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Floral Diversity of the Tlemcen Mountains (Western Algeria)

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Abstract. Mountains of Tlemcen offer a very interesting model for studying the evolution of the flora in the region, since their landscapes variety remains very remarkable and the vegetation distribution is conditioned by a significant number of ecological factors. Although there were registered manyfires in the area during the 1990s, the coexistence of some species, such as *Quercus faginea* subsp. *tlemcenensis* (DC.) M., *Pinus halepensis* Miller., *Calicotome intermedia* (Salzm.) C. Presl., *Lonicera implexa* L., *Ruscus aculeatus* L., indicates a dominant ecological atmosphere of the forest. In this study, a phytoecological and syntaxonomical analysis was made. More than 300 species were identified and indexed, belonging to more than 50 families, which shows the importance of the phyto-diversity of the studied area. Based on the analysis of the phytoecological parameters, we could note a decline of the ground vegetation in its diversity.

Key words: biodiversity, floristic inventory, phytoecology, Tlemcen Mts.

Introduction

In the Mediterranean regions, evolved a portion of forest area estimated at 2,145,000 ha. The latter has suffered in his life cycle of very difficult times: a forest in perfect balance toward a forest very degraded; there is sometimes a matorralisation of this portion, such as the Algerian forest.

Because of its geographical position, Algeria has a great diversity of biotopes occupied by important floristic richness. Its forest ecosystems are characterized by a noteworthy flora; some represent regions of global interest. According to DAHMANI (1997, Algeria, pers. com.) the knowledge of the biological and ecological characteristics of the species, just as the identification of the historical and current factors at the origin of the fluctuations of the flora are essential to any action of the biodiversity conservation.

The contemporary forests of the mountains of Tlemcen are result from the interaction of much diversified factors, concerning in particular topography, geology, climatology and especially by a long and deep anthropogenic action. Under this permanent pressure, the forests tend to be transformed into matorral. Sparse are destroyed consequently and their place is taken by thorny species and thermophytes (QUÉZEL, 2000).

This vegetation is subsequently a favorable environment to fires very often volunteers.

In addition, the drought that has known in the region of Tlemcen, has disrupted deeply

the nature resulting in plants of important phenomena of water stress and adaptation.

This introduction is quite dark, but agrees to this sad reality. That is what thus remains at the level of these forest ecosystems mediterranean. A presentation of the current stage of forests of the mountains of Tlemcen of point of view of the species that constitute will allow us to be located along a path ecological. Also this will help us to better carry out an action conservatoire (GHEZLAOUI *et al.*, 2011). The studies of the flora and its diversity in Western Algeria interested a certain number of researchers (BENABADJI *et al.*, 2010; QUÉZEL, 1956, 1957, 2000; KADI-HANIFI, 2003; GHEZLAOUI *et al.*, 2011; MESLI *et al.*, 2008; LETREUCH-BELAROUCI *et al.*, 2009; MEDJAHDI *et al.*, 2009; BOUAZZA & BENABADJI, 1998).

Materials and Methods

Study area. The Tlemcen Mts. are located in the Western part of Algeria, between the latitudes north of 34°30' and 35° and western longitudes of 0°30' and 2°. It is a mountain range which appears starting from 600 m and which culminates at certain points with more than 1800 m. It is connected to the Tellian Atlas (Fig. 1).

The forests of Tlemcen Mts. stand on a mountainous mass dating from the upper Jurassic made up mainly of sequanien sandstone and quaternary alluvia. The soils are in general more or less deep and of brown forest type. The herbaceous layer is rather rich, leading to the existence of a strong biological activity. The texture is clay-limestone and silt-clay with some concretions on the horizon A1. The humus is quite abundant and the organic matters are important. The brown fersialitic soils also are very developed (GAOUAR, 1980).

From the bioclimatic point of view, the recent period (1980-2013) varies clearly compared to the old one (1913-1938), with a reduction in precipitations and an increase in the temperatures.

Tlemcen Mts. are characterized with semi-arid and sub-wet Mediterranean climate characterized by two seasons: a short and cold winter and a long and dry summer. The maximum average temperature of the hottest month is of 32.67°C, which of the minimum of the coldest month is of 3.22 °C.

The pluviometric index of Emberger is of 42.10, which confirms an upper semi-arid climate with temperate variant. Current precipitations vary between 350 mm and 485 mm, (Fig. 2) which explains the rusticity of the plant species: *Pinus halepensis* Miller, *Olea europaea* L. subsp. *europaea*, *Ziziphus lotus* (L.) Desf, *Juniperus ocycedrus* subsp. *rufescens* L. of the area. The forests of the mountain appear among the habitats indexed like key issues (Hotspots) in the Mediterranean basin, where the vegetation east persists on the level of ecosystems refuges (MÉDAIL & DIADEMA, 2009) (Fig. 3).

Sampling procedures. The choice of the samples is based on a selection which takes account of the structure of the vegetation where the floristic and ecological criterion of homogeneity was privileged. We used the surface sampling method (minimal surface) which consists in choosing sites as typical as possible by noting down the environmental conditions (GOUNOT, 1969). Each floristic surface sample was elaborated according to the BRAUN-BLANQUET (1951) method.

The main literature used for the identification of the collected species in the field is starting from the studies carried out by BATTANDIER & TRABUT (1888-1889); QUÉZEL & SANTA (1962-1963); MAIRE (1952-1987); VALDÉS *et al.* (2002); DOBIGNARD & CHATELAIN (2010-2012); BLANCA *et al.* (2009).

Taxonomy. The taxonomy of the species follows "Index synonymique et bibliographique de la flore d'Afrique du Nord" (DOBIGNARD & CHATELAIN, 2010-2012) and the synonymes are given after "Nouvelle flore d'Algérie et des Régions désertiques méridionales" (QUEZEL & SANTA, 1962-1963).

Results and Discussion

Physiognomic description of the forests

As a whole, the forests of Tlemcen Mts. depend on the soil and climate conditions and the anthropogenic pressure. The various forests which the mountains constitute offer a great floristic diversity; it is interesting to tackle their description.

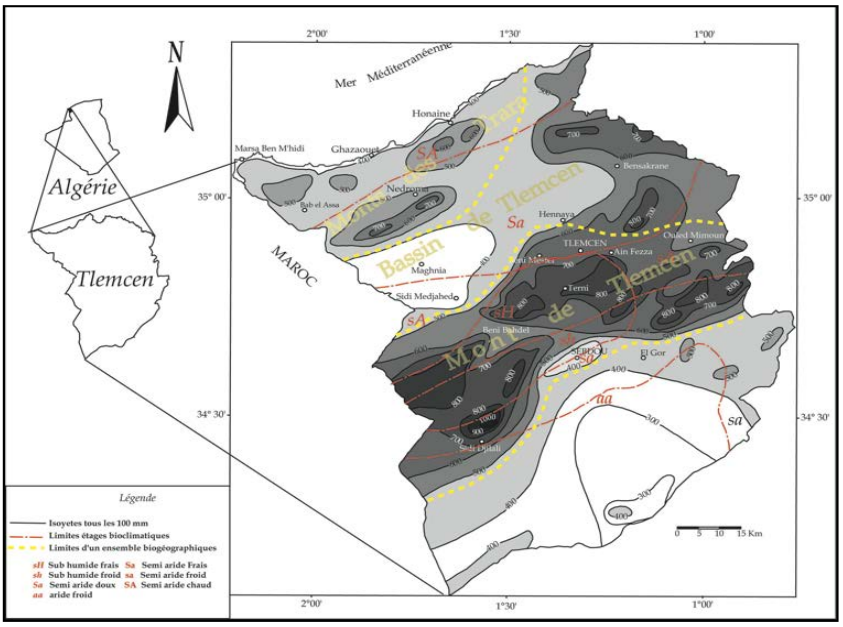

Fig. 1. Map of the study area.

