in the Sofia and Plovdiv city parks

Ascomycota
Eurotiales
Elaphomycetaceae
Elaphomyces granulatus Fr. (**Plate I, Fig. 5**)
Specimen examined: In the Plovdiv city park *Bunardzhika*, in soil, among

mosses, in a plantation of *Pinus sylvestris* L. and *Gleditschia triacanthos* L., 17.11.2006, leg. & det. M. Lacheva (SOA 6000387).

Critically Endangered (CR) species. Previously known from five floristic regions (Dimitrova & Gyosheva 2008; Dimitrova 2015a; Lacheva 2012a). This species, probably, is not rare in Bulgaria. It has been found several times by the authors (unpubl.) in big amounts, under spruces and pines on Vitosha Mt and Rila Mts.

Pezizales
Tuberaceae
Tuber aestivum Vittad.

Specimen examined: In the *Loven park*, Sofia, in soil, under *Quercus robur* L., 20.12.2016-30.1.2017, leg. & det. T. Nedelin (SOMF 29676). It was found several times at one place only, with an area of about 100 m^2.

Endangered (EN) species. Reported from Zapadna Stara planina Mts and valley of the River Struma (Dimitrova & Gyosheva 2008; Dimitrova 2015b).

This species is the most commonly encountered commercial truffle in Bulgaria but its distribution is less known in the country.

T. brumale Vittad. (**Plate I, Fig. 4**)

Specimen examined: In the Sofia city park *Borisova gradina*, buried in the soil, under *Q. robur*, 1.01.2017-14.02.2017, leg. & det. T. Nedelin (SOMF 29714). It was found several times at one place only, with a very limited area. The ectomycorrhizal roots (ectomycorrhizal association of *T. brumale* with *Q. robur*) are brown, ochre or yellowish-brown and the ramification is generally monopodial. Cystidia are very short (**Plate I, Fig. 4**, left corner).

The species was reported from a single locality in Northeast Bulgaria, in the vicinity of Nikolaevo village, near Ruse town (Dimitrova & Gyosheva 2008).

T. excavatum Vittad. (**Plate I, Figs. 1-2**)

Specimens examined: In the Sofia city park *Borisova gradina*, in soil, under *Q. robur,* 15.12.2016, leg. T. Nedelin, det. M. Gyosheva & T. Nedelin (SOMF 29715); in the Sofia city park *Yuzhen park*, in soil, under *Q. robur,* 20.12.2016, leg. & det. T. Nedelin (SOMF 29718).

The species was reported previously in Bulgaria from Northeast Bulgaria (Dimitrova & Gyosheva 2008; Nedelin et al. 2016), Zapadna Stara planina Mts (Nedelin et al. 2017) and Zapadni Rodopi Mts (Lacheva 2012a). The distribution of this species in Bulgaria is less known.

Basidiomycota
Agaricales
Hymenogastraceae
Hymenogaster luteus Vittad. (**Plate I, Fig.3**)

Specimens examined: In the Sofia city park *Borisova gradina*, in soil, under *Q.*

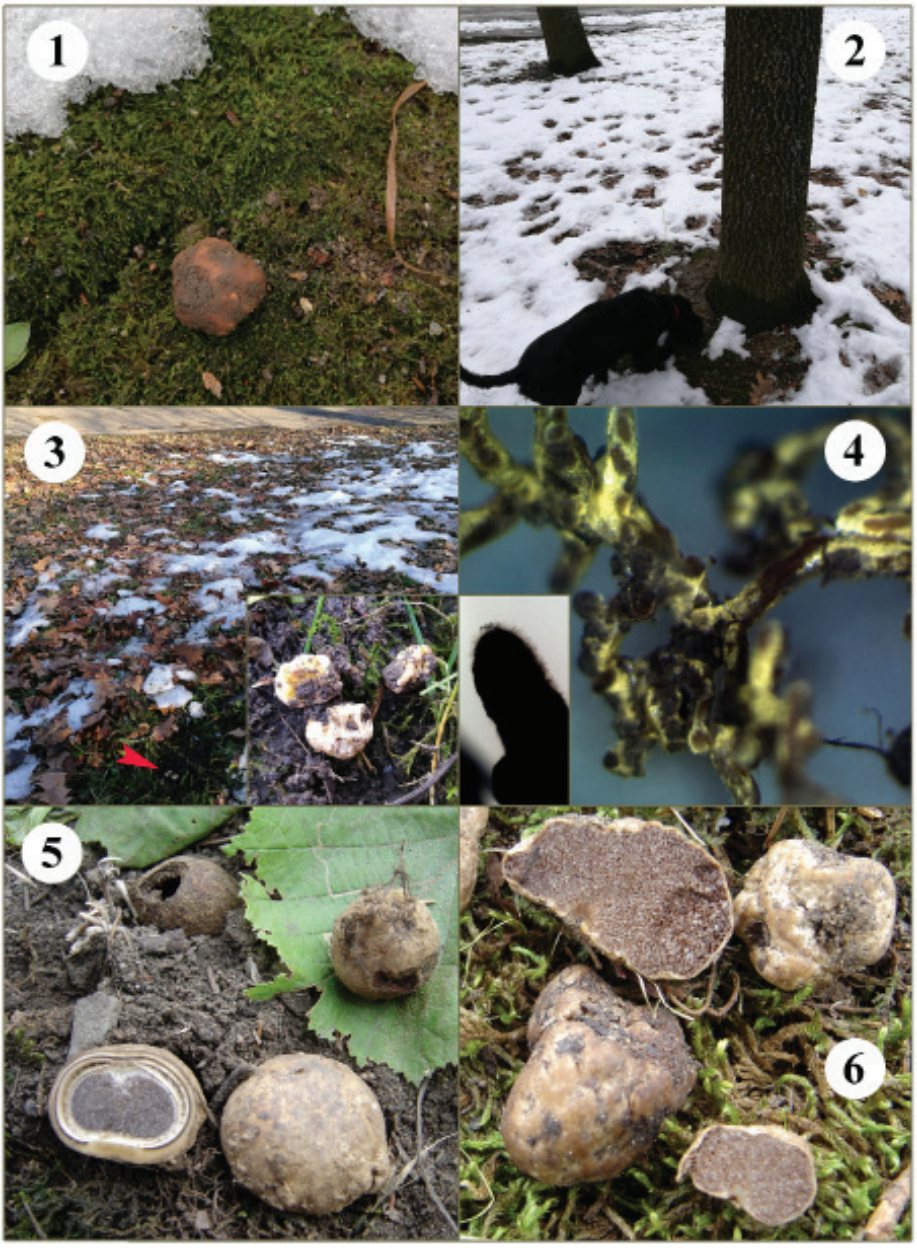

Plate I: **Fig. 1.** *Tuber excavatum* – ascoma *in situ*; **Fig. 2.** *Tuber excavatum* – locality in the Sofia city park *Borisova gradina*; **Fig. 3.** *Hymenogaster luteus* – locality in the Sofia city park *Borisova gradina*; basidiomata *in situ* (red arrow); **Fig. 4.** *Tuber brumale* – ectomycorrhizal root of *Q. robur* – general view (25x) and detail of the surface – cystidia (x63) – left corner; **Fig. 5.** *Elaphomyces granulatus* – ascomata *in situ*; **Fig. 6.** *Rhizopogon parksii* – basidiomata *in situ.*

robur, 20.12.2016-13.02.2017, leg. T. Nedelin, det. M. Gyosheva (SOMF 29716); in the Sofia city park *Loven park*, in soil, under *Q. robur,* 09.01. 2017, leg. & det. T. Nedelin (SOMF 29717). The species was found several times at two places in the Sofia city park *Borisova gradina*.

Endangered (EN) species. It was reported previously in Bulgaria from Rila Mts (Barsakoff 1931) and Centralni Rodopi Mts (Lacheva 2011; Denchev et al. 2015a).

H. verrucosus Bucholtz

Specimens examined: In the Plovdiv city park *Bunardzhika*, near Alyosha monument, in soil, in community of *Acer campestre* L. and *A. platanoides* L., 22.09. 2010*,* leg. & det. M. Lacheva (SOA 6000384); in the Plovdiv city park *Lauta*, in soil, under *Tilia cordata* Mill. and *T. tomentosa* Moench, 17. 08. 2009, leg. & det. M. Lacheva (SOA 6000383).

Endangered (EN) species. Reported previously in Bulgaria from Sredna Gora Mt (Lacheva 2011) and from the lowland Trakiyska nizina: Plovdiv city park *Lauta* (Stoichev & Anastassov 1988; Denchev et al. 2015b) and near Kadievo village (Lacheva 2011).

Boletales

Rhizopogonaceae

Rhizopogon luteolus Fr.

Specimen examined: In Plovdiv city park *Lauta*, in soil, in a community of *Pinus sylvestris* and *Acer negundo* L., 09. 09. 2007, leg. & det. M. Lacheva (SOA 6000389).

This species is widespread. It was reported from five floristic regions (Denchev & Assyov 2010; Lacheva 2012b).

R. parksii A. H. Sm. (**Plate I, Fig. 6**)

Specimen examined: In the Plovdiv city park *Bunardzhika*, in the roots of *Betula* sp., in soil, 06.10.2007, leg. & det. M. Lacheva (SOA 6000386).

This species is less known in Bulgaria. It was reported only once from Sredna Gora Mt (Lacheva 2012b).

DISCUSSION

The present work provides new chorological information for eight hypogeous ascomycetes and basidiomycetes collected by the authors on the territory of the Sofia and Plovdiv city parks. Seven of them are reported for first time from urban park areas of Bulgaria. All species are ectomycorrhizal fungi with roots of trees (Pegler et al. 1993). Three species are true truffles from the genus *Tuber.* Four hypogeous fungi are of high conservation value, included in the Red List of fungi in Bulgaria (Gyosheva et al. 2006) and also in the Bulgarian Red Data Book (Peev et al. 2015). They are listed in the following threat categories: Critically Endangerd

(CR) – one species (*Elaphomyces granulatus*), Endangered (EN) – three species (*Hymenogaster luteus, H. verrucosus* and *Tuber aestivum*).

CONCLUSION

The data presented in the paper suggest the conclusion that the urban green areas in the cities Sofia and Plovdiv are characterized by interesting species diversity of hypogeous macrofungi (ascomycetes and basidiomycetes). This conclusion is supported by the recorded species of conservation value and especially by the truffles. The members of genus *Tuber* are the pioneer species in forest ecosystems. They provide significant benefits for the plants in urban areas – more access to vital nutrients and diminishment of toxic deposits in soils.

Most of the collected hypogeous fungi in the city parks of Sofia and Plovdiv are threatened and less studied in the country. *Tuber brumale, T. excavatum* and *Rhizopogon parksii* should be evaluated according to IUCN criteria at the next update of Red List of fungi in Bulgaria.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this article.

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THE CORAL TOOTH FUNGUS *HERICIUM CORALLOIDES* (SCOP.) PERS. - A NEW MEMBER OF THE URBAN MYCOTA OF SOFIA CITY PARK *BORISOVA GRADINA*

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Abstract. Nowadays the studies of the urban fungal diversity with highlighting mostly macrofungal species of conservation concern is a rapidly growing field of interest. The present paper reports the first finding of the wood-inhabiting fungus *Hericium coralloides* (Scop.) Pers., which has been considered rare and threatened in Europe and is included in the Red List of Bulgarian fungi with *Near Threatened* category, in the Sofia city park *Borisova gradina*. The previous findings of the same species in Plovdiv and in the Sofia park *Vrana* together with the records of another close and threatened species of the same genus, considered as *Endangered* in Bulgaria, namely *H. erinaceus* (Bull.) Pers., in another city park of Sofia – *Zapaden park*, strongly suggests that both tooth fungi tend to be members of the urban mycota in Bulgaria despite their apparent rarity. This serves to prove the need to investigate currently under-utilized opportunity that cities with their distinct species assemblages present for biodiversity conservation, when they are recognized as hotspots for threatened species.

Key words: basidiomycetes, rare species, saprotroph, threatened species, wood-inhabiting fungi

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INTRODUCTION

Nowadays the understanding that cities represent appreciable opportunities for forwarding global biodiversity and sustainability goals increases significantly (Nilon et al. 2017). Therefore, research on urban biodiversity combined with a focus on threatened species conservation is a rapidly growing field of interest (*e.g.* Ives et al. 2016; Norton et al. 2016). This is also valid for the urban fungal diversity with highlighting mostly macrofungal species of greatest conservation concern. In Bulgaria, the macrofungal biodiversity was studied in the parks and streets of the cities Sofia and Plovdiv (for details see Stoyneva & Uzunov 2016). The present paper reports a new species of the urban mycota of Sofia city park *Borisova gradina* – the wood-inhabiting fungus *Hericium coralloides* (Scop.) Pers., which has been considered rare and threatened in Europe (Boddy et al. 2011).

MATERIAL AND METHODS

The finding presented in this study was made by the first author on 31.10.2017 in the north part of Sofia city park *Borisova gradina* (**Fig. 1**). Ten separate basidiomata were found on two dead oak trunks, one fallen and one standing (**Fig. 2a**), nearby to CSKA Sofia Stadium with coordinates 42 40 57 N 23 20 23 E. Small parts of two fruiting bodies from both trunks were collected and were almost immediately transferred to the Department of Botany of the Faculty of Biology of Sofia University "St. Kliment Ohridski", which is situated at the edge of the same city park. Identification was done on the next day after Hansen & Knudsen (1997). The collected specimens are kept in the Mycological Collection of Sofia University "St. Kliment Ohridski". Both species and author names were updated according to the Index Fungorum. The spore observations and measurements were carried out on non-permanent slides using light microscope Motic BA 400. Data on the general species distribution in Bulgaria were consulted mainly with the recent checklist of Bulgarian macromycetes (Denchev & Assyov 2013). According to the map provided by the last authors, it can be stated that they summarized and presented the fungal species distribution in the twenty floristic regions of Bulgaria, proposed by Jordanov (1966). In addition, the distribution provided in the papers by Pencheva et al. (2009), Assyov et al. (2010), Lacheva (2010) and Gyosheva et al. (2016) was taken into account. The nature conservation status was checked in the Red Lists of Bulgarian fungi (Gyosheva et al. 2000, 2006).

RESULTS

The fungus species found on the dead oak trunks (**Fig. 2. a-d**) was identified as *Hericium coralloides* (Scop.) Pers. (Dikaryomycota, Basidiomycetes, Russulales) according to the morphological features of both fruiting bodies (basidiomata,

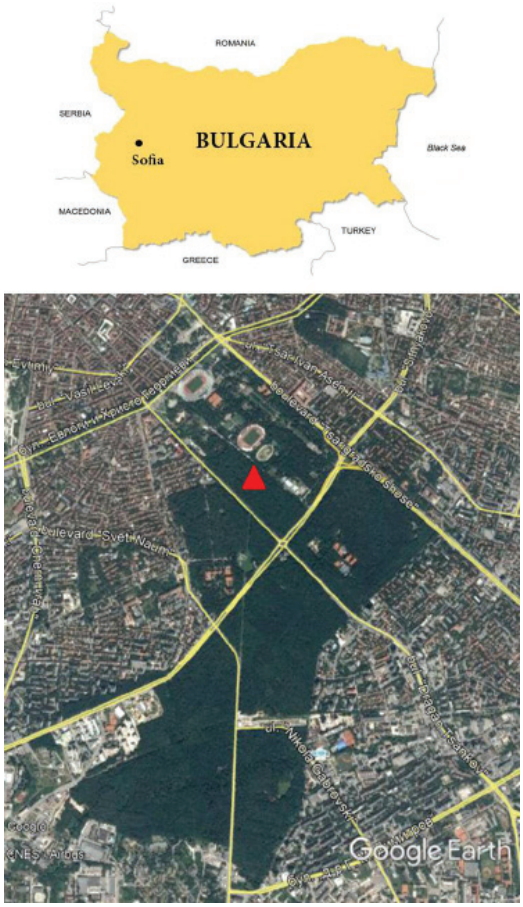

Fig. 1. Map of Bulgaria with indication of the capital city Sofia and Google Earth map of the city park Borisova gradina (dark green colour) with the site of finding of *Hericium coralloides* (top of the red triangular).

basidiocarps) and basidiospores. The basidiomata were up to 25-30 cm in diameter, mostly whitish with visible changes to pinkish or brownish at the surface during aging. They were branchy, coral-like with short (up to 5 mm long) equally distributed protrusions (hymenium spines). The basidiospores were smooth, oval, 2.5-3x3-5 µm. The finding of all well-developed fruiting bodies of the fungus on decaying wood, strongly suggests its saprotrophic character.

DISCUSSION

Hericium coralloides has been seen on living trees, but is widely accepted as a saprotroph that grow on the wood of broadleaved trees and its occurrence usually signify a relatively advanced state of underlying decay (*e.g.* Wald et al. 2004; Boddy et al. 2011). Its attractive fruiting body is commonly known as the *coral tooth fungus*. This macromycetous species has been scarcely distributed and rarely recorded in Europe and Red Listed in several European countries (*e.g.* Bulgaria, Denmark, Germany, Sweden, U.K.), although the rarity yet remains a moot point (*e.g.* Hallenberg 1983; Spooner & Roberts 2005; Boddy et al. 2011). In Bulgaria, in particular, it was documented from the wilderness in eleven regions of Bulgaria - the Black Sea coast, North-East Bulgaria, Forebalkan, Stara planina Mts, Sofia, Znepole region, Rila Mts, Mt Sredna Gora, the Rodopi, Trakiyska nizina, Mt Strandzha (Assyov et al. 2010; Denchev & Assyov 2013; Gyosheva et al. 2016). The species was recorded also in two Bulgarian cities: as a rare lignicolous fungus on the white mulberry *Morus alba* L. in a city park of Plovdiv (Lacheva 2010) and on *Populus* sp. in the park *Vrana* on the eastern edge of Bulgarian capital Sofia (Pencheva et al. 2009). *H. coralloides* was included

in the fungal Red Lists (Gyosheva et al. 2000, 2006) with a *Near Threatened* category. The present record is the first finding of the *coral tooth fungus* in the Sofia central city park *Borisova gradina*, from which recently 115 macrofungal taxa have been reported (Stoyneva & Uzunov 2016).