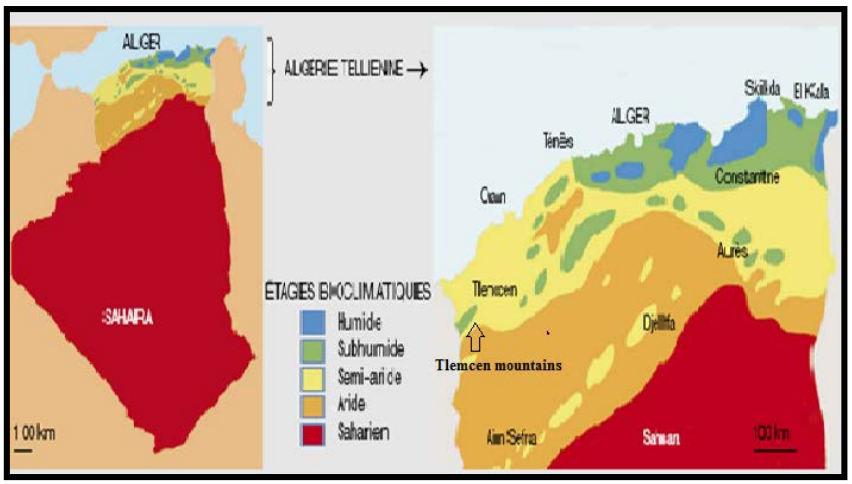

Fig. 2. Bioclimatic stage of Tlemcen Mts.

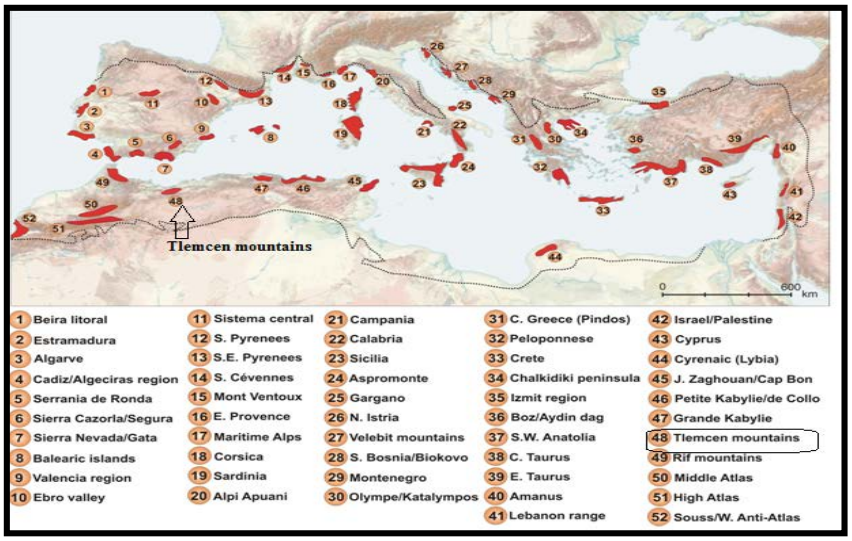

Fig. 3. Hotspots in the Mediterranean basin.

The forest of Hafir

It is a mature forest of Cork oak. This forest, formerly, produced the best cork of Algeria (BOUDY, 1955). It covers a surface of 9870 ha. The shrubby layer is composed primarily of: *Juniperus oxycedrus* subsp. *rufescens* L., *Quercus ilex* subsp. *ballota* (Desf.) Samp., *Quercus suber* L. and the oak Zeen (*Quercus faginea* Lamk). The last one is an oak with deciduous leaves of types meso- and supra-Mediterranean (QUÉZEL & MEDAIL, 2003; MESSAOUDÈNE *et al.*, 2008) endemic of the Western Mediterranean (Iberian peninsula, Morocco, Algeria and Tunisia) (ZINE EL ABIDINE, 1988). It would be represented in the Tlemcen Mts. by a subspecies: *Quercus faginea* subsp. *tlemcenensis* (CD.) M (Fig.4).

Fig. 4. Locality of cork oak (the forest of Hafir). Photo: F.Z. Chemouri, January 2015.

The matorral of Zarifet

On a surface of 944 ha, it is based mainly on the old settlements of Cork oak and Holm oak. Their growth is generally less strong after a fire. These species are typical of low intensity fires but common in the study zone (PRODON *et al.*, 1984; SCHAFFHAUSER *et al.*, 2012). The vegetation associated with these oaks cork is: *Genista tricuspidata* subsp. *duriaei* (Spach.) Beats., *Ampelodesmos mauritanicus* (Poiret) Dur. & Schinz., *Daphne gnidium* L., *Cistus salvifolius* L., *Cistus villosus* L., *Asparagus acutifolius* L., *Asphodelus microcarpus* Sal. & Viv., *Arbutus unedo* L., *Cytisus villosus* Pour. (Fig. 5). These plants prefer siliceous substrates.

Fig. 5. The matorral of Zarifet. Photo: F.Z. Chemouri, January 2015.

The forest of Beni Boussaid

It covers a surface of 11.350 ha, it acts of a vegetal formation in mixture with Holm Oak, Thuya and of Juniper, often of the matorrals containing *Quercus ilex* subsp. *ballota* (Desf.) Samp. Al one or mixed with *Tetraclinis articulata* (Vahl) Link. Endemic in North Africa (HADJADJ-AOUL *et al.*, 2009), it colonizes the zones with weak pluviometry (from 300 to 500 mm) (QUÉZEL, 2000) and of *Juniperus ocycedrus* subsp. *rufescens* L (Fig. 6). On the whole, it represents a rather advanced stage of degradation of a climactic forest of oak cork and of holm oak. The coppice of intensely exploited holm oak is able to be maintained while being regenerated remarkably and easily in spite of the strong anthropogenic pressure.

Fig. 6. The coppice of intensely exploited holm oak (the forest of Beni Boussaid). Photo: F.Z. Chemouri, January 2015.

The forest of El Khemis

Always in the series of the holm oak (11.655 ha), but in the presence of climatic and soil conditions and of the different human activities and especially less favorable than the preceding ones, this forest offers thanks to its old coppice of holm oak accompanied by *Juniperus ocycedrus* subsp. *rufescens* L., *Pinus halepensis* Miller, *Pinus pinea* L., *Cedrus atlantica* (Endl.) Career and *Cupressus sempervirens* L. Some of the species are in the ultimate stages of degradation (Fig. 7).

Fig. 7. The forest of El Khemis (Pine of Alep, Thuja, Genevrie). Photo: F.Z. Chemouri, December. 2014.

The forest of Azails

It consists of high matorral and of clear forest of Pin d'Alep and average matorral of Holm oak and prickly juniper. It is distributed on approximately 7.990 hectares and is dominated by the annual species (thermophytes) caused by the high anthropogenic pressure and an additional degradation (fires). This forest is characterized by its weakness since even *Pinus halepensis* Miller., *Juniperus ocycedrus* subsp. *rufescens* L., *Stipa tenacissima* L., which entirely invaded the underwood (Fig. 8). The holm oak is the dominant species and testifies to its adaptation to the ecological and anthropic conditions most difficult.

List of the species indexed by family in the mountains of Tlemcen.

The list includes 340 species belonging to 57 families, dominating by Asteraceae, Fabaceae, Lamiaceae, and Cistaceae.

Fig. 8. The forest of Azail (average matorral of Holm oak). Photo: F.Z.Chemouri, January 2015.

ANACARDIACEAE
Pistacia atlantica Desf.
Pistacia lentiscus L.
Pistacia terebinthus L.
APIACEAE
Ammoides pusilla (Brot.) Breistr.
Ammoides verticillata (Desf.) Briq.
Balansae glaberrimae (Desf.) Lange
Bunium alpinum W. & Kit.
Bupleurum balansae var.balansae B. & R.
Bupleurum rigidum L.
Daucus carota L.
Daucus muricatus Lamk.
Eryngium campesire L.
Eryngium maritimum L.
Eryngium tricuspidatum L.
Ferula communis L.
Foeniculum vulgare (Millet.) Gaertn.
Thapsia garganica L.
ARACEAE
Arisarum vulgare Targ.Tozz.
ARALIACEAE
Hedera helix L.
ARISTOLOCHIACEAE
Aristolochia longa L.
Lamium amplexicaule L.
ASTERACEAE
Anthemis punctata Vahl.
Artemisia alba ESA.
Asteriscus maritimus (L.) Less.
Asteriscus pygmaeus Coss & Kral.
Asterolinum linum-stellatum (L.) Duby.
Atractylis cancellata L.
Atractylis humilis L.

Bellis annua L.
Bellis silverstris L.
Calendula arvensis L.
Carduus pycnocephalus L.
Carlina lanata L.
Carthamus caeruleus L.
Carthamus lanatus L.
Carthamus pectinatus Desf.
Catananche caerulea L.
Catananche lutea L.
Centaurea acaulis L.
Centaurea incana Desf.non Lag.nec Ten.
Centaurea involucrata Desf.
Centaurea paviflora Desf.
Centaurea pullata L.
Centaurea solstitialis L.
Centaurea tenuifolia Duf.
Chrysanthemum coronarium L.
Chrysanthemum grandiflorum (L.).Beats
Chrysanthemum paludosum Poiret.
Cichorium intybus L.
Cirsium vulgere Ten.
Globe-thistle spinosus L.
Elichrysum stoechas (L.) DC.
Evax argentea Pomel.
Hypochoeris achyrophorus L.
Hypochoeris radicata L.
Inula montana L.
Leontodon hispidulus Poiret.
Leuzea conifer (L.) DC.
Micropus bombycinus Lag.
Pallenis spinosa (L.) Case.
Phagnalon saxatile (L.) Case.
Pulicaria odora (L.) Rchb.
Reichardia picroides (L.) Roth.
Scolymus grandiflorus Desf.
Scolymus hispanicus L.
Scolymus maculatus L.
Scorzonera undulata Beats. non Vahl.
Senecio vulgaris L.
Xanthium spinosum L.
Xeranthemum inapertum (L.) Millet
BORRAGINACEAE
Echium parviflorum Moench.
Echium flavum Desf.
Echium parviflorum Moench.
Echium vulgare L.
Lithospermum apulum (L.) Vahl.
Lithospermum arvens L.
BRASSICACEAE
Alyssum campestre L.
Alyssum granatense (B. & R)
Alyssum serpyllifolium Desf.
Alyssum spinosum L.
Arabis alpina L.
Arabis auriculata Lamk.
Arabis verna (L.) R. Br.
Biscutella didyma L.
Brassica nigra (L.) Koch.
Maximum Briza L.
Lobularia maritima (L.) Desv.
Raphanus raphanistrum L.
Sinapis alba L.
Sinapis arvensis L.
Thlapsi perfoliatum L.
Vella annua L.
CAMPANULACEAE
Campanula dichotoma L.
CAPRIFOLIACEAE
Lonicera etrusca Santi.
Lonicera implexa L.
Virbumum tinus L.
CARYOPHYLLACEAE
Arenaria aggregata Laws.
Arenaria grandiflora L.
Arenaria serpyllifolia L.
Cerastium pentandrum L.
Dianthus caryophyllus L.
Herniaria hirsuta L.
Gay Herniaria fontanesii J.
Minuartia campestris L.
Paronychia argentea (Pourr.) Lamk.
Silene tridentata Desf.
Vaccaria pyramidala Medik
CHENOPODIACEAE
Atriplex halimus L.
CISTACEAE
Cistus albidus L.
Cistus creticus L.
Cistus ladaniferus Lada.
Cistus monspeliensis L.
Cistus salvifolius L.
Cistus villosus L.
Fumana fontanesii Pomel.
Fumana thymifolia (L.) Verlot.
Halimium halimifolium (L.) Willk.
Helianthemum cinereum (Cav.) Sea-green.
Helianthemum cinereum subsp. *rubellum* (Presl.)
Helianthemum croceum (Desf.) Sea-green.
Helianthemum helinthemoides (Desf.) Grosser.
Helianthemum hirtum E. and Mr.
Helianthemum origanifolium (Lamk.) Sea-green.
Helianthemum pilosum (L.) Sea-green.
Helianthemum virgatum (Desf.) Sea-green.
Helianthemum racemosum (L.) Pau.
Triticum sativum B. Attic
Tuberaria guttata (L.) Sleeve
Tuberaria vulgaris Willk.
CONVOLVULACEAE
Convolvulus althaeoides L.
CRASSULACEAE
Sedum acre L.
Sedum sediforme (Jacq.) Pau.
Sideritis montana L.