In spite of the fact that *H. coralloides* and all other *Hericium* species produce basidiomata infreguently (the c*oral tooth fungus* tending to fruit from August to December), their easily visible large and attractive, epaulet-like or fractal-like fruit bodies are hard to miss and are probably not under recorded (Boddy et al. 2011). The previous findings of *H. coralloides* in Sofia and Plovdiv (Pencheva et al. 2009; Lacheva 2010) together with the records of another close species of the same genus, namely *H. erinaceus* (Bull.) Pers. (commonly known as *monkey head*, or *lion's mane fungus*), in another city park of Sofia – *Zapaden park* (Alexov et al. 2012), strongly suggests that both tooth fungi tend to be members of the urban mycota in Bulgaria despite their apparent rarity. According to Boddy et al. (2011) the rarity of the field observations could be explained with the low germination of the basidiospores and the possible latent endophytic development of the mycelia, which grow overtly only when the wood begins to dry (Parfitt et al. 2010). At the same time, it is worth mentioning the threatened character, the nature conservation status and the indicator use of these fungi. For example, *H. coralloides* as a wood-rotting

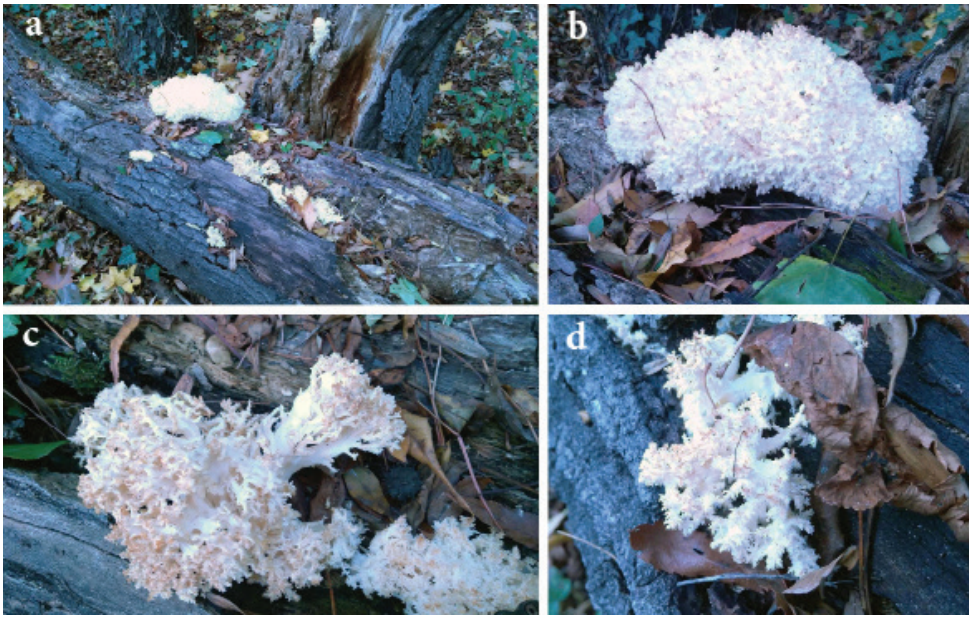

Fig. 2. Basidiomata of *Hericium corraloides* from the Sofia city park *Borisova gradina*: **a** – general view on some basidiomata on two dead *Quercus* trunks; **b** – the largest basidiome of the fungus; **c-d** – brownish and pinkish coloration of the basidiomata surface by aging; the short hymenium spines of the fractal-y branching coral-like bodies are well visible. Scale bar – 10 cm.

hydnoid fungus, was included in the list of 44 species used in a standard method for assessing forest conservation sites in Estonia (Parmasto 2001) and in Bulgaria *H. erinaceus* was Red Listed (Gyosheva 2000, 2006) and included as *Endangered* in the Bulgarian Red Data Book (Gyosheva 2015).

In addition to our previous evaluations of the utility features of the macromycetes from the same Sofia city park *Borisova gradina* (Stoyneva & Uzunov 2016), we have to mention that when young, *H. coralloides* is soft and edible with the slightly acrid taste, but as it ages the branches and hanging spines become brittle (Hansen & Knudsen 1997; Boa 2004).

CONCLUSION

The present record is the first finding of the rare and threatened in Europe coral tooth fungus *H. coralloides* for the Sofia city park *Borisova gradina*. With this last finding, the number of the edible species in this city park becomes 69 (for details check Stoyneva & Uzunov 2016), the number of xylotrophs – 33 (op. cit.) and the number of threatened species - four (or 3%, op. cit.). The recent general distribution of the coral tooth fungus in Bulgaria, which inhabits eleven regions, proves the *Near Threatened* status of the species, which has been declared earlier by Gyosheva et al. (2000, 2006). It is possible to claim also that both tooth fungi *H. coralloides* and *H. erinaceus*, in spite of their rarity and threatened character, could be enlisted as members of the urban mycota in Bulgaria. This serves to prove the need to investigate the currently under-utilized opportunity that cities with their distinct species assemblages present for biodiversity conservation, when they are recognized as hotspots for threatened species (Ives et al. 2016; Aronson et al. 2017).

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this article.

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MAPPING OF ECOSYSTEMS IN MALA PLANINA MT, BULGARIA

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Abstract. The main aim of the current study is to differentiate and analyze types of ecosystems in Mala planina Mt. The investigation is based on the typology of the Working Group for Mapping and Assessment on Ecosystems and their Services (MAES), following Action 5 of the EU Biodiversity strategy requiring member states to map and assess the state of ecosystems and their services in their own territories. The provided methodological framework for mapping of ecosystems is for the continental scale of Europe and it is applied to the local scale of a Bulgarian mountain. The map of the ecosystems in Mala planina Mt based on the MAES typology is created on the basis of information from CORINE Land Cover 2012 dataset. All other ecosystem types of terrestrial category except wetlands, heathland and shrub are presented in a different areal pattern. Grassland, woodland and forest are the most widely distributed ecosystem types of level 2, while urban, cropland and sparsely vegetated areas are randomly distributed.

Key words: ecosystem type, CORINE Land Cover, MAES

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INTRODUCTION

We live in the decade of biodiversity. When the 10th meeting of the Conference of the Parties to the Convention on Biological Diversity was held in Nagoya, Japan, almost seven years ago in October 2010, a Strategic plan for Biodiversity 2011-2020 (CBD & UNEP 2010), which is of a global importance, was discussed. The Aichi Biodiversity Targets (CBD & UNEP 2010) were also agreed by governments. The constantly raising awareness regarding the significance of biodiversity and ecosystem preservation led to development of EU Biodiversity Strategy, aiming to fight against the loss of biodiversity and ecosystem services in the European Union (http://ec.europa.eu/environment/nature/biodiversity/strategy/index_en.htm). Many tasks were designed, and one of them was applied by the Working Group for Mapping and Assessment on Ecosystems and their Services (MAES), following Action 5 of the EU Biodiversity strategy. The member states of European Union were required to map and assess the status of the ecosystems and their services in their own territories. The economic importance and value of these services have to be assessed as well. The first and the second technical reports (Maes et al. 2013, 2014) provided a coherent analytical framework and indicators that member states are obliged to apply to mapping and assessment of biodiversity, ecosystem condition and ecosystem services.

Nedkov et al. (2017) proved the applicability of the mapping of the ecosystems in Bulgaria (as a member country of EU) based on MAES typology. The present paper is aimed on differentiation and analysis of different types of ecocystems in Mala planina Mt based on the same typology.

MATERIALS AND METHODS

The aim of the study is to differentiate and analyze different types of ecosystems in Mala planina Mt. The studied area is located in the western part of the country, going to the north of the capital city Sofia. The boundaries of Mala planina Mt are discussed by Grigorov & Assenov (2015). The investigation of the ecosystems in the area is based on the MAES typology (http://biodiversity.europa.eu/maes/typology-of-ecosystems) which consists of three major ecosystem categories: terrestrial, fresh water and marine, marked as level 1, and these three categories are subdivided into ecosystem types for mapping and assessment at level 2. This subdivision, in particular, is the basis of the investigation of ecosystems in Mala planina Mt. The terrestrial category is subdivided into seven ecosystem types at level 2: urban, cropland, grassland, woodland and forest, heathland and shrub, sparsely vegetated land and wetland. Considering the geographic characteristics of the studied area, the other two major categories at level 1 may be omitted.

The CORINE Land Cover 2012 dataset was a free download from the Executive Environment Agency website (http://eea.government.bg/bg/projects/

korine-14/kzp-danni-clc-data). It corresponds directly to MAES' ecosystem types at level 2 (Maes et al. 2013). The information concerning the territory of Mala planina Mt was extracted from the dataset and modified for the purpose of investigation. The mountainous territory consists of 15 CORINE Land Cover classes at level 3 (**Fig. 1**). They are as follows: discontinuous urban fabric, industrial or commercial units, mineral extraction sites, non-irrigated arable land, fruit trees and berry plantations, pastures, complex cultivation pat-terns, land principally

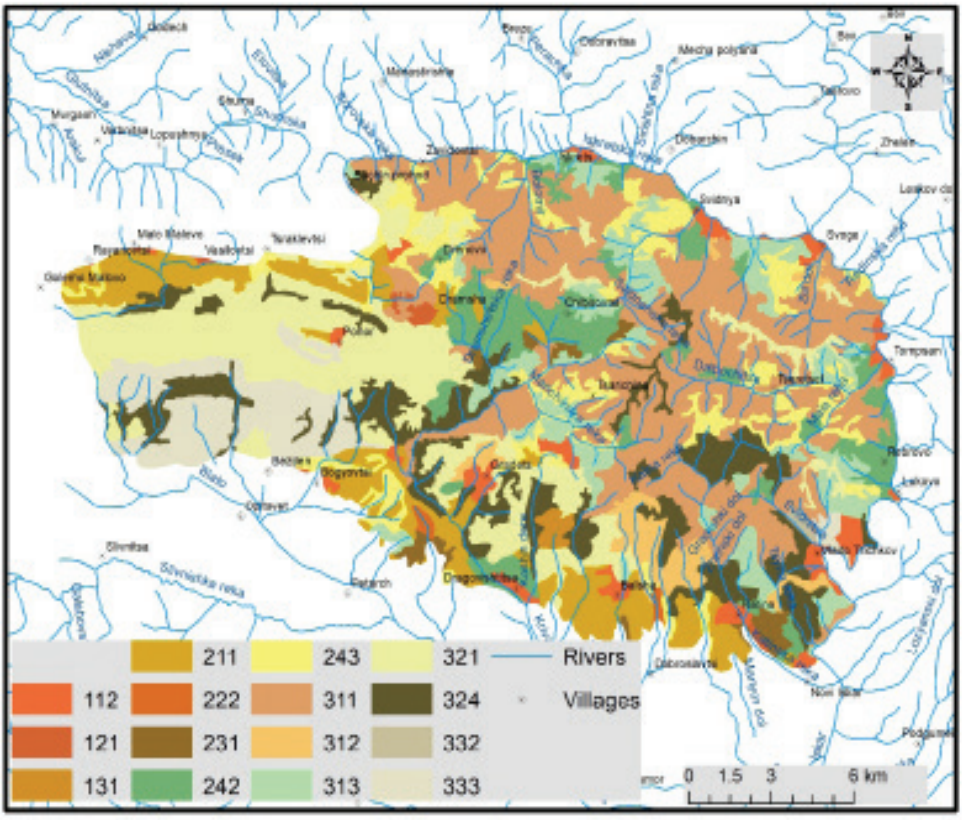

Fig. 1. CORINE Land Cover 2012 dataset for Mala planina Mt.

occupied by agriculture with significant areas of natural vegetation, broad-leaved forest, coniferous forest, mixed forest, natural grassland, transitional woodland/ shrub, bare rock, sparsely vegetated areas. As far as the territory of Mala planina is concerned, apart from wetlands and heathland and shrub, all other five types of the terrestrial category are represented in the investigated area. The map of the ecosystems in Mala planina Mt was created by the use of ArcGIS 10 software product by establishing the correspondence between the presented CORINE Land Cover classes at level 3 with the proposed ecosystem types at level 2.

RESULTS

The total area covered by the mountain is 351.3 km². Five ecosystem types of level 2 (MAES typology) are represented in Mala planina (**Fig. 2**). 164.9 km² or 46,9 % of the territory is covered by the woodland and forest ecosystem type. This is the most widely spread ecosystem type in the studied area. Among the EUNIS habitats, the largest territories of this ecosystem type are covered by: Moesio-Danubian thermophilous oak forests (G1.768), Dacio-Moesian hornbeam forests (G1.A322), Moesian white oak woods (G1.7372) and Balkan Range neutrophile beech forests (G1.6932). The dominant species in the current ecosystem type

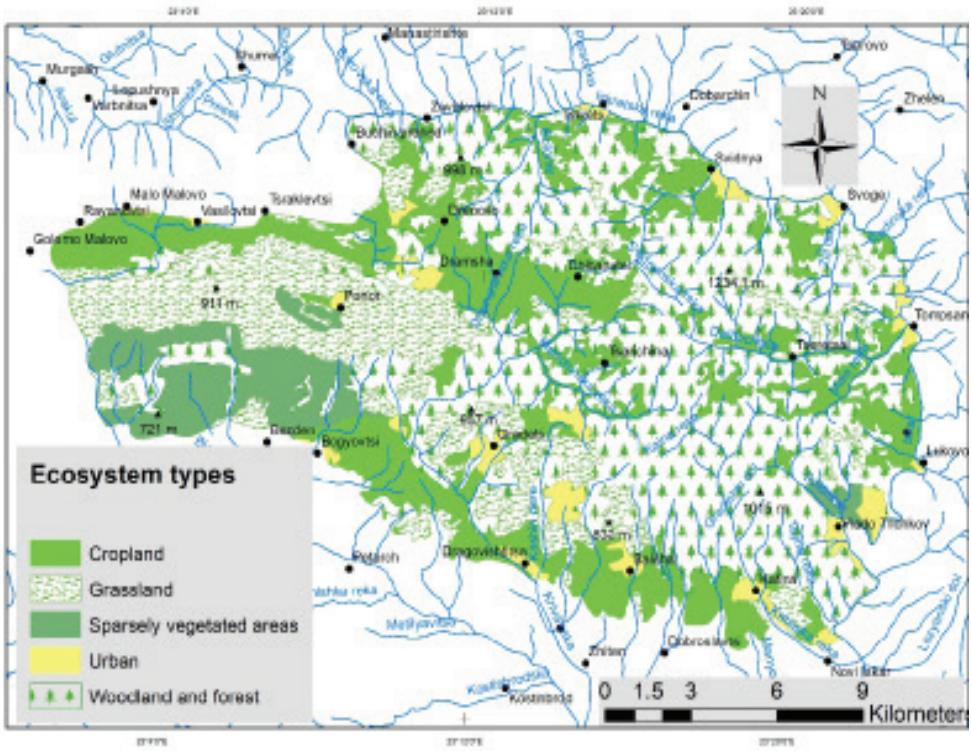

Fig. 2. Ecosystem types of Mala Planina according to MAES typology.

are *Quercus dalechampii* Ten., *Quercus cerris* L., *Quercus frainetto* Ten., *Fagus sylvatica* L., *Carpinus betulus* L., *Acer pseudoplatanus* L., *Fraxinus excelsior* L., *Fraxinus ornus* L., *Quercus pubescens* Willd. and *Carpinus orientalis* Mill. Middle European dry-slope limestone beech forests (G1.661), Dacio-Moesian ash-alder woods (G1.2116), Eastern European poplar-willow forests (G1.1112), Deciduous exotic *Quercus* plantations (G1.C2) and *Robinia* plantations (G1.C3), dominated by *Alnus glutinosa* (L.) Gaertn., *Robinia pseudoacacia* L., *Quercus rubra* L., *Salix*

purpurea L. occupy more limited territories. Woodlands and forests are located mainly in the eastern part of Mala planina Mt and their highest density is in remote areas, where the influence of the anthropogenic factor is weaker. The ridge Kamuka which in fact represents the western part of Mala planina Mt, lacks widely dispersed woodland and forest areas with the exception of few oak forests in the coombs to the south.

Croplands occupy the second place as an ecosystem type in Mala Planina, as far as covered area is concerned. They share 24,7% of the whole territory, or ca. 87.1 km². Croplands are situated to the north, where Mala planina Mt is divided from the Chepun Mt, especially near the villages of Tsruklevtsi, Vasilovtsi, Malo Malovo, Rayanovtsi and Golemo Malovo. This is a flat territory, where different kinds of crops, such as wheat, maize and a variety of vegetables are grown. Other wide croplands are situated on the lands of villages at the central part of Mala planina Mt - Drumsha, Drenovo and Chibaovtsi. There is also a band of croplands to the south, where the downward movement of Mala Planina slopes gently transforms in the flatland of Sofia valley (Sofiysko pole) - ranging from the village of Bogyovtsi to the village of Kutina. The other cropland areas in the investigated territory have fragmented distribution. A part of them can be seen near the gorge of Iskur River (Iskursko defile) surrounding the town Novi Iskur and the villages Vlado Trichkov, Lukovo and Tompson. However, the steep slopes of Mala planina to the east prevent development of vast cropland areas. Another fragmented band of croplands is observed to the north, near Iskretska River's valley. This part of the mountain is also characterized by steep slopes with a significant denivelation and the few cropland areas cover the territories of villages Buchin prohod, Zavidovtsi, Iskrets and Svidnya, as well as the area of Svoge town.

Grassland ecosystems are at the third place by territorial coverage in Mala planina (62.2 km² of the mountain, or 17,7%.) The vastest territories covered by this type of vegetation are located to the west from the ridge Kamuka. Among the EUNIS habitats, Moesio-Carpathian steppes (E1.222), Moesio-Carpathian meadow-steppes (E1.234), Helleno-Balkanic *Satureja montana* steppes (E1.21), Low and medium altitude hay meadows (E2.2), *Molinia caerulea* meadows and related communities (E3.51) and Balkan Range calcicolous chasmophyte communities (H3.2A13) cover the largest territories of this ecosystem type. The dominant species are: *Festuca valesiaca* Schleich. ex Gaudin, *F. stojanovii* (Acht.) Kožuharov, *F. dalmatica* (Hack.) K. Richt., *F. rupicola* Heuff., *Dichanthium ischaemum* (L.) Roberty, *Chrysopogon gryllus* (L.) Trin., *Poa pratensis* s.l., *Briza media* L., *Thymus* spp., *Dactylis glomerata* L. and *Molinia caerulea* (L.) Moench. Apart from the ridge Kamuka, there are also fragmented grassland ecosystems - in the triangle of Gradets, Balsha and Dragovisthitsa to the south, near the villages of Chibaovtsi, Tsarichina, Drenovo and Buchin prohod to the north.

The ecosystem type of sparsely vegetated areas covers 23.7 km² or 6,8% of Mala planina. These ecosystems are located in the central and southern parts of the

ridge Kamuka, between the villages of Ponor and Bezden, as well as near Vlado Trichkov village. Apart from forest and grassland, shrub vegetation is also formed here. The EUNIS habitats are Moesian oriental hornbeam thickets (F3.2431) and Moesian lilac thickets (F3.2432), dominated by the species of *Carpinus orientalis* Mill., *Rosa canina* L., *Crataegus monogyna* Jacq. and *Syringa vulgaris* L.

The urban areas occupy 3,9 % of the mountain (13,4 km²) territory. Two towns (Svoge and Novi Iskur), larger villages (Iskrets, Svidnya, Gradets, Chibaovtsi, Drumsha) and a few smaller villages (such as Rayanovtsi, Malo Malovo, Vasilovtsi, Tseretsel) are situated in Mala planina. An important characteristic of the mountain is the presence of enormous number of villas, cottages and huts, adding more weight to the anthropogenic influence, typical for urban areas. It is essential to stress that the urban ecosystem type in level 2 of MAES typology do not always cover all parts of a particular village. Based on the fragmentation in the distribution of secluded villas in the outer layers of a village, there are sections that are not included in the urban ecosystem category, but in one of the other types. There are villages, which do not fall in this category at all, following their scattered character (*e.g.* Tseretsel and Tsarichina villages).

CONCLUSION

The typology of Working Group for Mapping and Assessment on Ecosystems and their Services (MAES) is a direct result from European Union challenge - each member state to map and assess the state of ecosystems and the services they provide in their own territory. This study is based on the application of this approach on a small scale: to a mountainous territory of Bulgaria, Mala planina, in particular. There twelve ecosystem types based on EUNIS habitat classification were identified. Five of the seven ecosystem types in level 2 (terrestrial major category in MAES typology) are represented in the studied area, with the exception of wetlands and heathland and shrub.

Using a map, based on CORINE Land Cover 2012 dataset, for the territory of Mala planina, a new map is generated, comprising the ecosystem types in MAES typology. The largest area of the mountain (46,9 % of its territory) is occupied by the woodland and forest ecosystem type, while the smallest area (3,9%) belongs to the urban type. The typical plant species for a mountain range at these latitudes dominate in the described ecosystem types. They play an important role for the presence and health of ecosystems in Mala planina Mt. The grassland ecosystem type takes up to 17,7% of the mountain area, while it is also an integral part of the sparsely vegetated areas. The croplands are the other integral type of ecosystem in Mala planina, covering over 87 km².

The current investigation, along with the work of Nedkov et al. (2017) can be used as a base for other studies, concerning the application of MAES typology for ecosystems in Bulgaria. The present study shows promising results and it can

be used as an example for more comprehensive and elaborate future investigations of ecosystems diversity in Mala planina and in the Western Balkans.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this article.