CUPRESSACEAE
Callitris articulata (Vaht.) Link.
Cupressus sempervirens L.
Juniperus oxycedrus L. subsp. *rufescens*
CYPERACEAE
Carex halleriana ESA.
DIPSACACEAE
Cephalaria leucantha (L.) Schard.
DYPSACACEES
Scabiosa stellata L.
EPHEDRACEAE
Ephedra fragilis Desf.
ERICACEAE
Arbutus unedo L.
Erica arborea L.
EUPHORBIACEAE
Euphorbia exigua L.
Euphorbia falcata L.
Euphorbia nicaeensis All.
Euphorbia sulcata de Lens.
FABACEAE
Adenocarpus decorticans Wood.
Adenocarpus bacquei (B. & T)
Anagyris foetida L.
Anthyllis Montana L.
Anthyllis tetraphylla L.
Anthyllis vulneraria L.
Astragalus armatus Willd.
Asragalus incanus L.
Calicotome intermedia (Salzm.) C. Presl = *Calycotome villosa* subsp. *intermedia* (Salzm.) Mr.
Capsella bursa-pastoris L.
Ceratonia siliqua L.
Cerinthe major L.
Colutea arborescens L.
Coronilla juncea L.
Coronilla minimum L.
Coronilla scorpiodes Koch.
Cynoglossum cheirifolium L.
Cytisus villosus Pourret. = *Cytisus triflorus* Herit.
Erinacea anthyllis Link.
Genista erioclada subsp. *atlantica* (Spach.) Mr.
Genista ramosissima (Desf.) Poiret. = *Genista cinerea* subsp. *ramosissima*
Genista erioclada Spach.
Genista spartioides Spach.
Genista tricuspidata subsp. *duriaei* (Spach.) Beats.
Hedysarum coronarium L.
Hedysarum flexuosum L.
Hippocrepis multisiliquosa L.
Hippocrepis multisiliquosa subsp. *ciliata* (Willd.)
Hornungia petraea (L.) R.Br.
Lagurus ovatus L.
Lathyrus sphaericus Retz.
Lotus edulis L.
Medicago minima Grufb.
Medicago rugosa Desr.
Melilotus sulcata Desf.
Odontites purpurea Gift.
Onobrychis alba (W.et K) Desv.
Ononis natrix L.
Scorpiurus muricatus L.
Solenanthus lanatus cd.
Tetragonolobus purpureus Moench.
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Trifolium tomentosum L.
Stauracanthus boivinii (Webb) Samp = Ulex boivinii Webb var. *webbianus* (Cosson) Mayor
Vitia sativa L.
FAGACEAE
Quercus coccifera L. subsp. *coccifera*
Quercus faginea subsp. *tlemcenensis* (cd.) Mr. = *Quercus faginea* subsp. *broteroi* (Coutinho) A. Camus
Quecus ilex subsp. *ballota* (Desf.) A. cd.
Quercus suber L.
FUMARIACEAE
Fumaria capreolata L.
GERANIACEAE
Erodium guttatum (Desf.) Willd.
Erodium moschatum (Burm.) Her.
Geranium molle L.
Geranium robertianum L.
GLOBULARIACEAE
Globularia alypum L.
IRIDACEAE
Iris tingitana (B. & R.) B. & T.
LAMIACEAE
Ajuga chamaepytis (L.) Schreber. = *Ajuga chamaepytis* Schreb.
Ajuga iva subsp. *iva* (L.) Schreber.
Ballota hirsuta Benth.
Lavandula dentata L.
Lavandula multifida L.
Lavandula stoechas L.
Marrubium vulgare L.
Micromeria inodora Benth.
Nepeta multibracteata Desf.
Origanum glandulosum Desf.
Origanum hirtum Beats. non Link.
Phlomis herba venti L.
Prasium majus L.
Rosmarinus officinalis L.
Rosmarinus tournefortii de Noé.
Salvia officinalis L.
Salvia verbenaca Beats.
Satureja graeca L.
Satureja rotundifolia (Near.) Briq
Satureja vulgaris (L.) Fritsch.
Teucrium fruticans L.
Teucrium polium L.

Teucrium pseudochamephitys L.
Thymus ciliatus Desf.
Thymus munbyanus subsp. *coloratus* (Wood. & Reuter) Greuter & Burdet = *Thymus ciliatus* subsp. *coloratus* (B. & R.) Beats.
LILIACEAE
Allium nigrum L. = *Allium roseum* L.
Allium roseum subsp. *have-roseum* Windt
Allium senecens L.
Allium triquetrum L.
Aphyllantes monspelinsis L.
Asparagus acutifolius L.
Asparagus albus L.
Asparagus stipularis Forsk.
Asphodelus microcarpus Salzm. & Viv.
Gagea arvensis (Pers.) Dum.
Gallium aparine L.
Gallium parisiense L.
Gallium rotundifolium L.
Minuartia montana L.
Muscari comosum (L.) Millet.
Ornithogallum umbellatum L.
Ruscus aculeatus L.
Ruscus hypophyllum L.
Smilax aspera L.
Drimia maritima (L.) Speta = *Urginea maritima* var. *pancration* (Stein.) Baker.
LINACEAE
Linum corymbiferum Desf.
Linum strictum L.
Linum suffruticosum L.
MALVACEAE
Lavatera maritima Gouan.
Malva sylvestris L.
MYRTACEAE
Muscari neglectum Guss.
OLEACEAE
Fraxinus angustifolia Vahl.
Jasminum fruticans L.
Olea europaea L. subsp. *europaea* = *Olea europea* var. *oleaster*
Phillyrea angustifolia L.
Phillyrea latifolia L. = *Phillyrea angustifolia* subsp. *latifolia* (L.) Mr.
ORCHIDACEAE
Gennaria diphylla (Link.) Parl.
OROBANCHACEAE
Broomrape alba Steph.
PALMACEAE
Chamaerops humilis subsp. *argentea* Andre.
PAPAVERACEAE
Papaver hybridum L.
Papaver rhoeas L.
PINACEAE
Cedrus atlantica (Endl.) Career = *Cedrus libanotica* Link.
Pinus halepensis Miller.
Pinus pinea L.
PLANTAGINACEAE
Plantago albicans L.
Plantago lagopus L.
Plantago ovata Foresk.
Plantago psyllium L.
Plantago serraria L.
POACEAE
Aegilops triuncialis L.
Aegilops ventricosa Tausch
Aira cupaniana Guss.
Aira cupaniana subsp.genuina Briq.
Ampelodesmos mauritanicus (Poiret) Dur. & Sch. = *Ampelodesma mauritanica* (Poiret) Dur. & Sch.
Avena sterilis L.
Brachypodium distachyon (L.) P.B.
Bromus madritensis L.
Anisantha rubens (L.) Nevski = *Bromus rubens* L.
Bromus squarrosus L.
Bromus tectorum L.
Cynosurus elegans Desf.
Dactylis glomerata L.
Echinaria capitata (L.) Desf.
Festuca atlantica Duv. Jouve.
Festuca scaberrimae Lange.
Festuca caerulescens Desf.
Festuca triflora Desf.
Hordeum murinum L.
Koeleria vallesiana (Honk.) Bert.
Lamarckia aurea (L.) Moehch.
Melica minuta subsp. *major* (Parl.) Trab.
Scandix pecten-veneris L.
Schismus barbatus (L.) tel.
Macrochloa tenacissima (L.) Kunth = *Stipa tenacissima* L.
Vulpia geniculata (L.) Link.
PRIMULACEAE
Anagallis arvensis subsp. *latifolia* (L.) Br.- Bl. & Mr.
Anagallis arvensis subsp. *phoenicea* (Gouan) Vollus
Maximum androsace L.
RANUNCULACEAE
Adonis annua L.
Adonis dentata LED.
Clematis cirrhosa L.
Clematis flammuia L.
Delphinium peregrinum L.
Nigella damascena L.
Ranunculus bulbosus L.
Ranunculus gramineus L.
Ranunculus spicatus Desf.
RESEDACEAE
Reseda alba L.
Reseda luteola L.
Reseda phyteuma subsp. *phyteuma* Mr.
RHAMNACEAE
Rhamnus alternus L. subsp. *alternus*
Rhamnus lycioides subsp. *oleoides* (L.) Jah. & M

Ziziphus lotus (L.) Desf
ROSACEAE
Crataegus oxyacantha L.
Rosa sempervirens L.
Rubus ulmifolius Schott.
Sanguisorba minor Scop.
RUBIACEAE
Asperula arvensis L.
Asperula hirsute L.
Rubia laevis Poiret.
Rubia peregrina L.
RUTACEAE
Ruta chalepensis L.
SANTALACEAE
Osyris alba L.
SCROPHULARIACEAE
Anarrhinum fruticosum Desf.
Annarhinum pedatum Desf.
Linaria gharbensis Beats. & Piterd.
Linaria heterophylla Desf.
Linaria reflexa Desf.
SOLANACEAE
Veronica arvensis L.
THYMELAEACEAE
Daphne gnidium L.
Thymelea nitida Desf
Thymelea virgata Desf
ULMACEAE
Celtis australis L.
VALERIANACEAE
Fedia cornucopiae (L.) Gaerth.
VIOLACEAE
Viola silvestris Lamk.
ZYGOPHYLLACEAE
Fagonia cretica L.

Conclusions

The degradation of the forest of Tlemcen Mts. is the result of the interference of several natural factors, anthropogenic, historical and of forest management. The capacities of resistance of the forest decreased much and the signs of its degradation are very apparent. Repeated fires combined with human action in this forest type cause changes to two different types of vegetation.