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VASCULAR PLANT BIODIVERSITYOF THE NATURAL NON-FOREST HABITATS IN THE NATURA 2000 PROTECTED SITES *KAMCHIA* (BG0000116) AND *SHKORPILOVTSI BEACH* (BG0000100)

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Abstract. The current state of the vascular plant biodiversity of four natural non-forest habitats in the protected sites *Kamchia* and *Shkorpilovtsi Beach* was evaluated.

The study was carried out in the framework of the project *Mapping and determination of the environmental status of natural habitats and species – phase I. Contract Nr. 04-014/05.04.2011*.

Totally 96 species of vascular plants were recorded, 47 in *Kamchia* and 81 in *Shkorpilovtsi Beach*. Among them fifteen species were with conservation status. Due to the negative impact of the intensive development of tourism and urbanization, construction works, waste, camping and sand thickening, the future permanent monitoring of both sites is strongly recommended.

Key words: anthropogenic factors, Black Sea coast, flora, non-forest habitats, protected species, threatened species

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INTRODUCTION

The coastal Natura 2000 protected sites *Kamchia* (BG0000116, 129 199.37 dka) and *Beach Shkorpilovtsi* (BG0000100, 51256.53 dka**)** were declared as such in 2007 (State Gazette № 107/2007). Both sites are protected according to Directive 92/43/EEC (1992) (more popular as the Habitat Directive) and Directive 2009/147/EC (Birds Directive) under the names *Complex Kamchia* (BG0002045) and *Kamchia Mountains* (BG0002044).

The plant biodiversity of *Complex Kamchia* was studied by Ivanov et al. (2002) who found 442 species from 79 families. Data on vascular plant species occurring as dominants or accompanying taxa were

Table 1. Geographical coordinates of the experimental plots (EP) in the non-forest natural habitats recorded in the Natura 2000 protected sites *Kamchia* (K) and *Shkorpilovtsi Beach* (S).

Experimental Plots	Geographical coordinates		Altitude [m]	Date
	N	E		
Geographical coordinates of phytocenological descriptions of natural habitat 1240				
EP 1 S	42.92084	27.89738	0	23.07.2011
Geographical coordinates of phytocenological descriptions of natural habitat 2110				
EP 1 K	42.98357	27.89254	0	1.08.2011
EP 2 K	42.98954	27.89139	0	1.08.2011
EP 3 K	43.01356	27.88931	0	2.08.2011
EP 4 S	42.94431	27.90174	0	21.07.2011
EP 5 S	42.95154	27.89968	2	22.07.2011
EP 6 S	42.92026	27.89664	1	23.07.2011
EP 7 S	42.97901	27.89347	6	25.07.2011
Geographical coordinates of phytocenological descriptions of natural habitat 2120				
EP1 K	43.02508	27.88885	2	2.08.2011
EP 2 K	43.02017	27.88876	4	2.08.2011
Geographical coordinates of phytocenological descriptions of natural habitat 2130				
EP 1 K	42.99013	27.88729	0	1.08.2011
EP 2 K	43.01715	27.88831	4	2.08.2011
EP 3 K	42.99861	27.88650	0	6.08.2011
EP 4 S	42.97836	27.89257	9	21.07.2011
EP 5 S	42.94812	27.90052	3	22.07.2011
EP 6 S	42.96499	27.89629	2	24.07.2011
EP 7 S	42.94899	27.89990	0	25.07.2011

provided by Tzonev et al. (2005) in a more general study of the psammophyte vegetation along the Black Sea coast. The conservation importance of plant diversity of the dune complexes of the Northern Black Sea coast was evaluated and lead to the classification of the outflow of the Kamchiya river as an Important Plant Area – IPA (Peev et al. 2003, 2009). The aim of the present paper is to provide recent data on the vascular plant biodiversity of the non-forest natural habitats of both protected sites and its conservational significanse.

MATERIAL AND METHODS

The field work was carried out in the period July-September 2011. The complete floristic inventory was done in 17 experimental plots (EP), each 16 m^2 (4x4 m). The plots were situated in the non-forest habitats of both sites. In addition, the of cover of each taxon was evaluated by percent coverage and abundance after the scale of Braun-Blanquet (1964). The identification of habitats was done according to Kavrukova et al. (2008), Bulgarian Red Data Book (Biserkov 2015) and the EUNIS classification. Choosing the places for description was done after visual evaluation of typical sectors within a plant community. GPS coordinates, including altitude, were scored for each EP with the dates of visits and descriptions (**Table 1**).

The plant taxa were identified according to Jordanov (1963-1989), Kuzmanov (1979), Velchev (1982, 1989), Kožuharov (1995), Delipavlov & Cheshmedzhiev (2011) and Kožuharov & Anchev (2012). The conservation status of each species was evaluated after the Red List of Bulgarian vascular plants (Petrova & Vladimirov 2009), Bulgarian Red Data Book of plants and fungi (Peev 2015), Biological Diversity Act (Act on Amending and Supplementing) /2007/(Appendices №3 and 4, amended State Gazette №101/22.12.2015), Directive 92/43/EC/21.05.1992 for conservation of natural habitats of the wild flora and fauna, Convention on the Conservation of European Wildlife and Natural Habitats Appendix I. (Bern Convention 1979), List of Rare, Threatened and Endemic Plants in Europe (Lucas 1983) and European Red List of Vascular Plants (Bils et al. 2011).

RESULTS

During this study four types of non-forest natural habitats were recorded: 1) Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp. (1240). EUNIS: B3.3321 Western Pontic herbaceous sea-cliff communities; B3.3322 Western Pontic sea-cliff [*Ficus*] thickets; 2) Embryonic shifting dunes (2110). EUNIS: B1.313 Pontic embryonic dunes; 3) Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) (2120). EUNIS: B1.324 Pontic white dunes; 4) Fixed coastal dunes with herbaceous vegetation (grey dunes) (2130). EUNIS: Southwestern Pontic fixed dunes. Their conservational significance is shown in **Table 2**.

Table 2. Conservation significance of the natural habitats in the Natura 2000 protected areas *Kamchia* and *Beach Shkorpilovtsi*. Abbreviations: CN – Code Natura 2000, BDA – Biodiversity Act (2007), BC – Bern Convention (1979), D92 - Directive 92/43/EEC, BRDB - Bulgarian Red Data Book of habitats (Biserkov 2015) with the following categories: EN – Endangered, CR – Critically Endangered, VU – Vulnerable, NT – Near Threatened.

№	Natural habitats	CN	BDA	BC	D92	BRDB
1	Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp.	1240	+	-	+	EN
2	Embryonic shifting dunes	2110	+	+	+	EN
3	Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes)	2120	+	+	+	EN
4	Fixed coastal dunes with herbaceous vegetation (grey dunes)	2130	+	+	+	EN

Table 3. Floristic and phytocenological characterization of natural habitat 1240 *Vegetated sea cliffs of the Mediterranean coasts with endemic Limonium* spp. in the in the experimental plot (EP1) in the protected site *Beach Shkorpilovtsi*.

№	Species	Abundance (after Braun-Blanquet 1964)
		EP1
Trees		
1	*Gleditsia triacanthos* L.	1
2	*Robinia pseudoacacia* L.	+
3	*Ulmus minor* Mill.	+
Shrubs		
4	*Cionura erecta* (L.) Griseb.	1
5	*Colutea arborescens* L.	1
6	*Jasminum fruticans* L.	+
Herbaceous plants		
7	*Anthemis tinctoria* L.	+
8	*Atriplex hastata* L.	1 - 2
9	*Avena fatua* L.	+
10	*Bromus sterilis* L.	+
11	*Cardaria draba* (L.) Desv.	+
12	*Chenopodium album* L.	+
13	*Chenopodium opulifolium* Schred. ex Koch & Ziz	+

№	Species	Abundance (after Braun-Blanquet 1964)
		EP1
14	*Chondrilla juncea* L.	+
15	*Convolvulus lineatus* L.	+
16	*Crithmum maritimum* L.	+
17	*Cynanchum acutum* L.	+ - 1
18	*Ecballium elaterium* (L.) A. Rich.	2
19	*Erysimum diffusum* Ehrh.	+
20	*Euphorbia agraria* M. Bieb.	+
21	*Goniolimon collinum* (Griseb.) Boiss.	+
22	*Hypericum perforatum* L.	+
23	*Lactuca tatarica* (L.) C. A. Mey.	+
24	*Lappula marginata* (M. Bieb.) Gurke	+
25	*Linaria genistifolia* (L.) Mill.	+
26	*Melica ciliata* L.	+
27	*Melilotus albus* Medicus	1 - 2
28	*Polygonum aviculare* L.	+
29	*Reseda lutea* L.	+
30	*Salsola ruthenica* Iljin	+
31	*Scabiosa argentea* L.	+
32	*Silene euxina* (Rupr.) Hand.-Mazz.	+
33	*Solanum nigrum* L.	+
34	*Sonchus oleraceus* L.	+
35	*Verbascum* sp.	+
36	*Xanthium italicum* Moretti	+
37	*Xeranthemum annuum* L.	+ - 1

All results on the vascular plant biodiversity obtained during the study are presented in **Tables 3-6** for each of the non-forest habitats of both protected sites, respectively. According to the number of species found in each of these habitats it could be stated that habitat 2130 had the highest plant biodiversity (46).

Totally 96 vascular plant species were recorded, 47 in *Kamchia* and 81 in *Shkorpilovtsi Beach*. Fifteen of these, or 16%, were of conservation importance, twelve of which occurred in the PS *Kamchia*, and thirteen – in the PS *Beach Shkorpilovtsi* (**Table 7**).

Table 4. Floristic and phytocoenological characterization of the natural habitat 2110 *Embryonic shifting dunes* in the experimental plots (EP) in the protected sites *Kamchia* (EP1K-EP3K) and *Beach Shkorpilovtsi* (EP4S-EP7S).

№	Species	Abundance (after Braun-Blanquet 1964)						
		EP1K	EP2K	EP3K	EP4S	EP5S	EP6S	EP7S
Trees								
1	*Fraxinus oxycarpa* M. Bieb. ex Willd.	-	-	-	-	-	+	-
Shrubs								
2	*Periploca graeca* L.	-	1	-	-	-	-	-
Herbaceous plants								
3	*Alyssum borzaeanum* Nyar.	+	r	+	-	-	-	-
4	*Ammophila arenaria* (L.) Link	+	+ - 1	+	+	+ - 1	2 - 3	1
5	*Anchusa velenovskyi* (Gusul.) Stoj.	-	r	-	-	-	-	-
6	*Artemisia campestris* L.	+	1	2	-	-	-	1
7	*Bromus tectorum* L.	-	-	-	+	-	-	-
8	*Cakile maritima* Scop.	-	-	-	-	-	+	-
9	*Carex ligerica* J. Gay	-	-	-	-	1	-	-
10	*Centaurea arenaria* M. Bieb.	+	+	+	+	-	-	+
11	*Chondrilla juncea* L.	-	-	-	-	+	+	-
12	*Cichorium intybus* L.	-	-	-	-	-	+	-
13	*Conium maculatum* L.	-	-	-	-	-	+	-
14	*Conyza canadensis* (L.) Cronquist	-	-	-	-	-	+	-
15	*Crambe maritima* L.	+	+	-	+	+	1	+
16	*Elymus farctus* (Viv.) Runemark ex Melderis	1	1	1	-	2	-	+
17	*Eryngium maritimum* L.	2	+	-	+	+ - 1	+	1 - 2
18	*Euphorbia paralias* L.	+	-	-	-	-	-	-
19	*Euphorbia peplis* L.	+	-	+	-	+	+	-
20	*Galilea mucronata* (L.) Parl.	-	+	-	-	-	-	-
21	*Glaucium flavum* Crantz	-	-	-	-	-	+ - 1	-
22	*Jasione heldreichii* Boiss. & Orph.	+	+	-	-	-	-	-
23	*Jurinea albicaulis* Bunge	1 - 2	1 - 2	1	1	+	-	+ - 1
24	*Lactuca tatarica* (L.) C. A. Mey.	+ - 1	+	-	-	-	+ - 1	+
25	*Leymus racemosus* (Lam.) Tzvelev	1	1	+	1	+ - 1	-	1
26	*Linaria genistifolia* (L.) Mill.	+	r	+	+	+	+	+
27	*Medicago falcata* L.	-	-	-	2	+	+	-
28	*Medicago minima* (L.) Bartal.	-	-	-	-	-	+	-
29	*Melilotus albus* Medicus	-	-	-	-	-	+ - 1	-
30	*Peucedanum arenarium* Waldst. & Kit.	+	+	-	-	-	-	-

№	Species	Abundance (after Braun-Blanquet 1964)						
		EP1K	EP2K	EP3K	EP4S	EP5S	EP6S	EP7S
31	*Plantago scabra* Moench	-	-	+	-	-	-	+
32	*Polygonum maritimum* L.	+	-	+	-	-	-	+
33	*Salsola ruthenica* Iljin	+	+	+ - 1	+	+	-	+
34	*Scabiosa argentea* L.	-	-	-	+	-	-	-
35	*Secale sylvestre* Host	+	-	-	+	-	-	-
36	*Silene euxina* (Rupr.) Hand.-Mazz.	+	+	+	+	+	-	-
37	*Silene thymifolia* Sm.	+	+	1	+ - 1	-	-	+
38	*Stachys maritima* Gouan	+	-	+	-	-	+	-
39	*Teucrium polium* L.	-	-	-	+	-	-	-
40	*Tragopogon* sp.	-	-	-	-	-	+	-
41	*Tribulus terrestris* L.	-	-	-	-	-	+	-
42	*Xanthium italicum* Moretti	+	-	+	+	+	+ - 1	+

Table 5. Floristic and phytocoenological characterization of the natural habitat 2120 *Shifting dunes along the shoreline with Ammophila arenaria (white dunes)* in the experimental plots (EP) in the protected site *Kamchia* (EP1K-EP2K).

№	Species	Abundance (after 1964) Braun-Blanquet	
		EP1K	EP2K
Shrubs			
1	*Amorpha fruticosa* L.	+	-
Herbaceous plants			
2	*Ammophila arenaria* (L.) Link	2-3	2
3	*Artemisia campestris* L.	-	1
4	*Centaurea arenaria* M. Bieb.	-	+
5	*Elymus farctus* (Viv.) Runemark ex Melderis	-	+ - 1
6	*Eryngium maritimum* L.	1	+
7	*Euphorbia peplis* L.	-	+
8	*Lactuca tatarica* (L.) C. A. Mey.	1 - 2	1
9	*Leymus racemosus* (Lam.) Tzvelev	+	+ - 1
10	*Phragmites australis* (Cav.) Trin. ex Steud.	+	-
11	*Salsola ruthenica* Iljin	-	+
12	*Xanthium italicum* Moretti	+	+

Table 6. Floristic and phytocoenological characterization of the natural habitat 2130 *Fixed coastal dunes with herbaceous vegetation (grey dunes)* in the in the experimental plots (EP) in the protected areas *Kamchia* (EP1K-EP3K) and *Beach Shkorpilovtsi* (EP4S-EP7S).

№	Species	Abundance (after Braun-Blanquet 1964)						
		EP1K	EP2K	EP3K	EP4S	EP5S	EP6S	EP7S
Trees								
1	*Pyrus pyraster* Burgsd.	-	-	+	-	-	-	-
Shrubs								
2	*Chamaecytisus heuffelii* (Wierzb.) Rothm.	-	-	-	-	-	+	-
3	*Crataegus monogyna* Jacq.	-	-	+	-	-	-	-
Herbaceous plants								
4	*Agrostis capillaris* L.	-	-	1	-	-	-	-
5	*Allium flavum* L.	-	-	-	-	-	-	+
6	*Allium* sp.	+	-	+	-	-	-	+
7	*Alyssum borzaeanum* Nyar.	-	2 - 3	-	1	+	1	+
8	*Artemisia campestris* L.	1 - 2	1	2	1	-	1 - 2	-
9	*Aurinia uechtritziana* (Bornm.) Cullen & Dudley	1 - 2	+	-	1	-	+	+ - 1
10	*Bromus tectorum* L.	-	-	-	-	+	-	+
11	*Carex ligerica* J. Gay	+ - 1	-	-	-	-	+	3
12	*Centaurea arenaria* M. Bieb.	+	-	2	+	+	+	+ - 1
13	*Cerastium* sp.	+	-	-	-	-	-	-
14	*Chondrilla juncea* L.	-	-	+ - 1	-	+	-	1 - 2
15	*Chrysopogon gryllus* (L.) Trin.	-	-	1 - 2	-	-	-	-
16	*Conyza canadensis* (L.) Cronquist	-	-	-	-	-	-	+
17	*Daucus guttatus* Sm.	-	-	-	-	-	-	+
18	*Erysimum diffusum* Ehrh.	-	-	+	-	-	-	-
19	*Festuca valesiaca* Schleich. ex Gaudin	+ - 1	-	-	-	-	-	-
20	*Galilea mucronata* (L.) Parl.	-	-	-	2	2	1 - 2	-
21	*Gnaphalium luteo-album* L.	+	-	-	-	-	-	+
22	*Iris pumila* L.	-	-	+	-	-	-	-
23	*Jasione heldreichii* Boiss. &Orph.	+ - 1	+ - 1	2	+ - 1	2	1 - 2	1 - 2
24	*Jurinea albicaulis* Bunge	-	+	-	+ - 1	1 - 2	1	1
25	*Lactuca serriola* L.	-	-	-	-	-	-	+
26	*Lerchenfeldia flexuosa* (L.) Schur	-	-	-	+	-	-	-
27	*Linaria genistifolia* (L.) Mill.	+	+	+	+	+	+	-
28	*Linum tauricum* Willd.	-	-	-	-	+	-	-
29	*Medicago falcata* L.	-	-	-	-	+	+	+

№	Species	Abundance (after Braun-Blanquet 1964)						
		EP1K	EP2K	EP3K	EP4S	EP5S	EP6S	EP7S
30	*Orobanche* sp.	-	-	+	-	-	-	-
31	*Papaver rhoeas* L.	-	-	-	+	-	-	+
32	*Papaver* sp.	-	-	-	-	+	+	-
33	*Peucedanum arenarium* Waldst. & Kit.	-	-	-	-	+	+	-
34	*Plantago scabra* Moench	-	-	-	-	+	-	-
35	*Rumex tenuifolius* (Wallr.) A. Love	+ - 1	-	+	-	+	-	+
36	*Scabiosa argentea* L.	-	1	-	+ - 1	+	+	-
37	*Secale sylvestre* Host	-	-	-	-	+	-	-
38	*Sideritis montana* L.	-	-	+	-	-	-	-
39	*Silene euxina* (Rupr.) Hand.-Mazz.	+	+	-	+	+	+	-
40	*Silene frivaldszkyana* Hampe	+	-	2	-	-	-	-
41	*Silene thymifolia* Sm.	-	1 - 2	-	+	1	+	-
42	*Stachys maritima* Gouan	-	-	-	-	-	+	-
43	*Teucrium polium* L.	-	+ - 1	-	+	+	-	-
44	*Trifolium arvense* L.	-	-	-	-	-	-	1
45	*Xeranthemum annuum* L.	-	-	+	-	-	-	-
46	Bryophyta	-	4	5	3	-	-	-

Table 7. Conservation status of the species of higher plants established on the territory of the protected areas *Kamchia* and *Beach Shkorpilovtsi*: Abbreviations: BRDB - Bulgarian Red Data Book of Plants and Fungi (Peev 2015) with the following categories: EN – Endangered, CR – Critically Endangered, VU – Vulnerable, NT – Near Threatened, E - List of Rare, Threatened and Endemic Plants in Europe (Lucas 1983) for Bulgaria (E-BG) and Europe (E-EU) with I - Indeterminate and V - Vulnerable; EPL - European Red List of Vascular Plants (Bils et al. 2011) with the category Data Deficient – DD; EL2 – European List (2011); BE – Balkan Endemic, BDA – Biodiversity Act (2007), BC – Bern Convention (1979). Species indexed by 1 – the species was recorded on the territory of *Kamchia*; Index 2 – the species was recorded on the territory of *Beach Shkorpilovtsi*.

№	Species	BRDB	E-BG	E-EU	EPL	BE	BDA	BC
1[1,2]	*Alyssum borzaeanum* Nyar.	EN	R	I	DD	-	+	+
2[1]	*Anchusa velenovskyi* (Gusul.) Stoj.	-	-	-	-	+	+	-
3[1,2]	*Aurinia uechtritziana* (Bornm.) Cullen & Dudley (Syn.: *Lepidotrichum uechtritziana* (Bornm.) Velen.)	EN	V	V	DD	-	+	+
4[1,2]	*Centaurea arenaria* M. Bieb.	-	-	-	-	-	+	-
5[2]	*Convolvulus lineatus* L.	EN	-	-	-	-	+	-
6[2]	*Crithmum maritimum* L.	EN	-	-	-	-	-	-

№	Species	BRDB	E-BG	E-EU	EPL	BE	BDA	BC
7[1,2]	*Eryngium maritimum* L.	EN	-	-	-	-	+	-
8[1,2]	*Euphorbia peplis* L.	-	-	-	-	-	+	-
9[1,2]	*Galilea mucronata* (L.) Parl. (Syn.: *Schoenus mucronatus* L.)	EN	-	-	-	-	-	-
10[2]	*Goniolimon collinum* (Griseb.) Boiss.	-	-	-	-	-	+	-
11[1,2]	*Lactuca tatarica* (L.) C. A. Mey.	EN	-	-	-	-	+	-
12[1,2]	*Silene euxina* (Rupr.) Hand.-Mazz.	EN	-	-	-	-	+	-
13[1]	*Silene frivaldszkyana* Hampe	-	-	-	-	+	-	-
14[1,2]	*Silene thymifolia* Sm.	EN	-	-	-	+	-	-
15[1,2]	*Stachys maritima* Gouan	EN	-	-	-	-	+	-
	Total	**10**	**2**	**2**	**2**	**3**	**11**	**2**

DISCUSSION

The results obtained during this study confirm the rich biodiversity of vascular plants (96 species) and the natural conservation significance of all four non-forest natural habitats with 15 conservationally important plant species in both Natura 2000 protected sites *Kamchia* and *Shkorpilovtsi Beach*. However, the intensive development of tourism and urbanization, construction works, waste, camping and sand thickening could be outlined among the most important anthropogenic factors with a negative impact in the area. Therefore, the future permanent monitoring of both sites is strongly recommended.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this article.

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MEDICINAL PLANTS IN THE ROPOTAMO RESERVE: BIODIVERSITY AND CONSERVATION SIGNIFICANCE

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Abstract. The paper presents the recent diversity and conservational importance of the medicinal plants in the Ropotamo Reserve (SE Bulgaria): 211 species from 181 genera and 68 families. They comprised significant part of the total plants biodiversity of the reserve, which consisted of 550 species.

The spread of the medicinal plants in different habitats of European significance was shown together with the threatened status of the species and their relative abundance. The distribution of all medicinal species was analyzed according to the frequency or rarity of their occurrence and it was proved that the reserve area hosted some rare for Bulgaria species of medicinal plants.

Key words: Black Sea coast, Bulgaria, rare species, threatened species

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INTRODUCTION

Ropotamo Reserve was created in 1940 to preserve the dense forests (*longozes*) along the banks of the river Ropotamo. In 1975, it was declared as Ramsar site. The reserve is a part of a wetland complex of great national and international significance and recently has been included in a Natura 2000 network protected site (Michev & Stoyneva 2007; Vassilev et al. 2013).

The reserve with its complicated relief is characterized by rich floristic diversity caused mainly by the diversity of habitats (*e.g.* dense forests along the river banks, swamps, rocky shores, dunes, open spaces and oak forests). Although the spread of some medicinal plants has been studied (Bondev & Velchev 1984; Gussev et al. 2003; Sidjimova 2007), a complex study on the recent distribution and resources of all medicinal plants in Ropotamo Reserve has not been conducted so far (Vitkova et al., in press). Therefore, the present paper represents detailed data on the species composition of the medicinal plants in the area, collected during larger study aimed at the preparation of the new Ropotamo Reserve Management Plan (2015-2025), abbreviated hereafter as RRMP.

MATERIAL AND METHODS

Ropotamo Reserve is situated between 150 and 0 metres above the sea level along the lowest stream of the Ropotamo River in South-eastern Bulgaria. It occupies an area of 1000.7 ha and falls in the European Continental and Continental-Mediterranean climatic areas characterized by mild winter and warm, dry summer (Subev & Stanev 1963).

For the implementation of the task, field trips were organized in the autumn period of 2014 and two methods were applied: Route method and Method for monitoring of higher plants (Gussev et al. 2008) with the following important features of the populations taken into account: area, horizontal structure, number, project coverage. Species identification was done in the filed with some additional cameral work, following mainly Jordanov (1963-1979), Velchev (1982, 1989), Kožuharov (1995) and Delipavlov et al. (2003). In addition to our own findings, all data concerning medicinal plants in the available literature were analyzed in terms of floristics and nature conservation significance. The list of medicinal plants was prepared after the Application to Art. 1 of the Medicinal Plants Act (2000 - MPA). The threatened status of each species was determined according to different international and national documents: Bern Convention (1979), CITES (1973), IUCN (2001), Medicinal Plants Act (2000 - MPA), Biological Diversity Act (2002), Act on Amending and Suplementing the Biological Diversity Act (2007 - BDA), Red List of Bulgarian vascular plants (Petrova & Vladimirov 2009 - RL) and Red Data Book of the Republic of Bulgaria (Peev 2015 - RDB). The habitats were classified according to EUNIS (2007).

Table 1. Medicinal plants in the Ropotamo Reserve. Abbreviations used: SCS – Species of conservation significance; RS – resources (G – group, Gs - groups, N– numerous, Sp – single plants); EHb – habitat (indicated by its relevant number); RL - Red List of vascular plants (Petrova & Vladimirov 2009); RDB - Red Data Book of the Republic of Bulgaria (Peev 2015): EN (Endangered); VU (Vulnerable); LC (Least Concern); BDA - Biological Diversity Act (2002); SRPU - Special Regime of Protection and Use according to Medicinal Plants Act (2000); BC - Bern Convention (1979); CITES - Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973); * - Literary data. Families and species are enlisted in alphabetical order.

№	Family	*Taxon*	SCS	RS	EHb
1	Aceraceae	*Acer platanoides* L.		Sp	G1.76A1
2	Aceraceae	*Acer tataricum* L.		Gs	G1.2232; G1.76A1
3	Alliaceae	*Allium rotundum* L.		G	F1.4344
4	Alliaceae	*Nectaroscordum siculum* ssp. *bulgaricum* (Janka) Stearn.*		G	G1.2232
5	Alismataceae	*Alisma plantago-aquatica* L.		N	C3.2
6	Amarillidaceae	*Galanthus nivalis* L.*	EN, RL, RDB, BDA (Suppl. 3), CITES	Gs	G1.76A1
7	Amarillidaceae	*Leucojum aestivum* L.*	VU, RL, BDA	N	G1.2232
8	Anacardiaceae	*Cotinus coggygria* Scop.		N	G1.76A1; B1.4B11; B1.7
9	Apiaceae	*Anethum graveolens* L.*		G	
10	Apiaceae	*Angelica sylvestris* L. *		G	
11	Apiaceae	*Anthriscus cerefolium* (L.) Hoffm.		G	G1.76A1
12	Apiaceae	*Chaerophyllum temulentum* L.		N	G1.2232
13	Apiaceae	*Eryngium campestre* L.		N	
14	Apiaceae	*Eryngium maritimum* L.	EN, RL, RDB, BDA (Suppl.3)	Sp	B1.313
15	Apiaceae	*Ferulago sylvatica* (Besser) Rchb.*		Gs	
16	Apiaceae	*Heracleum sibiricum* L.		Gs	
17.	Apiaceae	*Opopanax chironium* ssp. *bulgaricum* (Velen.) Andreev*	VU, RL, BDA (Suppl. 4)	Sp	
18	Apiaceae	*Pimpinella saxifraga* L.		N	G1.76A1
19	Apiaceae	*Tordylium maximum* L.		Gs	
20	Apocynaceae	*Trachomitum venetum* (L.)	EN, RL, RDB, BDA (Suppl.3)	N	B1.4B11
21	Araceae	*Arum maculatum* L.		Gs	G1.76A1
22	Araliaceae	*Hedera helix* L.		N	G1.2232; G1.76A1; F5.51A4
23	Aristolochiaceae	*Aristolochia clematitis* L.		Gs	G1.2223
24	Asclepiadaceae	*Cionura erecta* (L.) Griseb.		N	B1.4B11

№	Family	*Taxon*	SCS	RS	EHb
25	Asclepiadaceae	*Periploca graeca* L.		N	G1.2232
26	Asclepiadaceae	*Vincetoxicum hirundinaria* Medic.		Gs	G1.76A1
27	Aspleniaceae	*Asplenium adiantum-nigrum* L.*		Gs	
28	Aspleniaceae	*Asplenium ruta-muraria* L.*		Gs	
29	Aspleniaceae	*Asplenium trichomanes* L.	SRPU	Gs	G1.76A1
30	Asteraceae	*Achillea collina* J. Becker ex Reichenb.		N	E1.4344; B1.7
31	Asteraceae	*Anthemis cotula* L.		Gs	
32	Asteraceae	*Anthemis tinctoria* L.		Gs	G1.76A1; B1.4B11
33	Asteraceae	*Arctium lappa* L.		Gs	
34	Asteraceae	*Artemisia absinthium* L.		N	B1.4B11
35	Asteraceae	*Artemisia campestris* L.		N	B1.4B11; B1.7
36	Asteraceae	*Artemisia santonica* L.	SRPU	N	B1.4B11
37	Asteraceae	*Artemisia vulgaris* L.		N	
38	Asteraceae	*Bellis perennis* L.		N	
39	Asteraceae	*Carduus acanthoides* L.		Gs	
40	Asteraceae	*Carlina vulgaris* L.		Gs	E1.4344; B1.7
41	Asteraceae	*Centaurea cyanus* L.		Gs	B1.4B11; G1.76A1; B1.7
42	Asteraceae	*Cichorium intybus* L.		Gs	
43	Asteraceae	*Cnicus benedictus* L.*	SRPU	G	
44	Asteraceae	*Filago vulgaris* Lam.		Gs	
45	Asteraceae	*Inula ensifolia* L.		N	
46	Asteraceae	*Matricaria chamomilla* L.		N	
47	Asteraceae	*Scorzonera hispanica* L.		Gs	
48	Asteraceae	*Senecio vulgaris* L.		Gs	
49	Asteraceae	*Taraxacum officinale* Web.		N	
50	Asteraceae	*Tanacetum vulgare* L.		N	G1.76A1
51	Asteraceae	*Tragopogon pratensis* L.		Gs	
52	Asteraceae	*Xanthium strumarium* L.		Gs	B1.4B11
53	Asteraceae	*Xeranthemum annuum* L.		Gs	E1.4344
54	Betulaceae	*Alnus glutinosa* (L.) Gaertner		N	G1.2232
55	Betulaceae	*Carpinus betulus* L.		N	G1.2232
56	Betulaceae	*Corylus avellana* L.			G1.76A1
57	Boraginaceae	*Anchusa officinalis* L.		N	
58	Boraginaceae	*Buglossoides purpurocaerulea* (L.) I. M. Johnst.		Gs	G1.76A1
59	Boraginaceae	*Cynoglossum officinale* L.		Gs	
60	Boraginaceae	*Echium vulgare* L.		Gs	

№	Family	*Taxon*	SCS	RS	EHb
61	Boraginaceae	*Lithospermum officinale* L.		Gs	G1.76A1
62	Brassicaceae	*Alyssum alyssoides* L.		N	
63	Brassicaceae	*Capsella bursa-pastoris* (L.) Medic		N	
64	Brassicaceae	*Cardamine bulbifera* L.		N	G1.76A1
65	Brassicaceae	*Lepidium ruderale* L.		N	
66	Brassicaceae	*Nasturtium officinale* R. Br.		N	G1.2223
67	Brassicaceae	*Thlaspi arvense* L.		Gs	
68	Butomaceae	*Butomus umbellatus* L.		Gs	G 3.2
69	Campanulaceae	*Campanula persicifolia* L.		G	G1.76A1; B1.7
70	Caprifoliaceae	*Sambucus ebulus* L.		Gs	
71	Caprifoliaceae	*Sambucus nigra* L.		Gs	G1.76A1; G1.2232
72	Caryophyllaceae	*Herniaria hirsuta* L.		Gs	
73	Caryophyllaceae	*Lychnis flos-cuculi* L.		Gs	E1.4344
74.	Caryophyllaceae	*Stellaria media* (L.) Vill.		N	G1.2232
75	Caryophyllaceae	*Viscaria vulgaris* ssp. *atropurpurea* (Griseb.) Stoj.		Gs	
76	Celastraceae	*Euonymus europaeus* L.		Gs	G1.76A1
77	Celastraceae	*Euonymus verrucosus* Scop.		Gs	G1.76A1
78	Chenopodiaceae	*Chenopodium album* L.		Gs	
79	Convolvulaceae	*Calystegia sepium* (L.) R. Br.		Gs	G1.2232
80	Convolvulaceae	*Convolvulus arvensis* L.		N	
81	Cornaceae	*Cornus mas* L.		Gs	G1.76A1; B1.7
82	Crassulaceae	*Sedum maximum* (L.) Suter		G	
83	Cucurbitaceae	*Ecballium elaterium* (L.) A. Richard		Gs	B1.313
84	Dioscoreaceae	*Tamus communis* L.		Gs	G1.2232
85	Dipsacaceae	*Knautia arvensis* (L.) Coult.		Gs	
86	Ephedraceae	*Ephedra distachya* L.*	VU, RL, BDA (Suppl. 3)	G	B1.4B11
87	Equisetaceae	*Equisetum sylvaticum* L.		Gs	G1.2232
88	Equisetaceae	*Equisetum telmateia* Ehrh		Gs	G1.2232
89	Euphorbiaceae	*Euphorbia amygdaloides* L.		Gs	G1.76A1
90	Euphorbiaceae	*Euphorbia cyparissias* L.		Gs	E1.4344; B1.7
91	Euphorbiaceae	*Euphorbia peplis* L.	VU, RL, BDA (Suppl. 3)	Sp	B1.313
92	Euphorbiaceae	*Mercurialis perennis* L.		N	
93	Fabaceae	*Bituminaria bituminosa* (L.) Stirt.		G	G1.76A1
94.	Fabaceae	*Chamaecytisus hirsutus* (L.) Link.		Gs	G1.76A1
95	Fabaceae	*Coronilla varia* L.		Gs	E1.4344

№	Family	*Taxon*	SCS	RS	EHb
96	Fabaceae	*Lathyrus niger* (L.) Bernh.		Gs	G1.76A1; B1.7
97	Fabaceae	*Lathyrus sylvestris* L.		Gs	G1.76A1
98	Fabaceae	*Lathyrus vernus* (L.) Bernh.		Gs	G1.76A1
99	Fabaceae	*Lotus corniculatus* L.		N	
100	Fabaceae	*Melilotus officinalis* (L.) Palla.		N	
101	Fabaceae	*Ononis spinosa* L.		N	E1.4344
102	Fabaceae	*Trifolium pratense* L.		N	
103	Fabaceae	*Vicia cracca* L.		N	
104	Fagaceae	*Fagus orientalis* Lipsky		N	G1.76A1
105	Fagaceae	*Quercus frainetto* Ten.		N	G1.76A1; B1.7
106	Geraniaceae	*Geranium robertianum* L.		N	G1.76A1
107	Geraniaceae	*Geranium sanguineum* L.		Gs	G1.76A1; B1.7
108	Hypericaceae	*Hypericum androsaemum* L.*	EN, RL, RDB, BDA (Suppl. 3)	Sp	G1.76A1
109	Hypericaceae	*Hypericum perforatum* L.		N	E1.4344; G1.76A1
110	Hypolepidiaceae	*Pteridium aquilinum* (L.) Kuhn		N	G1.76A1; B1.7
111.	Iridaceae	*Iris pseudacorus* L.		N	G1.2232
112.	Lamiaceae	*Acinos arvensis* (Lam.) Dandy		N	
113.	Lamiaceae	*Ajuga laxmannii* (L.) Benth.		Gs	G1.76A1
114	Lamiaceae	*Ballota nigra* L.		Gs	
115	Lamiaceae	*Clinopodium vulgare* L.		Gs	G1.76A1
116	Lamiaceae	*Glechoma hederacea* L.		N	G1.76A1
117.	Lamiaceae	*Lamium purpureum* L.		Gs	
118	Lamiaceae	*Lycopus europaeus* L.		Gs	C3.2
119	Lamiaceae	*Marrubium peregrinum* L.		Gs	B1.4B11; B1.7
120	Lamiaceae	*Melissa officinalis* L.		Gs	G1.76A1
121	Lamiaceae	*Mentha arvensis* L.		Gs	
122	Lamiaceae	*Mentha spicata* L.		Gs	
123	Lamiaceae	*Origanum vulgare* ssp. *vulgare* L.		N	E1.4344
124	Lamiaceae	*Prunella vulgaris* L.		N	
125	Lamiaceae	*Salvia verticillata* L.		N	E1.4344
126	Lamiaceae	*Sideritis montana* L.		N	
127	Lamiaceae	*Stachys recta* L.		G	
128	Lamiaceae	*Teucrium chamaedrys* L.		N	B1.4B11; G1.76A1; B1.7
129	Lamiaceae	*Teucrium polium* L.		N	B1.4B11; B1.7
130	Lamiaceae	*Thymus longidentatus* (Deg. et Urum.) Ronn.		N	E1.4344; G1.76A1
131	Lamiaceae	*Thymus sibthorpii* Benth.		N	E1.4344

№	Family	*Taxon*	SCS	RS	EHb
132	Lemnaceae	*Lemna minor* L.		N	C3.2
133	Liliaceae	*Colchicum autumnale* L.		N	
134	Liliaceae	*Polygonatum odoratum* (Millr) Druce	BDA (Suppl. 4)	Gs	G1.76A1; B1.7
135	Liliaceae	*Ruscus aculeatus* L.	BDA (Suppl. 4) SRPU	N	G1.76A1; G1.2232; F5.51A4
136	Liliaceae	*Scilla bifolia* L.	BDA (Suppl. 4)	N	G1.76A1
137	Lorantaceae	*Viscum album* L.		G	
138	Lytraceae	*Lythrum salicaria* L.		N	G1.2232
139	Lytraceae	*Lythrum virgatum* L.		Gs	C3.2
140	Malvaceae	*Malva sylvestris* L.		Gs	
141	Nymphaeaceae	*Nuphar lutea* (L.) Sibth. et Sm.	EN, RL, RDB, BDA (Suppl. 3)	N	C3.2
142	Nymphaeaceae	*Nymphaea alba* L.	EN, RL, RDB, BDA (Suppl. 3)	N	C3.2
143	Oleaceae	*Fraxinus ornus* L.		N	G1.76A1; F5.51A4; B1.7
144	Oleaceae	*Fraxinus oxycarpa* Willd.		N	B1.7
145	Oleaceae	*Ligustrum vulgare* L.		Gs	G1.76A1
146.	Oleaceae	*Phyllirea latifolia* L.		N	F5.51A4
147.	Orchidaceae	*Anacamptis pyramidalis* (L.) L. C. M. Reichard*	VU, RL, BDA (Suppl. 3), CITES	Sp	E1.4344
148.	Orchidaceae	*Orchis papilionaceae* L.*	VU, RL, BDA (Suppl. 3), CITES	Sp	E1.4344
149.	Papaveraceae	*Chelidonium majus* L.		Gs	
150.	Papaveraceae	*Glaucium flavum* Grantz.	SRPU	G	B1.313
151.	Papaveraceae	*Papaver rhoeas* L.		Gs	E1.4344
152.	Plantaginaceae	*Plantago lanceolata* L.		Gs	
153.	Plantaginaceae	*Plantago media* L.		Gs	
154.	Polygonaceae	*Persicaria hydropiper* (L.) Opiz		N	G 3.2
155.	Polygonaceae	*Polygonum aviculare* L.		N	
156	Polygonaceae	*Rumex acetosella* L.		N	E1.4344
157	Polypodiaceae	*Polypodium vulgare* L.		Gs	G1.76A1
158	Portulacaceae	*Portulaca oleracea* L.		Gs	
159	Primulaceae	*Anagallis arvensis* L.		Gs	
160	Primulaceae	*Cyclamen coum* Mill.	LC, RL, BC, BDA (Suppl. 3), CITES	N	G1.76A1
161	Primulaceae	*Lysimachia nummularia* L.		N	G1.2232
162	Primulaceae	*Primula acaulis* ssp. *rubra* (Sm.) Greuter & Burdet	VU, RL	Gs	G1.76A1
163	Primulaceae	*Primula veris* L.	SRPU	Gs	G1.76A1