In more high altitudes the forest is replaced by groupings with thorny xerophytes similar to those which one finds above the limit altitudinal trees: they cover 60 to 100% of the ground in mixture with the xerophytes thorn-bush: *Genista tricuspidata* subsp. *duriaei* (Spach.) Beats, *Ziziphus lotus* L. A lower altitude the sequence understands the following stages:

- Forest of oaks (Holm oak, oak Zen and oak cork) imbricating some relics of cedar *Cedrus atlantica (*Endl.) Carrière.
- Maquis with holm oak and juniper oxycedre.
- The forests of Zeen oak can also be described as pyrolabile; they occupy the zones with rainfall raised in North Africa, in Portugal and in Spain. The rainfall is always higher than 800 mm and often than 1000 mm.
- Lawns with thyme: *Thymus ciliatus* Desf. and *Thymus munbyanus* subsp. *coloratus* (Boiss. & Reuter) Greuter & Burdet.

The deterioration of the forest structure and the absence of regeneration are as many manifestations of the state of destruction of the strength and the integrity of the forest which constitutes a central axis for any initiative of the development of the zone. The population actuality and the mistakes of alternative solutions, has drawn and draws even the forest resources (aromatic plants: *Rosmarinus officinalis* L., medicinal: *Ammoides pusilla* (Brot.) Breistr., and others). This situation will certainly lead towards an irreversible degradation of the plant cover even to turning into a desert of the environment. This requires the immediate execution of an inclusive and sustainable development strategy based on the conservation and the rehabilitation of these forests, on the one hand, and the improvement of the standard of living of the local population, on the other hand.

References

BATTANDIER A., L. TRABUT. 1888-1890. *Flore d'Algérie (Dicotylédones)*. 860 p.

BENABADJI N., B-E. GHEZLAOUI, M. BOUAZZA, N. BENDIMERAD. 2010. Phytoécologie et composés secondaires d'un peuplement végétal steppique: Cas de *Pseudocytisus integrifolius* (Salisb.) rehder dans le Chott El-Gharbi (Oranie-Algérie). - *Mediterranea*, 21: 43-78.

BLANCA G., B. CABEZUDO, M. CUETO, C. FERNANDEZ LOPEZ, C. MORALES

TORRES. 2009. *Flora Vascular de Andalucía Oriental*, Consejería de Medio Ambiente, Sevilla.

BOUAZZA M., N. BENABADJI. 1998. Composition floristique et pression anthropozoique au Sud-Ouest de Tlemcen. - *Revue Sciences et Technologies*, 10: 93-97.

BOUDY P. 1955. *Description forestière de l'Algérie et de la Tunisie.* EdLarose, Paris, 483 p.

BRAUN-BLANQUET J. 1951. *Plfanzen-soziologie. Grundzuge der vegetetions Kunde.* Ed. 2. Springer. Vienne. Autriche, 631 p.

DOBIGNARD A., C. CHATELAIN. 2010-2012. *Index synonymique et bibliographique de la flore d'Afrique du Nord.* Vol. 1-4, C. J. B. G., Genève.

GAOUAR A. 1980. Hypothèse et réflexion sur la dégradation des écosystèmes forestiers dans la région de Tlemcen. - *Revue Forêt Méditerranéenne,* 2: 131-146.

GHEZLAOUI B-A., N. BENABADJI, D. BENMANSOUR, A. MERZOUK. 2011. Analyse des peuplements végétaux halophytes dans le Chott El-Gharbi (Oranie-Algérie). - *Acta Botánica Malacitana*, 36: 113-124.

GOUNOT M. 1969. *Méthodes d'études quantitatives de la végétation*, vol. 1, Ed. Mass. Paris, 314 p.

HADJADJ-AOUL S., M. CHOUIEB, R. LOISEL. 2009. Effet des facteurs environnementaux sur les premiers stades de la régénération naturelle de *Tetraclinis articulata* en Oranie. - *Ecologia Mediterranea,* 35: 19-30.

KADI-HANIFI H. 2003. Diversité biologique et phytogéographique des formations à *Stipa tenacissima* L. de l'Algérie. - *Science et changements planétaires / Sécheresse*, 14(3): 169-179.

LETREUCH-BELAROUCI A., B. MEDJAHDI, N. LETREUCH-BELAROUCI, KH. BENABDELI. 2009. Diversité floristique des subéraies du parc national de Tlemcen. - *Acta Botanica Malacitana*, 34: 77-89.

MAIRE R. (Ed.) 1952-1987. *Flore de l'Afrique du Nord (Maroc, Algérie, Tunisie, Tripolitaine, Cyrénaïque et Sahara).* Le Chevalier, Paris. Vol. 1-16.

MÉDAIL F., K. DIADEMA. 2009. Glacial refugia influence plant diversity patterns in the Mediterranean Basin. - *Journal of Biogeography*, 36(7): 1333-1345 DOI:10.1111/j.1365-2699.2008.02051.x

MEDJAHDI B., M. IBN TATTOU, D. BARKAT, KH. BENABEDLI. 2009. La flore vasculaire des monts des Traras. - *Acta Botanica Malacitana*, 34: 57-75.

MESLI K., M. BOUAZZA, M. GODRON. 2008. Ecological characterization of the vegetable groupings of the Mounts of Tlemcen and their facies of degradation (west-Algeria). - *Environmental Research Journal*, 2(5): 271-277.

MESSAOUDENE M., M. TAFER, A. LOUKKAS, R. MARCHAL. 2008. Propriétés physiques du bois de chêne zéen de la forêt des Aït Ghobri (Algérie). - *Bois et Forêts des Tropiques*, 298: 37-48.

PRODON R., R. FONS, A. PETER. 1984. L'impact du feu sur la végétation, les oiseaux et les micromammifères dans diverses formations méditerranéennes des Pyrénées Orientales: Premiers résultats. - *Revue d'écologie, Terre et Vie,* 39: 128-158.

QUEZEL P. 1956. *Contribution à l'étude des forêts de chênes à feuilles caduques d'Algérie*. Mém. Soc. Nat. Afrique du Nord, Alger, annuelle série, I, 57 p.

QUEZEL P. 1957. *Peuplement végétal des hautes montagnes de l'Afrique du Nord.* Paris, Ed. Lechevalier, Paris, 464 p.

QUEZEL P. 2000. *Réflexions sur l'évolution de la flore et de la végétation au Maghreb méditerranéen.* Ibis Press. Paris. 117 p.

QUEZEL P., S. SANTA. 1962-1963. *Nouvelle flore d'Algérie et des régions désertiques méridionales.* CRNS, Paris (FR), Tome I: 1-565, Tome II: 566-1170.

QUÉZEL P., F. MEDAIL. 2003. *Ecologie et biogéogra- phie des forêts du bassin méditerranéen*. Elsevier, Paris, 592 p.

SCHAFFHAUSER A., T. CURT, E. VELA, T. TATONI. 2012. Feux récurrents et facteurs environnementaux façonnent la végétation dans les boisements à *Quercus suber* L. Et les maquis. – *Comptes Rendus Biologies*, 335: 424-434. DOI:10.1016/j.crvi.2012.04.006.

VALDES B., M. REJDALI, A. KADMIRI, S. JURY, J. MONTSERRAT. 2002. *Catalogue des plantes vasculaires du Nord du Maroc incluant des clés d'identification*. Consejo Superior d'Investigaciones Científicas, Biblioteca de ciencias, Madrid, Vol. I and II, 1007.

ZINE EL ABIDINE A. 1988. Analyse de la diversité phyto- écologique des forêts du chêne zeen (*Quercus faginea* Lamk.) Au Maroc. - *Bulletin Institut Scientifique de Rabat*, 12: 69-77.

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Effect of Ecotourism on Plant Biodiversity in Cherlagh Protected Area North-Eastern Iran

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Abstract. Due to importance of considerable effects of ecotourism on environment, the effect of ecotourism on plant biodiversity in Cherlagh zone was investigated .To acquire the aim of the article, the sampling area was selected under the condition that the ecotourism is solely the variable factor and the slope, direction and height are considered constant factor after evaluation of the ecological land unit drawings. Two zones of high pressured and low pressured ecotourism were considered after evaluation of related drawings. Samples were taken in spring 2010. For evaluation of the plant biodiversity 60 samples of 1 m^2 (30 samples in each zone) were taken randomly and then the list of flora and the cover percentage of vegetation were recorded and then the percentage of vegetation data were analyzed in PAST software individual , the biodiversity (Shanon, Simpson) richness (Menhinick, Margalef) evenness (Dominance, Berger parker,) indices were calculated. The mentioned indices were inserted in SPSS II software and the data normality was tested through Kolomogrov-Smirnov test also the homogeneity of variances was tested using Leven test. Due to data normality, non-paired T test was used in order to compare diversity analysis. The results indicate that the richness and individual indices show significant effects of ecotourism on biodiversity indices.

Key words: Ecotourism, Biodiversity, Evenness, Dominance, Richness.

Introduction

Protected Areas (PA) are the cornerstone for conserving mostimportant biodiversity in the face of rapid environmental change (PAUDEL & HEINEN, 2015). Ecotourism is a relatively new idea and hasemerged in the late 1980s that has dramatically capturedthe attention of many people from a variety of backgrounds (ESHETU, 2014).

Nowadays, many of ecotourism planning is done in a way that will damage the environmental sustainability. Sustainable ecotourism planning must aim to help and preserve nature, without altering tourists' basic mission to explore and unique status of ecotourism in the global environmental scheme (MIRSANJARI, 2012).

Many efforts have been conducted to determine the benefits of visitors who visit recreation areas of forest and national parks (AMIRNEJAD & KHALILIAN, 2006). Although there tends to be limited tourism infrastructure within protected areas there are often tracks, trails, roads, lookouts, fixed campsites, car parks and sometimes visitor

centers and accommodation. Although the total area allocated to infrastructure may be relatively small compared to the total area of the park, the impacts at that site are severe and often permanent (SMITH & NEWSOME, 2002; PICKERING & BUCKLEY, 2003; TURTON, 2005). The most obvious and direct impact is vegetation clearance, however, damage is not restricted to the initial removal of native vegetation, there are usually indirect effects in adjacent natural vegetation (SUN & WALSH, 1998). A common problem is that increasing visitor use can result in incremental hardening of sites with a gradual change from a natural to an urbanized environment (BUCKLEY & PANNELL, 1990). In addition, there may be displacement of park users and/or changes in the expectations of tourists, with those participating in mass tourism often requiring more sophisticated facilities, than those engaging in nature or adventure tourism (PICKERING & HILL, 2007). Review studies in Iran show that there are few studies on the estimation of recreation value of parks. For management of parks' assets to be effective and successful, it is necessary to obtain information about visitors' characteristics as well as their opinions. Ecotourism, as nature-based tourism with its special characteristics, is also considered as the impetus and economic investment for management of natural resources. To promote proper planning in this field, the current research uses data mining from the recreation values of Iran's parks, rate of WTP, amount of WTP, and separating influential factors on visitors' rate of WTP and amount. This knowledge then allows managers to manage parks accordingly. It can be effective in foreseeing the needs, eliminating the shortages, and developing the tourism in the parks. Iran has a long history of nature protection (KOLAHI *et al.*, 2013). Currently, PAs are divided into four categories under the management of Iran's Department of the Environment (DOE). However, since the 1950s, following new definitions of PAs, the number of PAs in Iran has increased dramatically, especially during the last 10 years. In total, 253 PAs have been declared which cover 10.12 % of the country's area (see Table 1).

Table 1. Protected and other natural areas in Iran (after KOLAHI *et al.*, 2013).

Categories	Number	Area (Ha)	% to the whole PAs	% to the country
National Parks	26	1960537	11.76	1.19
National Natural Monument	35	38697	0.23	0.02
Wildlife Refuge	42	5567643	33.39	3.38
Protected Area	150	9109857	54.63	5.53
Total	253	16676734	100	10.12

This article aims to contribute to the discussion on tourism in relation to biodiversity. It evaluates the effects of ecotourism on plant biodiversity by comparing the diversity, richness, dominance and evenness indices in two high-pressured and low-pressured zones and consequently presents the environmental management strategies for better conservation.

Materials and Methods

Site characteristics. "Tandoureh" National Park (37.19 N to 37.33 N; 58.33 E to 58.54 E), encompassing an area of approximately 4448 ha, is located 30 kilometers southwest of the Daregaz Region in Khorasan Razavi Province and close to the Turkmenistan border (Fig. 1). This park has significant heights, deep valleys and have mountainous climate. There are rare species of animals and plants in this park thus making it one of the most important wildlife areas nationally and internationally. Some of the important wild hosts for adult ticks in the park are wild sheep and goats, leopards, wild cats, wolves, jackals, foxes, rabbits and wild boars.

Most rain falls in winter and spring, comprising between 72% and 76% of all the annual rainfall. Fluctuations in annual temperature are large. Mean annual temperature is about 14.3°C, and warmest month of the year is July with a mean temperature of about 34.1°C and the coldest month January with a mean temperature of about 2.7°C. In Fig. 2, the sampling area has been depicted.

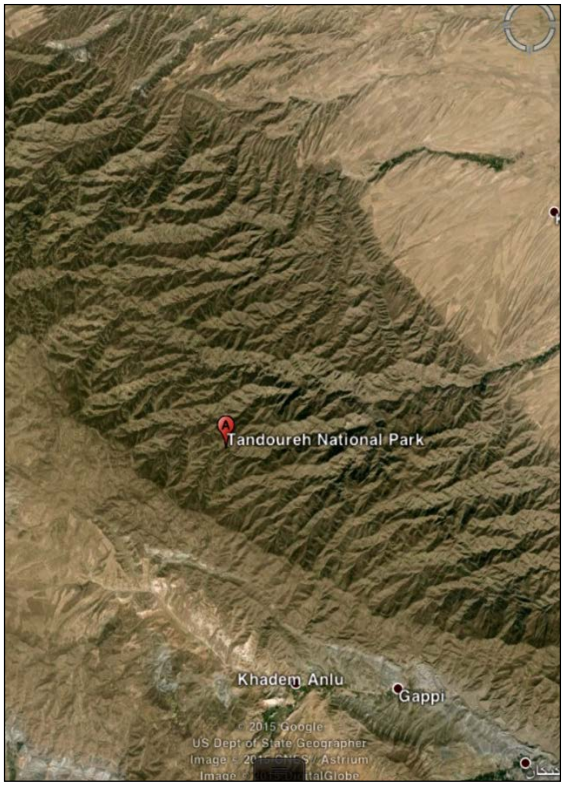

Fig. 1. Situation Map of the study area.