№	Family	*Taxon*	SCS	RS	EHb
164	Ranunculaceae	*Adonis aestivalis* L.		Gs	
165	Ranunculaceae	*Clematis vitalba* L.		N	G1.2232
166	Ranunculaceae	*Consolida hispanica* (Costa) Greuter & Burdet		Gs	B1.7
167	Ranunculaceae	*Helleborus odorus* Waldst. & Kit.		Gs	E1.4344
168	Ranunculaceae	*Ranunculus ficaria* L.		N	G1.2232
169	Ranunculaceae	*Ranunculus repens* L.		N	
170	Rhamnaceae	*Paliurus spina-christi* Mill.		N	B1.4B11; G1.76A1; F5.51A4; B1.7
171	Rhamnaceae	*Rhamnus catharticus* L.		Sp	G1.76A1; B1.7
172	Rosaceae	*Agrimonia eupatoria* L.		N	E1.4344
173	Rosaceae	*Crataegus monogyna* Jacq.		Gs	G1.76A1; B1.7
174	Rosaceae	*Crataegus pentagyna* W. et K. ex Willd.		G	G1.76A1
175	Rosaceae	*Filipendula vulgaris* Moench.		N	E1.4344
176	Rosaceae	*Fragaria vesca* L.		N	G1.76A1; B1.7
177	Rosaceae	*Geum urbanum* L.		N	G1.2232
178	Rosaceae	*Malus sylvestris* Mill.		Sp	G1.76A1
179	Rosaceae	*Potentilla reptans* L.		N	G1.2232
180	Rosaceae	*Prunus spinosa* L.		Gs	G1.76A1
181	Rosaceae	*Rosa gallica* L.		Gs	G1.76A1
182	Rosaceae	*Rubus caesius* L.		Gs	G1.76A1
183	Rosaceae	*Sanguisorba minor* Scop.		Gs	E1.4344
184	Rosaceae	*Sorbus aucuparia* L.		Sp	G1.76A1
185	Rosaceae	*Sorbus domestica* L.		Sp	
186	Rosaceae	*Sorbus torminalis* (L.) Crantz.		Sp	G1.76A1
187	Rubiaceae	*Cruciata laevipes* Opiz.		N	G1.76A1
188	Rubiaceae	*Galium aparine* L.		N	G1.2232
189	Rubiaceae	*Galium verum* L.		N	E1.4344
190	Salicaceae	*Salix alba* L.		N	
191	Scrophulariaceae	*Digitalis lanata* Ehrh.		Gs	E1.4344
192	Scrophulariaceae	*Scrophularia nodosa* L.		Gs	
193	Scrophulariaceae	*Verbascum densiflorum* Bertol.		Gs	
194.	Scrophulariaceae	*Verbascum phlomoides* L.		Gs	G1.76A1
195	Scrophulariaceae	*Verbascum phoeniceum* L.		Gs	G1.76A1
196	Scrophulariaceae	*Veronica officinalis* L.		Gs	G1.76A1
197	Smilacaceae	*Smilax excelsa* L.		N	G1.2232
198	Solanaceae	*Datura stramonium* L.		Gs	

№	Family	*Taxon*	SCS	RS	EHb
199	Solanaceae	*Solanum dulcamara* L.		Gs	G1.2232
200	Solanaceae	*Solanum nigrum* L.		Gs	B1.7
201	Tiliaceae	*Tilia tomentosa* Moench		Gs	G1.76A1
202	Typhaceae	*Typha angustifolia* L.		N	C3.2
203	Ulmaceae	*Celtis australis* L.		Sp	B1.7
204	Ulmaceae	*Ulmus minor* Mill.		Gs	G1.2232
205	Urticaceae	*Parietaria officinalis* L.		Gs	G1.2232
206	Urticaceae	*Urtica dioica* L.		N	G1.2232
207	Valerianaceae	*Valeriana officinalis* L.	SRPU	G	G1.76A1
208	Verbenaceae	*Verbena officinalis* L.		Gs	
209	Violaceae	*Viola odorata* L.		N	G1.76A1
210	Vitaceae	*Vitis sylvestris* C.C.Gmelin		Sp	G1.2232
211	Zygophyllaceae	*Tribulus terrestris* L.		N	B1.4B11

RESULTS

All documented medicinal plants of the Ropotamo Reserve are enlisted in **Table 1**. The list contains 197 species found by us during the present study, together with 14 other species which have been recorded at least once in the area and published in the relevant literature (indicated by asterisk - *). The total list of medicinal plants reported from the reserve comprised 211 species belonging to 181 genera and 68 families. This number represents 38% of all 550 species of vascular plants known form the reserve territory (for details see Vitkova et al., in press) and 28% of all medicinal plants in Bulgaria (MPA).

Twenty-three species of the medicinal plants, or 11%, were threatened according to different documents (**Table 1**): seven were *Endangered* in the Bulgarian Red Data Book (Peev 2015), fifteen were from the Red List of Bulgarian vascular plants (Petrova & Vladimirov 2009), eighteen species were from the Biological Diversity Act (2002), four species were from the species protected under CITES and seven species were protected by the MPA with Special Regime of Protection and Use (2000).

Many medicinal plants were found to grow in habitats of European significance according to EUNIS (2007) – **Table 1**. The mixed oak forests, which represent the habitat EUNIS G1.76A1 *Euxino-Thracian [Quercus frainetto]–[Quercus cerris] forests* (**Fig. 1**), cover large areas in the reserve reaching the coastal area north of the megalith Begliktash, the shores above the Black Sea bay St. Paraskeva (**Fig. 2**) and the slopes of the Vulchanovoto Kale area as well. Totally 68 medicinal plants were found there, ten of them were of conservation significance (**Table 1**). Three species were protected: *Cyclamen coum, Galanthus nivalis* and *Hypericum androsaemum.*

C. coum and *Ruscus aculeatus* were abundant (Vitkova et al., in press).

Both banks of the Ropotamo River are covered with dense forests (**Fig. 3**). The periodically flooded mixed deciduous forests along the banks of the river represent the habitat EUNIS G1.2232 *Helleno-Balkanic ash-oak-alder forest* (**Fig. 4**). Thirty-one medicinal plants were found there, and two of them were of conservation significance - *Leucojum aestivum* and *Ruscus aculeatus* (**Table 1**).

The habitat EUNIS C3.2 *Water-fringing reedbeds and tall heleophytes other than cans* (**Fig. 5**) is represented by the vegetation of the Arkutino marsh, where we found nine medicinal plants. Two of them were with conservation status - *Nymphaea alba* and *Nuphar lutea* (**Table 1**).

The secondary grasslands at the sides of destroyed forests represent the

Figs. 1-4: 1 - Habitat *G1.76A1 Euxino-Thracian [Quercusfrainetto]–[Quercuscerris] forests:* Over the bay of St. Paraskeva; **2** - The bay of St. Paraskeva; **3** - Ropotamo River; **4** - Habitat *G1.2232 Helleno-Balkanicash-oak-alder forest*: Ropotamo River bank.

habitat EUNIS E1.4344 *Helleno-Balkanic andropogonoid grass steppe.* Twenty-two medicinal plants were found there, among which two were of conservation significance - *Anacamptis pyramidalis* and *Orchis papilionaceae* (**Table 1**).

Habitat B1.7. *Coastal dune woods* occupies the eastern steep and the western sloping slopes of the dune at the Cape Kaya (**Fig. 6**). This is the largest dune along the Bulgarian Black sea coast covered with woods. The forest communities on the dune have typical xerothermic features, the trees are low and branched. These coenoses are dominated by *Carpinus orientalis* Mill., *Fraxinus ornus*, *Quercus cerris* Morariu, *Q. frainetto*, *Q. pubescens* Schwarz and *Celtis australis* is also characteristic. Twenty-four medicinal plants were found in this habitat (**Table 1**).

The habitat EUNIS B1.4B11 *Southwestern Pontic fixed dunes* (**Fig. 7**) is widely presented in the reserve by fixed grey dunes. We found 15 medicinal plants

Figs. 5-8: 5 - Habitat C*3.2 Water-fringing reedbeds and tall heleophytes other than cans:* Arkutino marsh; **6** - Coastal dune woods: Cape Kaya; **7** - Habitat *B1.4B11 Southwestern Pontic fixed dunes*; **8** - Habitat *B1.313 Pontic embryonic dunes*.

there, two of which were of conservation significance – *Trachomitum venetum* and *Ephedra distachia* (**Table 1**).

The habitat EUNIS B1.313 *Pontic embryonic dunes* represents the first stages of the dune formation (**Fig. 8**). Four medicinal plants, mostly obligate psammophytes, were found there. Two species were of conservation significance: *Eryngium maritimum* and *Euphorbia peplis* (**Table 1**). During the study, we

proved that the localities of the threatened medicinal plants *Eryngium maritimum*, *Euphorbia peplis* and *Glaucium flavum* often fall into the beach area actively used for recreation.

The next habitat of European significance in the reserve is EUNIS F5.51A4 *Eastern [Phillyrea] thickets* which occupies the exposed dry slopes in the locality Luvska Glava. There, besides the main species *Phillyrea latifolia*, four other medicinal plant species were found: *Fraxinus ornus*, *Paliurus spina-christi, Hedera helix*, *Ruscus aculeatus* (**Table** 1).

The largest number of medicinal plants was found in the habitats G1.76A1 *Euxino-Thracian [Quercus frainetto]–[Quercus cerris] forests* (68 species) followed by G1.2232 *Helleno-Balkanic ash-oak-alder forest* (31) B1.7. *Coastal dune woods* (24), E1.4344 *Helleno-Balkanic andropogonoid grass steppe* (22) and B1.4B11 *Southwestern Pontic fixed dunes* (15). The largest number (10) of conservationally significant species was found in the habitat G1.76A1.

Some of the recorded medicinal plants are of medium to high rarity in Bulgaria. Moreover, some of them are distributed only along the Black Sea coast and Strandzha Mountain (*e.g. Artemisia santonicum, Eryngium maritimum, Euphorbia peplis*, *Glaucim flavum, Hypericum androsaemum, Trachomitum venetum*). Worthy to note is that 58% of the medicinal species were found as single plants, in a group or in groups (14, 14 and 95 species, respectfully), and only 42% (88 species) were more abundant (**Table 1**).

DISCUSSION

The high number of medicinal plants recorded in the reserve territory (211), which represents 38% of its flora and the finding of 23 threatened species (six of which with the IUCN category *Endangered*) proves the nature conservation significance of the flora of the Ropotamo Reserve. Noteworthy, some of the threatened species occur only as single specimens in the reserve area. In addition, 140 medicinal plants in eight reserve habitats of European significance were reported. Moreover, some of the medicinal species were rare for the country and this, combined with the well-known strong recent anthropogenic pressure on the Black Sea coast, increases their vulnerability and threat of extinction.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this article.

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AETHIONEMA ARABICUM ANDRZ. EX DC (CRUCIFERAE) IN BULGARIA - *IN SITU* AND *EX SITU* CONSERVATION

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Abstract. *Aethionema arabicum* Andrz. ex DC is extremely rare species of the Bulgarian flora. It is included in the Biological Diversity Act of Bulgaria and in the Red Book of Bulgaria with category *Critically Endangered*. The species is distributed in Balkan Peninsula (Bulgaria and Turkey), Southwest Asia (Asia Minor, Syria, Northern Iran) and the Caucasus. The only population of *A. arabicum* known in Bulgaria is situated in Eastern Stara planina floristic region, near Sotirya village, Sliven district. The population consists of only a few dozen individuals. This study provides information on the biology and ecology of the species, its population structure and the measures taken to increase the population. Protected area was designated to preserve this species.

Key words: endangered plant species, monitoring, long-term conservation, restoration

INTRODUCTION

The genus *Aethionema* R. Br. belongs to *Brassicaceae* family and includes 56 species with Old World distribution (http://www.theplantlist.org/1.1/browse/A/Brassicaceae/ Aethionema/). The territory of Turkey is considered to be the center of speciation of the genus. There are over 40 *Aethionema* species, twenty of which

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are endemics (Pinar et al. 2007). In the flora of Europe the genus is represented by six species (Chater 1964). Two of them are distributed in Bulgaria – *Aethionema arabicum* Andrz. ex DC and *A. saxatile* (L.) R. Br. (Vulev 1970). Recently, a new species was described from the Bulgarian part of the Rodopi Mts - *A. rhodopaeum* D. K. Pavlova (Pavlova 2007). Thus, there are three species of this genus in our flora.

The subject of this study is *Aethionema arabicum* – an extremely rare and protected taxon in the Bulgarian flora included in Appendix 3, Art. 37 of the Bulgarian Biodiversity Act and in the Red Book of the Republic of Bulgaria as *Critically Endangered* (Stanev 2015). It belongs to the category of species for which regeneration and maintenance activities are foreseen in point V.7. of the National Biodiversity Conservation Plan 2005-2010 of the Ministry of Environment and Waters (MoEW) of Bulgaria. Because of its high sensitivity and conservation value, it is subject to monitoring at national level included in the National Biodiversity Monitoring System of MoEW.

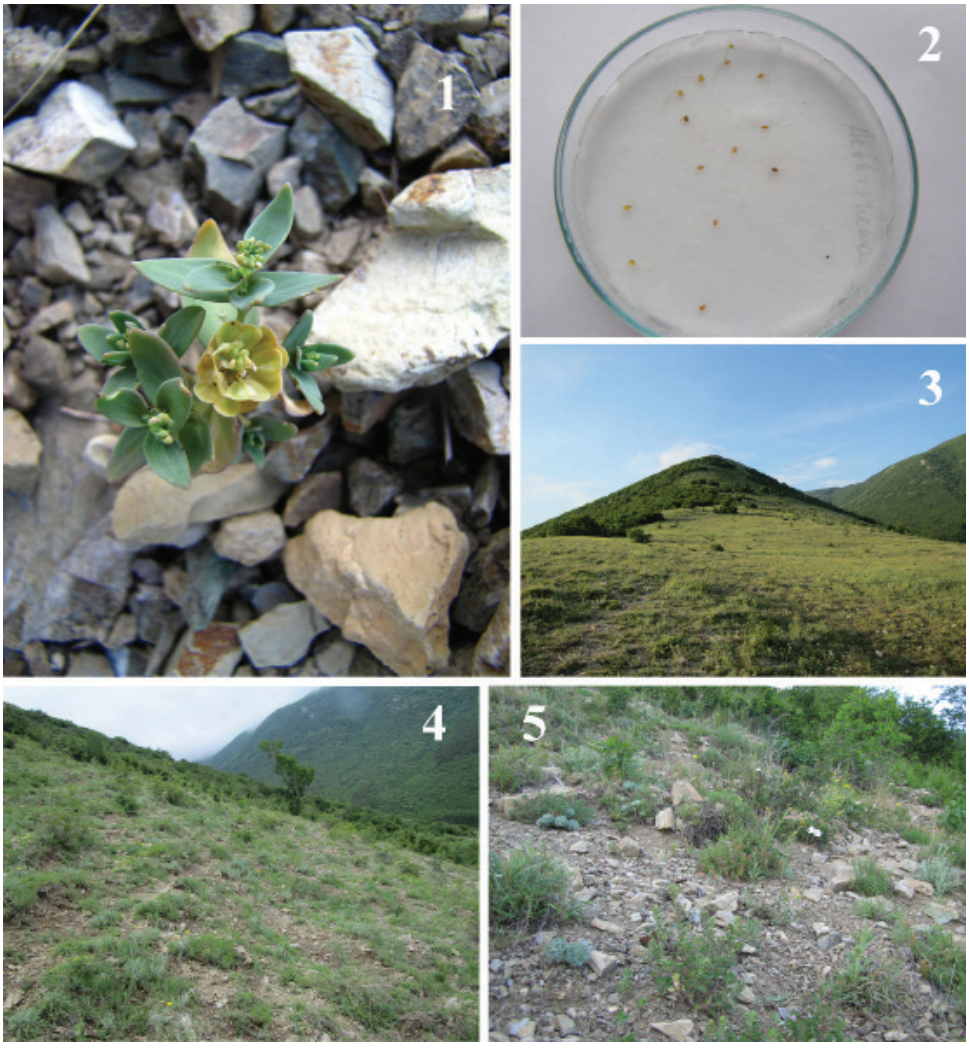
The only population of *A. arabicum* known in Bulgaria is situated in Eastern Stara planina floristic sub-region, at *Lale bair* locality, near Sotirya village, Sliven district. Prior to this study, the species was not found for more than ten years, despite repeated attempts to do so. The taxon is generally distributed in part of the Balkan Peninsula (Bulgaria, Turkey) as well as Southwestern Asia (Asia Minor, Syria, Northern Iran) and in the Caucasus.

The aims of the present study are: 1) Exploration of the biology and ecology of this extremely rare species for Bulgaria; 2) Establishment of conditions for a long-term monitoring; 3) Implementation of *in situ* and *ex situ* activities for long-term conservation and restoration of the species population.

MATERIALS AND METHODS

The survey was conducted between 2010 and 2014. The morphological description of the species is made on the basis of own observations, as well as analysis of the existing information from all the major literary sources (Hedge 1965; Takhtajan 1966; Valev 1970; Ketzhoveli 1979; Pinar et al. 2007) and the collections in the Bulgarian herbaria (SOM, SO, SOA).

To study the morphometric variability of the siliculae, eight plants derived from seeds collected from the natural locality of the species in 2011, were used. Three of the plants were grown under room conditions and five were grown in the Growing House of the Institute of Biodiversity and Ecosystem Research (IBER). In 2012, 50 siliculae from indoor and outdoor individuals were collected to establish the variability of 4 features of the generative sphere: Var1 – length of the siliculae, Var2 – width of the siliculae, Var3 – concavity of the siliculae, Var4 – number of the seeds in the siliculae. For analysis of the results the statistical program Statistica 7



Figs. 1-5: 1- *Aethionema arabicum* Andrz. ex DC – habit; **2** - Germination of *A. arabicum* on dipped filter paper in Petri dish; **3** - Locality *Lale bair*, near to Sotirya village, Sliven district; **4** - Habitat of *A. arabicum*; **5** - The characteristic substrate of the population of *A. arabicum*.

was used (StatSoft, Inc. 2004).

For recording the germination, 75 seeds obtained from *ex situ* cultivated plants were placed on moistened filter paper in Petri dishes.

The monitoring of the population of the target species has been carried out for three consecutive years in accordance with the *Methodology for monitoring of vascular plants* (Gussev & Bancheva 2011), developed according to the instructions

of Ryttäri et al. (2003) and Harding & Williams (2010). A *Field form for monitoring of vascular plants* of the Bulgarian Executive Environment Agency has been used, which has been supplemented and adapted for the particular species within a project LIFE08 NAT/BG/279 *A pilot network of small protected sites for plant species in Bulgaria using the plant micro-reserve model*, funded by the EU's Program Life+ (Life08NAT/BG/279). All collected data are fully compatible with the National Monitoring System of Bulgaria of the Ministry of Environment and Waters. Two types of indicators were collected: 1) Indicators for a single observation of the whole population, including: name of the target species, location, ecological and geographic characteristics, population boundaries, area, number and spatial structure of the population, land use, infrastructure elements close to the locality, *etc*.; 2) Indicators collected in different control plots: location of the plot using GPS coordinates, reporting unit, phenological phase, total projective cover of the vegetation, percentage cover of the control species, number of the individuals of the control species, phytocenological description, main threats for target species.

RESULTS AND DISCUSSION

Morphology and Biology

A. arabicum is an annual plant from *Brassicaceae* family, tertiary relict (Valev 1970). The stems are up to 10 cm, erect, and usually branched. The leaves are ovate, alternate, and naked. The flowers are small (sepals up to 4 mm long), white to pale violet. The fruits are siliculae, sub-spherical, bilocular with 1-4 seeds in each locus (Var4), opened by two valves; flattened and winged; densely crowded and imbricate; deeply concave to the top; the length of the siliculae (Var1) = 4,6-11 mm; the width of the siliculae (Var2) = 4-9 mm; the concavity of the siliculae (Var3) = 0,5–4 mm. The seeds are ovoid-elliptical, dark brown and very small (0.75×0.3 mm). The average seed weight is 0.0001 g. The flowering period is from April to May and the fruit-bearing period lasts from late April to June (**Fig. 1**).

Seed production

In 2012 for the establishment of seed production, eight plants were grown in the Growing House of IBER, three of which were left to be grown under indoor conditions. Of the eight plants, a total of 718 seeds were obtained (about 90 seeds per individual). These results show that the potential seed production of *A. arabicum* is quite high.

Germination

The 75 seeds of *A. arabicum* placed on dipped filter paper in Petri dishes in February 2013 (**Fig. 2**) were harvested from *ex situ* plants grown in the Growing House of IBER under natural conditions (40 individuals) and at room temperature (35 individuals). Within 3 months, 51 seeds germinated: 35 seeds obtained from

Figs. 6, 8-12: 6 - The monitoring of the population of *A. arabicum*; **8** - Planted seeds of *A. arabicum* at room temperature for *in-situ* actions; **9** - *Ex situ* plants of *A. arabicum* grown in the Growing House of IBER; **10** - *Ex situ* collection of *A. arabicum*; **11** - Marked plot for *in-situ* actions in the natural population of *A. arabicum*; **12** - Germination of *ex-situ* produced seeds in the natural population of *A. arabicum*.

outdoor plants and 16 seeds from plants grown at room temperature. The germination rate was relatively high - 68%. These results provide additional information on the breeding abilities of the species and give reason to conclude that *A. arabicum* has the ability to self-pollination. The data from the Bulgarian literature, known before

the present study, suggest only pollination by insects (Stanev 2015).

The self-fertilization is one of the most common evolutionary mechanisms in plants and has occurred in many taxonomic groups (Stebbins 1974; Barrett 2002). It is usually associated with peripheral and isolated populations (Stebbins 1957; Herlihy & Eckert 2005), such as the population of *A. arabicum* in Bulgaria.

Habitats, population structure and monitoring

The only population of *A. arabicum,* known in Bulgaria, is situated in Eastern Stara planina floristic sub-region, at *Lale bair* locality, near Sotirya village, Sliven district (**Fig. 3**). It belongs to the Protected site BG0000420 *Grebenets* of the NATURA 2000 ecological network. The species is generally distributed in part of the Balkan Peninsula (Bulgaria, Turkey) as well as Southwestern Asia (Asia Minor, Syria, Northern Iran) and the Caucasus.

A. arabicum is a pioneer and poorly competitive species. It grows on stony slopes (36-40°) and screes, on limestone (**Fig. 4**). Soils are very poor, shallow, dry and eroded (**Fig. 5**). It participates in xerophilous herbaceous and open scrub communities together with *Achillea millefolium* L., *Ajuga chamaepytis* ssp. *chia* (Schreb.) Arcang., *Astragalus monspessulanus* L., *A. spruneri* Boiss., *Astracantha thracica* (Griseb.) Podl., *Berberis vulgaris* L., *Bromus mollis* L., *Carduus nutans* L., *Carpinus orientalis* Mill., *Centaurea diffusa* Lam., *Chrysopogon gryllus* (L.) Trin., *Colchicum bibersteinii* Rouy, *Convolvulus cantabrica* L., *Crocus flavus* West., *Crupina vulgaris* Cass., *Cynodon dactylon* (L.) Pers., *Dactylis glomerata* L., *Dasypyrum villosum* (L.) Cand., *Erodium cicutarium* (L.) L'Her., *Eryngium campestre* L., *Euphorbia amygdaloides* L., *Euphorbia myrsinites* L., *Euphorbia peplis* L., *Fraxinus ornus* L., *Helianthemum nummularium* (L.) Mill., *Hypericum cerastoides* (Spach.) N. Robson, *Jasminum fruticans* L., *Lamium amplexicaule* L., *Leontodon crispus* Vill., *Paliurus spina-christi* Mill., *Plantago lanceolata* L., *Poa bulbosa* L., *Rosa pimpinellifolia* L., *Sanguisorba minor* Scop., *Satureja montana* L., *Stachys recta* L., *Syringa vulgaris* L., *Teucrium chamaedrys* L., *Teucrium polium* L., *Thlaspi alliaceum L.* and *Viola kitaibeliana* Schult.

The population of *A. arabicum* occupies an area of 8 dka. The total projective coverage of the vegetation is 40% (35% grasses and 5% shrubs), while the coverage of the examined species is below 1%. The spatial distribution of individuals in the population is in groups. The monitoring (**Fig. 6**) includes all individuals of the population within a period of 4 years (2010-2013). In 2010, 37 individuals were counted, in 2011 – 55 individuals, in 2012 – 18 individuals, and in 2013 – 233 individuals. All plants are generative, form a large number of fruits and are in good health. In 2011, we found that the average number of siliculae that an individual produced was 34. The average number of seeds formed in one siliculae is two (**Fig. 7**). These results show that the potential seed reproductive capacity of the species is quite high. For example, with 55 individuals established in 2011, potential seed production would be 3740 seeds. Indeed, despite the high potential seed

reproductive capacity, *in situ* germinate and survive an extremely low percentage of seedlings, due to a number of reasons: small seeds that are difficult to retain on the eroded substrate, strong winds, *etc*.

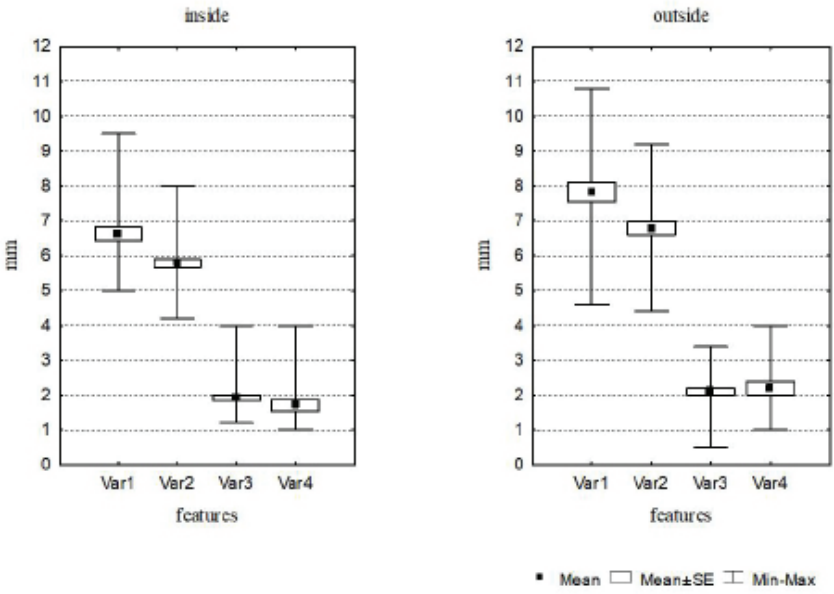


Fig. 7. Metric data of the siliculae of *Aethionema arabicum;* Legend: Var1 – siliculae height; V2 – siliculae width; V3 – concavity of the siliculae; V4 – number of seeds of the siliculae.

Threats

The population of *A. arabicum* is subject to active direct and indirect anthropogenic activities, which, combined with the weak resemblance of the species, poses a real threat that can lead to its disappearance from the flora of Bulgaria.

Ex situ and in situ actions

In order to support the recreation capacities of the only population of *A. arabicum*, *in situ* and *ex situ* activities were carried out as follows:

At the beginning of 2012, 70 seeds of *A. arabicum*, collected in May 2011 from its natural population, were planted in soil (**Fig. 8)**. Of these, only nine individuals sprouted and grew up (**Fig. 9**). Thousand and two hundred seeds were harvested from these plants. On 19 February 2013, one hundred of these seeds were planted in well-drained soil (Deno 1993) for the creation of an *ex situ* collection of the species at IBER. The first four plants sprouted after ten days. Within a period of 10 to 80

days, a total of 19 seeds germinated, 13 of them (13%) developing successfully (**Fig. 10**).

On 12 March 2013, another 200 seeds of the *ex-situ* produced plants were planted in ten specially marked plots in the natural locality of the species (**Figs. 11, 12**). On 13 April 2013, 60 seedlings (30%) were found. During the monitoring in 2013, the highest number of individuals was recorded, 233 compared to all other years since the establishment of the species for the Bulgarian flora to the present day. We believe that these results are mainly due to our targeted *in situ* and *ex situ* activities. The number of individuals remains constant over the next years (2015-2016).

In order to ensure the success of the activities to protect, support and restore the population of *A. arabicum* in Bulgaria, at the initiative of our team in 2012, a Protected Site *Lale Bair* was designated (Order No. RD-937 of 20.12.2011 of the Minister of the Ministry of Environment and Waters), and in December 2014 an Action Plan for the Conservation of the species was established (approved by Order No. RD-990 / 23.12.2014 of the Minister of Environment and Waters).

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this article.

ACKNOWLEDGMENTS

The results were obtained during the implementation of the project LIFE08 NAT/BG/279 *A pilot network of small protected sites for plant species in Bulgaria using the plant micro-reserve model*, funded by the EU Environment Program Life + and the Ministry of Environment and Waters.

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IMPACT OF DEMOGRAPHIC CHARACTERISTICS OF THE LOCAL POPULATION OF THE NORTHERN BLACK SEA COAST ON THE USE OF MEDICINAL PLANTS

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Abstract. The present study aims to examine the impact of demographic indicators gender, age, education and place of residence on the use of medicinal plants by the native population of the Northern Black Sea coast. The survey was conducted in eleven cities and nine villages between April and June 2015. The face-to-face interview technique was used and the respondents were randomly selected. The impact of demographic indicators on the respondents' answers was assessed by calculating the correlation coefficient of Pearson (r). The results show that the majority of respondents (83.78%) used medicinal plants mainly for treatment and prevention of diseases, approximately half of them (45.95%) used them for nutrition. Respondents using medicinal plants for decoration and for business have an insignificant share (9.73% and 1.08%, respectively). From the demographic analysis of the results, a moderate influence of all four demographic indicators on the respondents' answers was registered. The analysis of cross-links revealed that the attitude to the use of medicinal plants by women, unlike men, was not significantly influenced by age. The share of respondents from rural areas using medicinal plants for treatment and prevention of diseases was equal to those using them for nutrition, while the respondents from the cities using medicinal plants for treatment and prevention were twice more than those using them for nutrition. Regional differences were discovered comparing our data for use of medicinal plants of the local population with published data from the inland of the country.

Keywords: biodiversity, ethnobotany, face-to-face interview technique

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INTRODUCTION

Lifestyle and traditions of Bulgarians are closely bound to medicinal plants. For centuries medicinal plants have been used for healing, food, decoration and other purposes, and are firmly entangled in Bulgarian customs and rituals.

The area of the Northern Black Sea coast is characterized by a rich and diverse flora including a large variety of medicinal plants - 593 species (Zahariev et al. 2016). The available literature lacks a detailed ethnobotanical study on the traditional knowledge of medicinal plants and their uses in this area.

The present study is part of more extensive and detailed ethnobotanical study of traditional knowledge of medicinal plants and their use carried out in the North Black Sea coast area and aims to present the impact of demographic indicators gender, age, education and place of residence on different uses of medicinal plants by the local population.

MATERIALS AND METHODS

The survey was conducted in the period April - June 2015 in eleven cities and nine villages along the North Black Sea coast, using face-to-face interview technique commonly applied in such studies (Akaydin et al. 2013; Ploetz & Orr 2004). Interviewees were a random sampling of the local population with dissimilar demographic profile.

In order to check the purposes medicinal plants are used for, we asked the following question: *What do you use medicinal plants for?* In order to render an account of the demographic profile on responses, we mustered information on gender, age, education and residence of respondents.

The statistical significance of standard deviation of experimental data compared to the theoretically expected ones was analyzed by the $\chi 2$ method (Valtchev & Iordanova 2004; Dragoeva et al. 2015).

Pearson's coefficient (r) was used for assessment of the impact of various demographic indicators on respondents' answers.

RESULTS AND DISCUSSIONS

The majority of the respondents (83.78%) use medicinal plants mainly for treatment. Approximately half of the respondents use them for food - 45.95%. The rest of the applications have a limited share, with a minor exception of 9.73 % using them for decoration. The total amount of percentage exceeds 100 as 38.38 % of the respondents have given more than one answer. The small relative share of interviewees who declare that they use medicinal plants for business (1.08%), demonstrates that along the Black Sea coast herb gathering is not popular yet as a method of income generating.

A similar use of medicinal plants is reported in other studies (Ploetz 2000; Bele & Khale 2011; Kožuharova et al. 2013; Dragoeva et al. 2015), with our data correlating to the results published for the countryside where the highest percentage of the population uses medicinal plants for treatment, followed by their application as food, decoration and other purposes. It is noteworthy that the percentage of respondents using medicinal plants for treatment and food is relatively higher in our study, compared to data reported by Ploetz (2000) and Dragoeva et al. (2015).

Regional differences reveal that the North Black Sea coast population is oriented mainly towards the use of medicinal plants for treatment and food, much less for other purposes.

Demographic analysis displayed moderate impact of all four indicators on respondents' answers (**Table 1**).

Table 1. Impact of demographic characteristics on respondents' answers to the question *What do you use medicinal plants for?* Abbreviations: P – Statistical significance of deviation between expected and theoretical results; P≤0.05 - statistically significant, P> 0.05 - statistically non-significant; r - Pearson's coefficient; 0 <r <0.3 – minor impact, 0.3 <r <0.5 - moderate impact, 0.5 <r <0.7 - significant impact.

Demographic characteristics							
Gender		**Age**		**Education**		**Residence**	
P	**r**	**P**	**r**	**P**	**r**	**P**	**r**
P≤0,05	**r=0,56**	**P≤0,05**	**r=0,51**	**P≤0,05**	**r=0,50**	**P≤0,05**	**r=0,59**

Impact of the demographic characteristics gender and age

The cross-link analysis of gender and age reveals that the highest percentage of men using medicinal plants primarily for treatment are respondents of the age groups of 31 to 40 years of age and over 51 years old. For the same age groups, the percentage of interviewees using medicinal plants for food is twice as low. However, with the young generation in the picture, the situation is slightly different: the share of male interviewees 20-30 years of age using medicinal plants for food exceeds the share of those using them for treatment (**Fig. 1**).

Distribution of women using medicinal plants for treatment by age categories is approximately the same. The situation is similar for those using medicinal plants for food (**Fig. 2**).

Analysis reveals that women's attitudes towards medicinal plants and their uses, unlike for men, are not significantly influenced by age.

Impact of the demo-graphic characteristic education

The share of inter-viewees using medicinal plants for treatment, along with the share of those using them for food, is roughly the same regardless of education. In both cases,

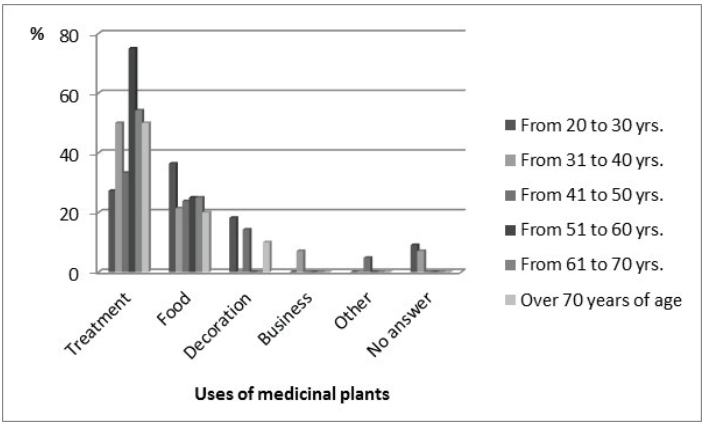

Fig. 1. Cross-links between the age of men and their answers.

this is a relatively high share which demonstrates a steady positive attitude towards the use of medicinal plants. Most likely, the level of awareness is not based on education but rather disseminated through families, not school.

Impact of the demographic characteristic residence

In rural areas, medicinal plants are used mostly for food and treatment, with the share of the two groups of respondents being the same – 70%. Urban respondents bring a different picture with the share of those using medicinal plants for treatment being twice higher (85.45%) than the share of those using them for food (43.03%). (**Fig. 3**).

The above data are more likely due to the fact that rural population is closer to the natural habitat of medicinal plants which makes them easily available and in sufficient quantity. Besides, they have the option of growing their own medicinal plants in the gardens.

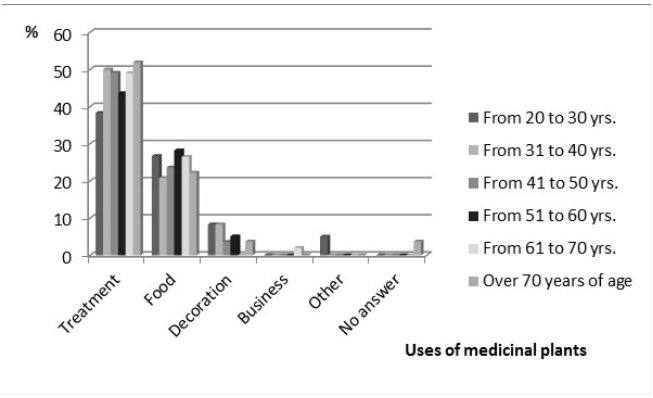

Fig. 2. Cross-links between the age of women and their answers.

CONCLUSION

The results of the survey reveal that the North Black Sea coast population is oriented mainly towards the use of medicinal plants for treatment and food, much less utilizing them for other purposes, such as decoration, business, *etc.*

The four analysed demographic indicators

have a moderate impact on the use of medicinal plants by the local population. In women, unlike men, the attitudes towards the use of medicinal plants are not significantly influenced by age. Rural respondents display same shares of usage of medicinal plants for treatment and food, while the share of urban respondents using medicinal plants for treatment is twice higher than those using them for food.

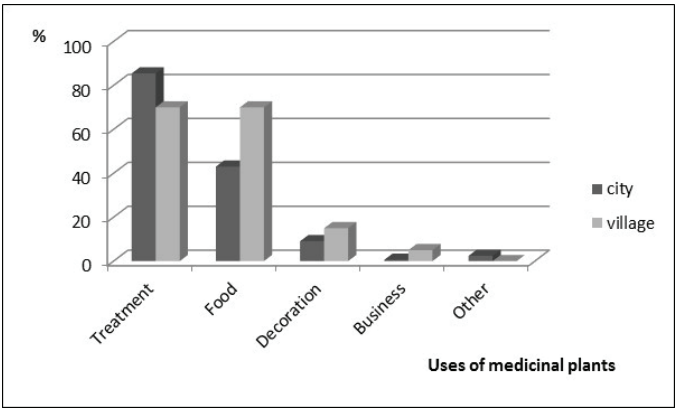

Fig. 3. Impact of residence as a demographic characteristic on respondents' answers

Comparing our data to similar surveys of the hinterland, regional differences have been observed in the uses of medicinal plants by the local population of the surveyed area.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this article.