For evaluation of the plant biodiversity 60 samples of 1 m² (30 samples in each zone) were taken randomly and then the list of flora and the cover percentage of vegetation were recorded and then the percentage of vegetation data were analyzed in Biopast software and the biodiversity (Shanon, Simpson) richness (Menhinick, Margalef) evenness (Dominance, Bergerparker,) indices were calculated.

Fig. 2. A feature of the study area

Data analysis. The mentioned indices were inserted in SPSS II software and the data normality was tested through Kolomogrov-Smirnov test. Due to data normality, non-paired T test was used in order to compare diversity analysis. The indices which have been evaluated in this paper have been indicated in table 2. As it has been presented, individual, the biodiversity (Shanon, Simpson), richness (Menhinick, Margalef) evenness (Dominance, Bergerparker,) indices were calculated in this study and the formulas have been presented in Table 2.

Table 2. Diversity Indices evaluated in PAST software.

Index	Reference	Formula
Shanon	PEET (1974)	H` = -ΣI PIln (PI)
Simpson	HILL (1973)	N2= (ΣIPI2)-1
Margalef	MARGALEF (1985)	Dmg = S-1/ln (N)
Manhenick	MENHINICK (1964)	Dmn=S/√n
Berger-Parker	MAY (1975)	d = Nmax / N
Dominance	MAGURAN (1988)	1-Simpson index
Evenness	MAGURAN (1988)	eH/S
Equitability	MAGURAN (1988)	Shannon diversity divided by the logarithm of number of taxa

Results and Discussion

As it has been indicated in figures 3 to 5, richness and individual indices show significant effects of ecotourism on plant biodiversity. A and B in the results indicate that the diversity, and evenness indices don't show significant effects of ecotourism on biodiversity indices, but the richness and individual indices show significant effects of ecotourism on biodiversity indices. Table 3 also shows the floristic list of Cherlagh area.

There are no statistics about ecotourism in Iran. Mainly due to the lack of basic infrastructure, facilities and information, but in relation to this issue, few studies have been conducted in Mazandaran jungles and several of them have been performed in protected areas or national parks. In majority of the investigated zones have high species and richness diversity indices. Several protected areas and national and forest parks have an abundance of vegetation cover due to less anthropogenic factors, for instance MAHMODI *et al.* (2005) found 119 species in protected Kelarabad

forests, however the dominant species were *Alnus sp.*

There are many threats to vegetation in Iranian protected areas from tourism. Greater recognition needs to be given to this by protected area managers. Although the flora is internationally significant and protected area tourism is very popular there is still limited research on direct and indirect impacts of tourism for many Iranian plant communities. The species damage impacts are extremely vivid due to soil trampling, damage to flora, setting fire and building sports and playground which lead to low diversity, richness, and dominance and evenness indices in studied area. In this zone two factors of (i) existence of *Ailanthus altissima* species in high pressure zone (ii) anthropogenic factors decline all the biodiversity indices.

High diversity and richness indices in low-pressured zone compared to high-pressured zone were related to tourism effects. High evenness indices in high-pressured zone in related to invasive species growth against anthropogenic factors (HOSSEINI *et al.*, 2011). GOLEIJI (2011) came to the same conclusion that high pressure of tourism cause significant impacts on reduction of plant species, diversity, richness as well as increase of evenness. As a whole findings of this study show that high impacts of ecotourism cause significant impact on the decrease of plant species diversity and richness as well as increase of evenness in Tandoureh National Park so the management strategies should be considered by concerned authorities.

ZARGHI & HOSSEINI (2014) reached different conclusion in Chelmir zone of Tandoureh National Park which was divided in two high pressured zone and low pressured zone. The results indicate that the diversity, richness, dominance and evenness indices show significant effects of ecotourism on biodiversity indices. But in this study the results are considerably different and it indicates that the effect of ecotourism is more severe in Chelmir zone.

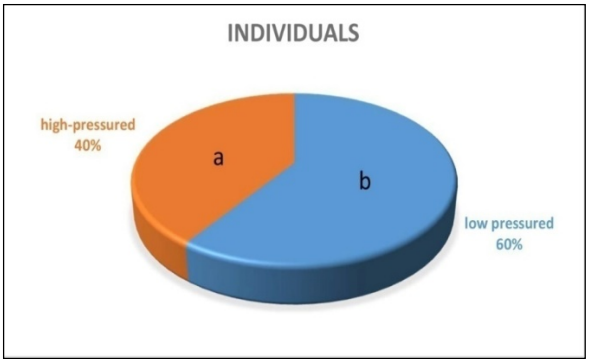

Fig. 3. Individual index show significant effects of ecotourism on biodiversity.

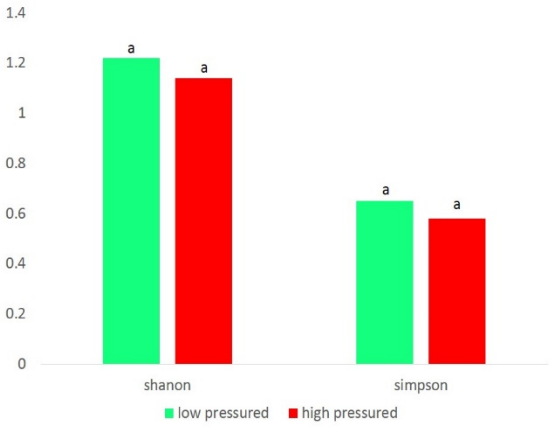

Fig 4. Biodiversity indices of plant biodiversity in low pressured and high pressured zones (explanations are in the text).

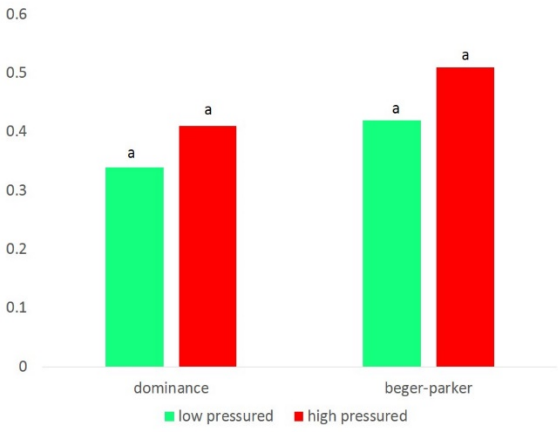

Fig. 5. Evenness indices of plant biodiversity in low pressured and high pressured zones (explanations are in the text).

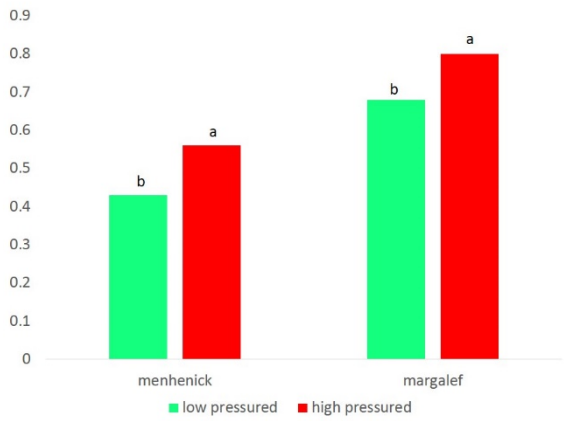

Fig. 6. Richness indices of plant biodiversity in low pressured and high pressured zones (explanations are in the text).