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PHYTOPLANKTON INTERACTIONS AS MAIN FOCUS OF THE 18TH WORKSHOP OF THE INTERNATIONAL ASSOCIATION OF PHYTOPLANKTON TAXONOMY AND ECOLOGY (IAP): AN OVERVIEW

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Abstract. This paper aims to summarize the work, topics and contributions of the 18th Workshop of the International Association of Phytoplankton Taxonomy and Ecology (IAP), which took place in Natal, Rio Grande do Norte – Brazil, from August 27 to September 3, 2017. The Organizing committee was chaired by professors from two Brazilian universities at Natal and Sao Carlos and comprised scientists from Brazil and Argentina. In total, 39 scientific reports (5 plenary lectures, 20 oral presentations and 13 posters), prepared by 152 contributors from 20 countries were presented. The phytoplankton interactions were the main focus of the workshop, introduced in five plenary lectures. Most other presentations also dealt with this topic: they considered interactions among phytoplankters and phytoplankton-zooplankton interactions, but there was also an interest for processes involving mixotrophic organisms, phytoplankton-bacteria interactions, phytoplankton-macrophytes interactions, parasitism and trophic webs. The factors influencing the phytoplankton development and diversity in different environments, as a background for phytoplankton interactions and drivers of phytoplankton diversity, were also discussed. Different aspects of the phytoplankton diversity were also presented with special emphasis on biodiversity conservation. Traditionally, methodological support for microscopic plankton counts and size measurements and trait-based approaches were among the side-topics of the workshop. Several future lines of research were suggested on the basis of the meeting summary.

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Key words: parasitism, phytoplankton-zooplankton interactions, mixotrophs, phytoplankton-bacteria interactions, phytoplankton-macrophytes interactions, trophic webs

INTRODUCTION

The 18th Workshop of the International Association of Phytoplankton Taxonomy and Ecology (IAP) took place in Natal, Rio Grande do Norte – Brazil, from August 27 to September 3, 2017. The Organizing committee was chaired by professors from two Brazilian universities at Natal and Sao Carlos and comprised scientists from Brazil and Argentina: Hugo Sarmento, Vanessa Becker, Vera Huszar, Irina Izaguirre, Carolina Davila Domingues, Luciane Oliveira Crossetti, Ines O´Farrell and Fernando Unrein.

Fourty-two scientists from fourteen countries participated in the meeting but the number of contributors was higher: 152 from 20 countries. In total, 39 presentations were discussed (5 plenary lectures, 20 oral presentations and 13 posters). The phytoplankton interactions were the main focus of the workshop.

Each day sessions were introduced by a plenary lecture. The first speaker was Antonio Calado, Department of Biology, University of Aveiro, Portugal. He spoke about the phylogeny of dinoflagellates, illustrating the feeding mechanisms associated with particular cell features in heterotrophic species, and showed that similar features exist in phototrophic taxa, suggesting they are mixotrophic. However, food uptake in phototrophic species was demonstrated for very few freshwater dinoflagellates (Calado 2017).

On the second day, Hugo Sarmento, Department of Hydrobiology, Universidade Federal de São Carlos, Brazil, reviewed theoretical concepts on biotic interactions, methods to quantify interaction strength and specialization in interaction networks. In this talk, he stressed that a number of studies had shown that tropical lakes are different from temperate ones in some fundamental ways: constantly high temperature affecting stratification patterns and biological processes; food web structure influenced by zooplankton small body size, etc. He suggested that a great amount of work is still needed to understand biotic interactions along latitudinal gradients (Sarmento 2017).

On the third day, the mid-workshop field trip took place and was focused on the visit of a reservoir in the *Caatinga*. Brazil has six biomes: Amazon, Brazilian savannah (*cerrado*), Atlantic forest, Pampa, Pantanal and Caatinga. In this trip, participants had a unique opportunity to experience the semi-arid conditions of Caatinga, a region where climate change has already influenced ecosystems and people's lives. The reservoir usually has high phytoplankton biomass - permanent blooms of *Cylindrospermopsis* are not rare when water level is decreasing, or dominated by mixotrophs (mainly cryptophytes and euglenoids) when water level reaches a critical depth. On this trip, the participants saw a critical state of the system, which has been affected by severe drought lasting for several years, leading

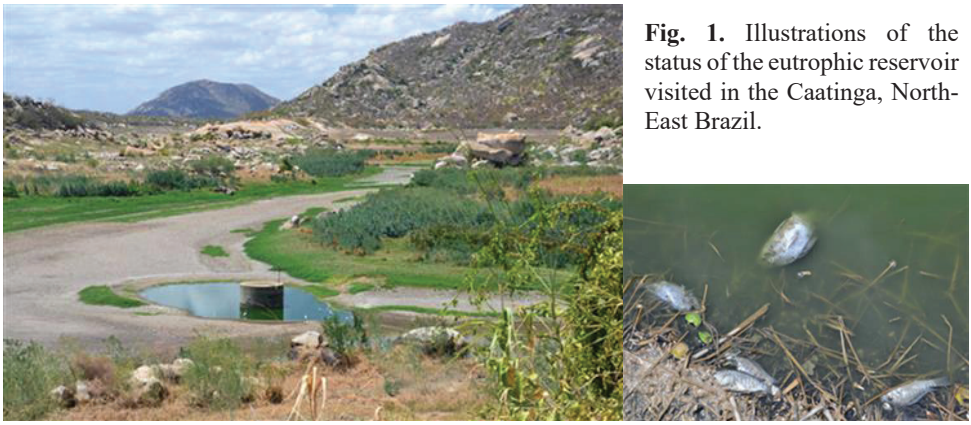

Fig. 1. Illustrations of the status of the eutrophic reservoir visited in the Caatinga, North-East Brazil.

to an extremely low water level, dominance of phytoplankton by small coccoid cyanoprokaryotes/cyanobacteria, and fish kills related to the extreme eutrophication resulting in dissolved oxygen depletion (**Fig. 1**).

On the fourth day, the session was introduced by a talk given by Mariângela Menezes, Department of Botany, Universidade Federal do Rio de Janeiro, Brazil. The contribution focused on the taxonomical updates on phytoflagellates, summarizing the current taxonomic treatment of mixotrophic phytoflagellates in freshwater systems, focusing on the reassessment of genera and species of cryptophytes and euglenophytes (Menezes 2017).

The last plenary, by Carla Kruk, Universidad de la República, Uruguay, focused on a trait-based approach of phytoplankton-zooplankton interactions. She developed classifications based on literature review of specific ingestion rates and selectivity in Rotifers and Cladocerans and applied them to a study of grazing pressure along a latitudinal gradient in South America (Kruk et al. 2017).

Most other presentations also dealt with the main workshop topic: they considered interactions among phytoplankters (Ali Ger et al. 2017; Crossetti et al. 2017; Muhl et al. 2017; Pires et al. 2017; Rangel et al. 2017; Song et al. 2017; Znachor et al. 2017; Zohary et al. 2017) and phytoplankton-zooplankton interactions (de Souza Cardoso et al. 2017; O'Farrell et al. 2017; Olrik 2017; Quesado et al. 2017; Selmeczy et al. 2017), but there was also an interest for processes involving mixotrophic organisms (Cagle et al. 2017; Costa et al. 2017; Naselli-Flores & Barone 2017; Unrein & Gerea 2017), phytoplankton-bacteria interaction (Devercelli et al. 2017; Piccini et al. 2017; Žutinić et al. 2017), phytoplankton-macrophytes interactions (Barbosa & de Araújo Alves 2017), parasitism (Rychtecky et al. 2017) and trophic webs (Domingues et al. 2017; Feitosa et al. 2017; Izaguirre et al. 2017; Wilk-Woźniak et al. 2017). The factors influencing the phytoplankton development and diversity in different environments, as a background for phytoplankton interactions and drivers of

phytoplankton diversity, were also discussed (Abonyi et al. 2017; Becker et al. 2017; Colina et al. 2017; Descy et al. 2017; Di Pasquale et al. 2017). Different aspects of the phytoplankton diversity were also presented (Huber & Unrein 2017; Metz et al. 2017) with special emphasis on biodiversity conservation (Porcel et al. 2017). Traditionally, methodological support for microscopic plankton counts and size measurements (Zohary 2017) and trait-based approaches (Borics et al. 2017) were among the side-topics of the workshop. All the above-mentioned works were multi-aspected and revealed also the need for more efforts in observations of living organisms for outlining the potentially mixotrophic organisms, the difficulties in determining coexistence, competition and cooperation, the influence of invasive species on size phytoplankton structure, the existence of different interaction patterns among the lakes or between free-flowing and impounded river stretches, the possibilities for phytoplankton development in the main river bed, some intriguing similarities between terrestrial and planktonic systems, the effects of different disturbances and species traits on phytoplankton development, *etc*.

Several future lines of research were suggested on the basis of the meeting summary. At the end, it was decided that the next IAP meeting will be held in Hungary and chaired by Gábor Borics, Department of Tisza River Research, MTA Centre for Ecological Research, Hungary. The main topic of this future workshop remains to be decided on.

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THE EFFECT OF THE *EMINIUM REGELII* EXTRACT ON CELLULAR IMMUNITY

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Abstract. The article presents the results of a study on the effects of the wild medicinal plant *Eminium regelii* Vved. extract to the body of intact and subjected to emotional stress animals on the background of a long-term low dose of gamma-radiation. The reaction of the animal organism to the effects of radiation, emotional stress and the introduction of the *E. regelii* extract were evaluated by the total content of leukocytes, absolute and relative content of lymphocytes (including CD3+, CD4+, CD8+), immunoregulatory index (IRI) and leukocyte migration inhibition reaction (LMIR). The experiments were performed on adult mongrel white rats of both sexes. At the early stage of the general adaptation syndrome (GAS) the injection of *E. regelii* extract caused a decrease in the total number of lymphocytes, an increase in the number of CD4+ lymphocytes and leukocytes lymphokinproduction abilities. Late stage of GAS was indicated by increased CD3+ and CD4+ lymphocytes, and increased values of the immunoregulatory index.

Keywords: emotional stress, gamma-radiation, general adaptation syndrome, immunoregulatory index, leukocytes, leukocyte migration inhibition reaction, lymphocytes

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INTRODUCTION

The human body is constantly exposed to ionizing radiation from both natural and artificial sources. There is a variety of published data on the effects of radioactive radiation, some of which are contradictory. For example, some researchers believed that low doses of radiation have a positive stimulating effect and lead to a radiation hormesis (Buldakov & Kalistratova 2005; Luan et al. 2006; Monfared et al. 2006; Luckey 2007; NAIR 2009; Nomura et al. 2013; Gapeyev et al. 2015; Hekim et al. 2015; Vivek Kumar et al. 2015; Cho et al. 2016)

Other studies denied any stimulating effects of any radiation dose and are convinced in the pathological reaction of the organism to radiation effects (El-Halim et al. 2015; Ivanov et al. 2015; Miñana et al. 2015; Oujifard et al. 2015). However, it is commonly accepted that radiation doses cause different functional changes in the cells, and subsequently, at the organismal level through the changing of the immunological reactivity of animals.

The phytotherapy of negative effects caused by ionizing radiation is also interesting. The use of herbal remedies is an alternative to the chemical radioprotectors that reduce the harmful effects of radiation therapy, at the same time causing series of adverse effects on humans (Islamian & Mehrali 2015) In the Central Asian medicinal plant *Eminium regellii* Vved. the flavo-noids luteolin and quercetin were discovered (Silybayeva et al. 2014) They are known to inhibit in vitro the growth of cancer HCT-15 cells (Zharykbasova et al. 2015). Therefore, it is promising to study the effect of the extract of this species and the long-term effect of the emotional stress on the cellular immunity of irradiated animals.

MATERIALS AND METHODS

The experiments were carried out on 170 white, not purebred adult rats weighting an average of 180 ± 20 g, which were divided into 5 groups. Group 1 – intact animals (n = 15), 2nd – irradiated animals of the long-term period (n = 20), 3rd – the intact animals, affected by emotional stress (n = 45), 4th – irradiated animals of the long-term period, affected by emotional stress (n = 45), 5th – irradiated animals of the long term, affected by emotional stress and treated with *E. regelii* extract (n = 45). The fifth group received a course of *E. regelii* extract at 2,5 mg kg^{-1} intragastrically with the help of gavage once a day (in the morning on an empty stomach) during a period of fourteen days. The dose of irradiation of animals from the 2nd, 4th and 5th groups with gamma-rays was ^{60}Co 0.2 Gr and was carried out on the Russian radiotherapy apparatus *Agat-RM* by gamma rays ^{60}Co. Assessment of the long-term immune status was performed after three months of the radiative effect of a dose of 0.2 Gr.

We used the rat tail hanging for an hour as emotional stress trigger. Blood sampling was carried out after one, two and three days after provoked emotional

stress. Blood samples were taken into tubes with heparin (25 U ml^{-1}) to measure the immune status. Isolation of lymphocytes from venous blood was performed by the conventional method (Garib et al. 1995) in a density gradient ficoll-verografin (1,077). The reaction inhibition of leukocyte migration (RILM) to phytohemaglutinin (PHA) was determined by the method of Artemova (1973). The emotional stress was provoked by the method by Zhetpisbayev et al. (1999). Immunological parameters were determined after one, two and three days after post-stress reaction.

Digital data were processed by standard methods of variation statistics (Montsevichyute-Eringene 1961).

The condition of cell immunity was assessed by the flow cytometry and differentiating functions of mytohen productional inhibition reaction by the number of total CD3+, CD4+ and CD8+ lymphocytes with appropriate monoclonal antibodies. The immunoregulatory index (IRI) was calculated. The principle of the method is to attach the human erythrocytes sensitized with monoclonal antibodies LT to the lymphocyte surface.

RESULTS

Within three months after the effect of low dose gamma radiation, normalization of the total number of white blood cells was observed, as well as a significant increase in the number of lymphocytes (**Table 1**). Statistically reduced, in comparison to the control group, remained the number of both relative and absolute numbers of CD3+ lymphocytes.

Table 1. T-immune system in the late period after low dose gamma irradiation.

Indicators, in 1 µl		**1st group of animals (Intact)**	**2nd group of animals (Irradiated)**
Leukocyte, absolute number		6520±150	6055±122
Lymphocytes	absolute number	2800±113	3792±115*
	portion of the total number of leukocytes, %	40±3,6	57±2,2*
CD3+ T-Lymphocytes	absolute number	1457±84	875±40.9*
	portion of the total number of lymphocytes, %	32±2,2	22±1,7*
CD4+ T-helpers	absolute number	698±45,9	477±25,9*
	portion of the total number of lymphocytes, %	21,2±1,9	18±1,2
CD8+ T-suppressors	absolute number	488±22,0	593±19,9*
	portion of the total number of lymphocytes, %	10,8±0,6	11±2,9
IRI (CD4+/CD8+)		1,96±0,16	1,6±0,24
LMIR (index)		0,8±0,06	0,72±0,01
Note: * - the differences from baseline were significant (P <0.05)			

Thus, the subpopulations of T-lymphocytes were different: absolute number of T-lymphocyte with helper activity was reduced to 32%, but the absolute number of T-lymphocyte with suppressive activity, in contrast, increased to 19% (P <0.05). This change caused a reduction of IRI to the control level. The lymphokinproductional ability of white blood cells corresponded to the control level.

At the same time, the analysis shows that, under the low doses of long-term gamma radiation, on the background of recorded lymphocytosis, the reduction of a subpopulation of T-lymphocytes with helper and T-lymphocytes increased with the increase of the suppressor activity.

T-system on the period of the stress effect reacted as follows **(Table 2)**: after 1st day of the stress, the leukocytes in the peripheral blood of irradiated animals were significantly reduced (1.45 times), the number of lymphocytes was reduced 2.26 times, the absolute number of CD3+ - 1.87 times, CD4+ - 1.6 times, CD8+ - 3.1 times, in comparison to the irradiated animals not treated by emotional stress (2nd group of animals). IRI and LMIR to PHA did not change much, the value of the latter was lower than the intact level.

Table 2. The indicators of the T-system after the long-term effects of a low dose of gamma radiation and of the emotional stress.

Indicators, in 1 µl		1st group of animals (Intact)	2nd group of animals (Irradiated)	Indicators after stress	
				after 1 day	after 3 days
Leukocyte, absolute number		6520±15	6055±122	4180±102*^{0}	10636±250*^{0}
Lympho-cytes	absolute number	2800±113	3792±115*	1672±37,6*^{0}	4999±120*^{0}
	portion in the total number of leukocytes, %	40±3,6	57±2,2*	40±2,5^0	47±2,3^0
CD3+ T-Lympho-cytes	absolute number	1457±84	875±40.9*	468±59*^{0}	1291±112^0
	portion in the total number of lymphocytes, %	32±2,2	22±1,7*	29±1,7^0	26,3±1,5*
CD4+ T-helpers	absolute number	698±45,9	477±25,9*	297±10,7*^{0}	712±65,4^0
	portion in the total number of lymphocytes, %	21,2±1,9	18±1,2	16,6±1,2*	14,3±1,4*^{0}
CD8+ T-suppres-sors	absolute number	488±22	593±19,9*	191,6±12,3*^{0}	578±42,1
	portion in the total number of lymphocytes, %	10,8±0,6	11±2,9	12,3±2,7	12,1±2,2
IRI (CD4+/CD8+)		1,96±0,16	1,6±0,24	1,6±0,34	1,2±0,31*
LMIR (index)		0,8±0,06	0,72±0,01*	0,74±0,015*	0,73±0,003*

Note: * - difference from the intact level is right (to 1 group) (P <0.05);
^{o} - the differences from baseline are right (to 2 group) (P <0.05).

After two days, the number of lymphocytes considerably increased (1.53 times). The CD4 + and CD3+ increased 1.43 and 2.0 times, respectively. The number of CD8+ and IRI did not undergo substantial changes, while LMIR to PHA tended to increase in comparison to the initial level.

After three days of stress, the total number of lymphocytes and CD3+ cells in the peripheral blood remained at a high level, exceeding the initial reference levels. The absolute number of CD4+ cells was 1.49 times higher than the control level and corresponded to the intact level; the number of CD8+ cells remained normal and this reliably caused a 1.63 times reduction in the immunoregulatory index. The indicator of LMIR to PHA was significantly higher than the respective level of the intact group.

These data allowed to conclude that the effect of a low dose of gamma radiation applied in a long-term period, in the early stages of the adaptation syndrome was marked by lymphopenia and reduced subpopulations of CD3+, CD4+ and CD8+ lymphocytes and increased lymphokinproductional ability of white blood cells. In the later stage of stress reaction, it was marked by lymphocytosis, by the rise of the absolute number of CD3+ and CD4+ lymphocytes, normalization of CD8+ cells and lymphokinproductional ability of leukocytes, and by the reduction of the immunoregulatory index.

The effect of the *E. regelii* extract and emotional stress on the irradiated body in a small dose of gamma radiation applied in a long-term period, was that the number of white blood cells in the early stage of the general adaptation syndrome (GAS) was considerably lower than in the intact group (**Table 3**). In the later stage of the GAS, the number of white blood cells was 1.28 times higher than this in the control group. The number of lymphocytes at an early stage of GAS exceeded the original level and remained at a high level in the later stage of the GAS.

In the first day after the stress effect, there were no notable changes in a part of CD3+, CD4+ and CD8+ lymphocytes in comparison to the baseline characteristics. In the case of the control group, the absolute and relative numbers of CD4+ -and CD8 + lymphocytes declined.

Two days after the stress effect, the absolute number of CD3+ was markedly higher than in the original and control group levels. The number of CD4+ and CD8+ was noticeably lower than the control group indexes.

Three days after the stress effect, the absolute and relative numbers of CD3+ lymphocytes were higher than in the control group, the absolute number of CD4+ lymphocytes was higher than the control group index, the number of CD8+ corresponds to the original and control group indexes.

Under the influence of the *E. regelii* extract and emotional stress on the irradiated body at a dose of 0.2 Gr, the immunoregulatory index throughout the monitoring was higher than the control group values. At the backdrop of the *E. regelii* extract in the early stages of the GAS the index of the leukocyte migration was lower than the control group values but three days after the stress effect this indicator tended to increase.

Table 3. The effect of *E. regelii* extract on the cellular part of the immune system in the late period after the combined effect of a low dose gamma radiation and emotional stress.

Indicators	Groups of rats	Intact animals		Indicators after emotional stress					
				after 1st day		after 2nd day		after 3rd day	
		The absolute number	The relative number, %	The absolute number	The relative number, %	The absolute number	The relative number, %	The absolute number	The relative number, %
Leukocytes	1	6,52±0,15		9,26±0,82*		8,32±0,75*		5,11±0,35*	
	2	6,05±0,12	-	6,02±0,46+	-	6,24±0,51+	-	6,13±0,52	-
	3	-		6,98±0,57+		6,55±0,43+		6,57±0,45+	
Lymphocytes	1	2,76±0,12	39,02±3,23	4,55±0,41*	45,65±2,88	3,54±0,28*	44,33±3,65	2,28±0,20	37,61±3,02
	2	3,80±0,11	57±2,2	4,43±0,42*	44,32±4,66	3,77±0,27*	41,11±3,54	3,15±0,20+	42,23±3,65
	3	-	-	3,87±0,41*	43,65±3,27	3,23±0,22	40,23±3,64	3,28±0,22+	41,28±3,47
CD3+	1	1,46±0,10	31,82±2,41	1,86±0,17*	36,44±3,11	1,12±0,09*	21,57±2,03*	0,87±0,09**	22,66±2,05*
	2	8,75±0,40	22,00±1,70	1,43±0,11	25,33±2,11*	1,34±0,12	28,56±2,23+	1,10±0,11*	27,35±2,35
	3	-	-	1,53±0,12	29,65±2,07	1,64±0,08*+	30,37±2,17+	1,53±0,14++#	29,62±2,17+
CD4+	1	0,70±0,04	20,93±1,41	1,02±0,11*	22,66±2,21	0,98±0,08*	19,31±1,77	0,60±0,07	18,77±1,57
	2	0,47±0,02	18,00±1,20	0,57±0,06++	15,82±1,63*+	0,61±0,05+	17,67±1,54	0,56±0,05*	16,77±0,91
	3	-	-	0,73±0,05+#	19,05±1,53	0,74±0,04#+	21,05±1,87	0,73±0,06#	19,58±1,37
CD8+	1	0,49±0,02	11,25±0,98	0,95±0,08***	14,25±1,35	0,81±0,07**	10,27±0,97	0,47±0,03	9,88±0,91
	2	0,59±0,01	11,00±2,90	0,39±0,04+	9,54±0,92+	0,44±0,04+	11,08±0,84	0,45±003	10,22±0,91
	3	-	-	0,44±0,03+	10,33±0,83+	0,45±0,03+	13,14±1,02+	0,46±0,03	10,37±0,85
IRI	1	1,44±0,11		1,07±0,12*		1,19±0,11		1,20±0,11	
	2	1,60±0,24	-	1,43±0,12+	-	1,38±0,11	-	25±0,10	-
	3	-		1,63±0,11+		1,64±0,08+		1,55±0,12+#	
LMIT (index)	1	0,79±0,04		0,67±0,07		0,70±0,06		0,85±0,08	
	2	0,72±0,01	-	0,89±0,04**+	-	0,85±0,06+	-	0,90±0,08	-
	3	-		0,75±0,05#		0,70±0,04#		0,81±0,06	

Note:
Groups of rats: 1 - intact animals are affected by emotional stress; 2 - irradiated animals are affected by emotional stress; 3 - irradiated animals are affected by emotional stress and received *Eminium regelii*;* - Reliably to the original (to the intact animals) (P <0.05); ** - Reliably to the original (to the intact animals) (P <0.01); *** - Reliably to the original (to ithe ntact animals) (P <0.001); + - Reliably to the first group (P <0.05); ++ - Reliably to the first group (P <0.01); # - Reliably to the second group (P <0.05).

In conclusion, the *E. regelii* extract in a dose of 2.5 mg kg^{-1} of body weight in the early stage of the GAS caused a decrease in the total number of lymphocytes, but lead to increase of the number of CD4+ lymphocytes and leukocytes lymphokinproductional ability. Late stage of GAS was demonstrated by increased CD3+, CD4+ lymphocytes and increased values of the immunoregulatory index.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this article.

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TRENDS IN E-LEARNING - TECHNOLOGICAL AND PEDAGOGICAL SOLUTIONS: AN OVERVIEW OF THE ROUND TABLE HOLD WITHIN THE FRAMEWORK OF THE YOUTH SCIENTIFIC CONFERENCE *KLIMENT'S DAYS 2017*

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Abstract. This report presents the trends for the future development of e-learning and an overview of the Round Table on *Trends in e-learning - technological and pedagogical solutions* are outlined, held within the framework of the Youth Scientific Conference *Kliment's days* 2017, 16-17 November 2017, Sofia, Bulgaria at the Faculty of Biology of Sofia University "St. Kliment Ohridski". The main objectives and guidelines for discussion of the organized event are outlined. Key conclusions and summaries are presented regarding future trends and perspectives in the implementation of e-learning.

Key words: e-learning, strategies for effective application of ICT, pedagogical models

INTRODUCTION

New approaches and strategies for teaching and learning have been implemented in recent years in the context of the accelerated development of information and communication technologies. E-learning enables universities to offer more flexible

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training than traditional forms, while striving for a higher quality of the learning process at the same time. E-learning provides new opportunities for realizing the pedagogical concept of lifelong learning as well as of personalizing the educational process in the context of modern pedagogical concepts (Asenova & Yotovska 2014а, в). This emphasis is placed not on the specificity of technology as a learning tool but on the specificity of the pedagogical capabilities of one or another technology in the preparation of professionals in a diverse educational context.

According to a number of researchers, the development of education in the higher education sector is heavily dependent on the IT infrastructure and places ever-increasing requirements such as maintaining and processing vast amounts of user data, dynamic resource sharing, rapid adaptation to changing information environment requirements, and service automation, measurability of technology costs, operational provision of various information services. The use of ICT in education is a key element in the documents of the European Commission. It ensures the efficiency of European educational systems and the competitiveness of the European economy (Recommendation of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning 2006/962/EC; http://europa.eu.int; http://ecet.ecs.ru.acad.bg/bvu).

The major trends of the 21st century in the development of e-learning are the following:

- Dominance of mobile communications in e-learning;
- Intensive development of hybrid e-learning models (mobile-computer-based);
- Mass distribution of open source platforms for e-learning development.

Synchronization with the Strategy for Effective Implementation of Information and Communication Technologies in Education and Science of the Republic of Bulgaria (2014-2020) and with the Strategy for Development of Higher Education in the Republic of Bulgaria for the period 2014-2020 is adopted. As a result the analysis of the Strategy for Development of Higher Education in the Republic of Bulgaria outlines the key priorities, which take into account the specific policies and management measures in the field of higher education in the period 2014-2020. Among these are the expansion and strengthening of the Lifelong Learning Network and wide application of various electronic forms for distance learning. E-learning is becoming the fastest growing industry in the world, focused on a great deal of human and financial potential (http://www.minedu.government.bg/news-home/2009/11-02-18_strategy2020.html).

In the process of globalization and dynamic technological development, higher education institutions need to increase their flexibility, customize their learning according to the needs and requirements of students and implement innovative

technological solutions to meet the growing demands of the labor market in a highly competitive environment. This requirement derives also from the start of the European e-Learning Initiative, which focuses on the following areas:

- Building infrastructure, providing equipment and providing access to the Internet of universities, schools, vocational training centers, and other organizations in the field of education;
- Information technology training at all levels – students in schools and universities, lecturers, employees in enterprises, *etc.*;
- Quality multimedia services and the development of quality training content;
- Networking of universities, schools, specialized training centers and cultural centers for exchange of experience, good practices in education and distance teaching and learning.

The management and regulation of the university education system, including and in relation to the development of e-learning, is based on legislation documents of different rank, with varying degrees of dominance in the management process, but in certain relations and relationships between them. In general, they describe the needed decision-making strategies in the process of solving professional tasks of different types, but also comply with the autonomy of the higher schools.

Within the framework of the National Program *e-Bulgaria 2010*, the following goals are set: average levels of the European indicators for development of the information society to be reached; projects related to a network of public broadcasting centers throughout the country to be launched and realized; computerization of Bulgarian schools; creation of computer labs, e-learning sites in state universities; building a high-speed information network between universities and research institutes (http://europa.eu.int).

In July 2014, a Strategy for Effective Implementation of Information and Communication Technologies in Education and Science of the Republic of Bulgaria (2014-2020) was accepted (http://ecet.ecs.ru.acad.bg/bvu; http://www.minedu.government.bg/news-home/2009/11-02-18_strategy2020.html).

The main goal of the Strategy is to provide equal and flexible access to education and scientific information at any time and from anywhere (from a desktop computer, a laptop, a tablet, a mobile phone). It is planned a unified information environment to be created serving school education, higher education and science. One of the priorities in the vision of the Strategy is the development of accessible, universal and compatible (standardized) electronic content (including access through own mobile devices) and a significant reduction in paper document flow in the field of education and science, as well as the development or adoption of recognized standards and metrics for ICT competence and putting ICT skills as an element in the career development of staff in education and science. Some of the main

objectives of the Strategy are: to create equal opportunities for everyone to obtain quality education services at the level of contemporary requirements and trends regardless of the place of residence and training by using modern ICT; building up personalities adapted to life in the information society with all its capabilities, threats, challenges and risks.

Besides the trends for the future development of e-learning mentioned above, and in accordance with them, the present paper provides an overview of the Round Table on *Trends in e-learning - technological and pedagogical solutions*, held within the framework of the Youth Scientific Conference *St. Kliment's days 2017.*

RESULTS

Based on the outlined trends for the future development of e-learning, a Round Table on *Trends in e-learning - technological and pedagogical solutions* was organized within the framework of the Youth Scientific Conference *St. Kliment's days 2017*, 16-17 November 2017, Sofia, Bulgaria at the Faculty of Biology of Sofia University "St. Kliment Ohridski".

The main objectives of the round table were:

- To discuss and outline the vision of the role and future development of e-learning, with respect to different users: learners, e-learning content designers as well as business needs;
- To discuss and analyze good practices in the context of e-learning as well as to share personal experiences and challenges;
- To discuss and analyze good practices in the context of e-learning as well as to share personal experiences and challenges.

The objectives thus formulated respond to the need to draw a common vision of the direction in which e-learning will develop and the steps that higher education institutions have to make towards gettingin line with European policy.

The following ten contributions were presented during the discussions at the Round Table, led and facilitated by Assoc. Prof. Asya Asenova, PhD and Chief Assist. Prof. Kamelia Yotovska, PhD from the Faculty of Biology of Sofia Univeristy "St. Kliment Ohridski":

Lecturer	Report
Assoc. Prof. Morris Grinberg, PhD New Bulgarian University Department of Cognitive Science and psychology	Using assistant technology for eye-tracking with a view in Bulgaria
Assist. Prof. Polina Mihova, PhD New Bulgarian University Department of Health Care and Social Activities	Parameters of evaluation of online learning platforms
Assoc. Prof. Vladislav Slavov, PhD Technical University Faculty of Automatics	Virtual labs in the context of engineering education
Radoslav Tsochev, Dipl. Eng. Cisco - Bulgaria	Capabilities of teleconferencing systems for training
Ivaylo Blagoev, PhD Bulgarian Academy of Sciences Institute of ICT	E-learning and business
Julius Afzali, PhD Technical University - Sofia	Application of the 3D printer in the training
Pavlin Dulev, PhD New Bulgarian University Department of Informatics	The future of e-learning
Assoc. Prof. Blagoy Uzunov, PhD, **Prof. Maya Stoyneva-Gärtner, PhD, DrSc &** **Chief Assist. Prof. Anelly Kremenska, PhD** Sofia University "St. Kliment Ohridski" Faculty of Biology	Electronic courses at the Faculty of Biology - good practices and results
Assoc. Prof. Asya Asenova, PhD Sofia University "St. Kliment Ohridski" Faculty of Biology	Place of e-learning in the professional training of future teachers of biology
Chief Assist. Prof. Kamelia Yotovska, PhD Sofia University "St. Kliment Ohridski" Faculty of Biology	A technological model of a university course for the training of biology teachers in a virtual environment

CONCLUSION

One of the highlights of the organized follow-up discussion in the framework of the Round Table was related to the theoretical aspects and the unification of a common framework regarding the overall process of implementing e-learning at different levels as well as the application of new technologies to promote innovation in the educational process and support the development of learners' creativity. Another aspect of the discussion was related to the development of information and communication technology infrastructure in terms of computer networks, hardware and software. A special focus of the Round Table discussions was related to questions and comments on the pedagogical aspects of applying new technologies to the educational process and their integration within a specific educational context. The dynamics with which new technologies are developing, improving and emerging was analyzed, as well as the emergence of innovations that influence each other and pose additional uncertainty concerning the forecast for the future. Last but not least, the importance of ICT for helping to develop new training methods and increasing the motivation of different groups of learners was discussed including those on children with special educational needs. In general the discussion has culminated with an assessment of the important role that ICT plays in shaping skills and competencies for the 21st century.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this article.

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Book review: Stoyneva-Gärtner M. P. & B. A. Uzunov 2017. Bases of the Systematics of Algae and Fungi. Publ. House "Dzhey Ey Em Dzhi", Sofia, 189 pp. (In Bulgarian)

The book under review presents a new textbook for all students of biology, issued for different bachelor courses within the field (such as Systematics of Algae and Fungi, Biodiversity of Algae and Fungi, Structure and Biodiversity of Algae and Fungi, General Botany or Botany – part Algae and Fungi, Pharmaceutical Botany – part Algae and Fungi, Algae and Fungi as Economic Resources, *etc.*). The book was intended to serve as a guideline in studying of the two distinct groups of Algae and Fungi. It combines traditional knowledge on their morphology, cytology, reproduction and ecology with modern data and recent classification systems based on ultrastructural data and molecular-genetical studies. It is obvious that the concise title of any students' handbook cannot reflect fully the diversity of taxonomic views on the organisms under consideration. Therefore, it is important to point out that the present guide contains a special chapter, in which the peculiarities of both groups are outlined. This chapter, in a brief, but consistent manner, follows the changing views on the position of Algae and Fungi in different systems of the organic world, starting with the simple division in Plants and Animals and ending with the various multikingdom systems, proposed nowadays on the basis of different taxonomic features and approaches. The colorful summarizing table of these main systems and chosen examples is invaluable for students to navigate throughout this diversity of views, opinions and constant changes. In this regard, it is necessary to highlight the usefulness of the provided historical information on the most influential authors and books, and of the added index of the original names of the authors and their Bulgarian equivalents.

By contrast to the wrong, but widely spread opinion that *systematics* means endless memorization of long lists of Latin names, the authors specifically noted that they *are not supporters of such meaningless memorizing*. This *declaration* is favored by the consecutive introduction of the terminology and by the provided explanations of the origin of each used term, of the main Latin names, and of the logics of their development in relation to the taxonomic hierarchy as well. Such approach is highly appreciated, especially when it is so successfully combined with the original and pictorial, colorful way of presentation of the modern classification

of all big taxonomic groups of Algae and Fungi (incl. Pseudofungi, Slime moulds and Lichens) in series of figures, where all members of the same group are given the same color on a permanent place. Each of these figures points to a specific taxonomic feature (or features) used in modern classifications, thus allowing for an easy comparative study. This is simplified by the fact that the main taxonomic groups are presented in the same way in the figures on the inner parts of the front (Algae) and back (Fungi) covers. The black and white illustrations within the text are the minimum necessary helpful support for its better assimilation.

The language of the book is completely scientific, but easily understandable and the content clearly follows the structure of the lectures of both authors, who prepared the textbook on the basis of their teaching experience of lectures, practical courses and field trips. This experience can also be seen in the reasonable volume of the presented knowledge and in the properly chosen publication format. The linguistic consultations of Prof. DrSc Stefana Dimitrova and the reviewer work of Prof. DrSc Dimitar Peev further ensure the quality of the new handbook. Last but not least, the interesting cover, in the background of which almost every Bulgarian biologist will easily recognize the specific brick-wall structure of the Faculty of Biology of Sofia University "St. Kliment Ohridski", designed by Dipl. Eng. Yana Stoyneva, shows not only the affiliation of the authors, but in a symbolic way points also on the long process of building of the systematic knowledge – successively, brick upon brick, brick by brick…

Following the classical structure of a book review, which needs to provide some criticism, it has to be suggested to the authors to publish this modern summary of the knowledge on Algae and Fungi in English for broadening its audience.

Assoc. Prof. Dr Dobri L. Ivanov,
Head of the Department of Biology,
Medical University "Prof. D-r P. Stoyanov" - Varna

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Journals:

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Books:

Dimitrov D. G. & Ivanov A. N. 2017. Biodiveristy of the seashores of Bulgaria. Springer, Heidelberg, 405 pp.

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Book chapters:

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Petrov F. K. 2000. *Padina pavonica*. – In: Ivanov W. J., Stoyanov H. P. & Petrov F. B. (Eds), Water ecosystems, Elsevier, New York, p. 49.

Conference papers (or abstracts if they provide essential information):

Bogdanov D. M. 2017. Danube Delta. - In: Somov N. P. & Karakudis F. E. (Eds), Proceedings of the First European Symposium *Conservation and management of biodiversity in the European seashores*, Melnik, Bulgaria, 8-12 May 2017, 36-46.

When the cited paper/abstract/summary occupies only one page, it should be written as follows:

Bogdan D. M. 2017. Biosphere reserves and special legislation for environmental protection. - In: Venev N. (Ed-in-Chief), Book of Abstracts, First European Symposium *Conservation and management of biodiversity in the European seashores*, Primorsko, Bulgaria, 8-12 May 2017, p. 36.

Or, alternatively, depending on the order of date and place in the original title of the Proceedings/Abstract books:

Bogdan D. M. 2017. Biosphere reserves and special legislation for environmental protection. - In: Venev N. (Ed-in-Chief), Book of Abstracts First European

Symposium *Conservation and management of biodiversity in the European seashores*, 8-12 May 2017, Primorsko, Bulgaria, p. 36.

Electronic publications should be cited with their author or title in the references with indication of the date of retrievement or of the last access of their full web address:

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Index Fungorum. Retrieved from http://www.indexfungorum.org/Names/Names.asp on 19.11.2017.

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Index Fungorum. http://www.indexfungorum.org/Names/Names.asp (Last accessed on 19.11.2017).

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Journal:

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Petkov N. H. 1915. La flore algologique du mont Pirin-planina.- Sbornik na Bulgarskata Akademiya na Naukite 20: 1–128 (In Bulgarian, French and Russian summ.).

Book:

Valkanov D. E., Draganova P. M. & Tsvetkova B. B. 1978. Flora of Bulgaria. Algae. Izd. Narodna Prosveta, Sofia, 642 pp. (In Bulgarian)

Valkanov D. E., Draganova P. M. & Tsvetkova B. B. 1978. Flora of Bulgaria. Algae. Izd. Narodna Prosveta, Sofia, 642 pp. (In Bulgarian, English summ.)

In case of **slavic languages, which do not use Cyrrilic**, double titles could be provided (optional):

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Footnotes should be avoided.

Transliteration should follow the Bulgarian legislative documents (State Gazette 19/13.03.2009, 77/01.10.2010, 77/09.10.2012, 68/02.08.2013 - http://lex. bg/en/laws/ldoc/2135623667). **The geographic names should be fully transliterated** except the cases of titles of published works.

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