The ongoing decline in global biodiversity is largely attributed to human-induced impacts (MITCHELL *et al.*, 2015). Valuation park services, based on people's preferences can be useful to regulate the transfer of payments from beneficiaries to providers in return for maintaining the supply of the park services. Ecotourism potentially provides a sustainable approach to tourism development across the world. Visitors in PAs can generate both positive and negative environmental impacts (MCCOL, 2006). But some efforts show that through developing sustainable ecotourism it can be possible to change attitudes and increase conservation (e.g., BUCKLEY, 2012; HUSSAIN *et al.*, 2012; MILLER *et al.*, 2012).

Table 3. Floristic list of the recorded plant biodiversity in studied area.

Family	Scientific name	Forms	High-pressured zone	Low-pressured zone
Poaceae	*Poa bulbosa*	Geophyta-bulbosa	*	
Poaceae	*Hordium morinum*	Chamaephyta frutescenia	*	
Poaceae	*Stipa barbata*	Hemicripto Caespitosa		*
Poaceae	*Doctylis glomerata*	Hemicripto Caespitosa		*
Poaceae	*Brumus tomentullus*	Hemicripto Caespitosa		*
Cypraceae	*Carex stenophylla*	Geophyta rhizomatosa	*	
Fabaceae	*Onobrychis chorassanica*	Hemicripto Caespitosa		*
Fabaceae	*Medicago sativa*	Hemicripto Caespitosa		*
Fabaceae	*Astragalus bassernerri*	Hemicripto.Scaposa		*
Lamiaceae	*Phlomis cancellata*	Hemicripto Caespitosa	*	
Lamiaceae	*Hymenocrater botuminosus*	*Chamaephyta frutescenia*	*	
Papaveraceae	*Papaver pevenium*	Therophyta caespitosa		*
Papaveraceae	*Papaver decaisnei*	Therophyta caespitosa		*
Brassicaceae	*Euclidium tenuminosus*	Chamaephyta frutescenia		*
Brassicaceae	*Alyssum heterotrichum*	Hemicripto Caespitosa	*	
Brassicaceae	*Cramb kotschyana*	Hemicripto.rosulata		*
Brassicaceae	*Capsellla bursa pastoris*	Therophyta Scaposa	*	
Asteraceae	*Lactuca khorasanica*	Hemicryptophytes		*
Asteraceae	*Artemesia aucherii*	Chamaephyta frutescenia		*
Asteraceae	*Sonchus olevaceaus*	Therophyta Scaposa		*
Asteraceae	*Tragopagon longirostris*	Geophyta radicigemma		*
Asteraceae	*Achillea wilhelmssig*	Hemicripto Caespitosa	*	
Asteraceae	*Acropliton repens*	Hemicripto Caespitosa		*
Asteraceae	*Seratula latifolia*	Hemicripto Caespitosa		*
Graniaceae	*Erodium cicutarium*	Therophyta caespitosa		*
Cunvulvulaceae	*Convolvulus arvensis*	Hemicripto.rosulata	*	
Iridaceae	*Gladiolus atrovioaceus*	Geophyta radicigemma	*	
Chenopodiaceae	*Chenopodium album*	Therophyta caespitosa		*
Alliaceae	*Allium bodeanum*	Geophyta-bulbosa		*
Amarylliadaceae	*Ixiolirion tataricum*	Geophyta radicigemma		*
Rhamanaceae	*Sanguisorba minor*	Hemicripto Caespitosa		*
Hypericaceae	*Hypericum scabrum*	Hemicripto Caespitosa	*	
Rubiaceae	*Galium verum*	Hemicripto Caespitosa		*
Podophyllaceae	*Bongardia chrysogonum*	Hemicripto Caespitosa	*	
Apiaceae	*Ferula gumosa*	Geophyta radicigemma		*
Apiaceae	*Ferula assa foetida*	Geophyta radicigemma	*	
Liliaceae	*Eremurus kopedaghensis*	Geophyta-bulbosa		*
Scrophularicaceae	*Verunica argute serrata*	Therophyta caespitosa	*	
Ephedraceae	*Ephedra procera*	Chamaephyta frutescenia		*

Highly successful ecotourism can support biodiversity conservation by influencing national policy. For example, WUNDER (2000) reported that a tourism lobby has successfully resisted efforts to open a biodiversity-rich site in Ecuador to oil exploration and the Government of Mozambique is establishing large conservation areas as a key element of its tourism development strategy. However, tourism on a scale that can generate this degree of political support also carries serious risks of negative environmental and social impacts (KISS, 2004).

To protect the biodiversity of PAs, all necessary facilities and equipment should be procured. Environmental codes should be developed and enforced to protect unique and fragile PAs and other natural resources. These codes should be strict and free of misinterpretation and misuse. More specifically, the laws related to the environment and PAs should be updated and amended for sustainable development. In addition, the DoE, various management levels, NGOs and local communities should be empowered to enforce these environmental codes. Significant monetary fines should be used to enforce code violations, and the revenue from fines should be used for the improvement and protection of local PAs. The capacity of the DoE (at national, provincial and local levels) should be strengthened to work with and influence other ministries, the media, and the private sector. The DoE should be helped in fulfilling its mandate by the Government, the Legislature and the Judicature (KOLAHI *et al*., 2012).

Conclusions

Based on findings of this study, Significant differences between high pressure and low pressures zones show different conservation management strategies in the mentioned areas from ecotourism point of view. Considering long history of "Tandoureh" National Park and also the adverse condition of the biodiversity indices at high pressure zone in Cherlagh Area, the executive solution are recommended in order to modify the existing conditions: (i) the high pressure area should be under conservation and tourism managements frequently for environmental remediation; (ii) the tourist dispersal should occur temporarily and short term periods in Cherlagharea, so that it will be prevented from population dispersal in one area and consequently the subsequent adverse impacts on flora. If some actions have not been taken in Cherlagharea, this area will be under adverse threat of ecotourism similar to Chelmir area.

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References

AMIRNEJAD H., S. KHALILIAN. 2006. Estimation of recreational value of forest parks of Iran by using the contingent valuation method: Case study in Sisangan forest park. - *Iranian Natural Resources Journal*, 59: 365-376.

BUCKLEY R., J. PANNELL. 1990. Environmental impacts of tourism and recreation in national parks and conservation reserves. - *Journal of Tourism Studies*, 1: 24-32.

BUCKLEY R. 2012. Tourism, conservation and the Aichi targets. - *Parks*, 18(2): 12-19. DOI: 10.2305/IUCN.CH.2012.PARKS-18-2.RB.en

ESHETU A. 2014. Ecotourism as a viable strategy for livelihood diversification and sustainable natural resource management in Ethiopia (from eco-development paradigm point of view). - *Journal of Environmental Science and Water Resources*, 3(2): 40-52.

GOLEIJI E., S. HOSSEINI, M. KIADALIRI. 2011. Effect of ecotourism on plant biodiversity in Chaldareh Forestry Park. - *Journal of Sciences and Techniques in Natural Resources*, 3: 85-97.

HILL M.O. 1973. Diversity and evenness: A Unifying Notation and its consequences. - *Ecology*, 54: 427-432.

HOSSEINI S., E. GOLEIJI, M. KIADALIRI. 2011. Effect of ecotourism on plant biodiversity in Chaldoran Forestry

Park. - *Journal of Sciences and Techniques in Natural Resources*, 3: 85-97.

HUSSAIN S., S. BARTHWAL, R. BADOLA, S. RAHMAN, A. RASTOGI, C. TUBOI, A.K BHARDWAJ. 2012. An Analysis of Livelihood Linkages of Tourism in Kaziranga National Park, a Natural World Heritage Site in India. - *Parks*, 18(2): 32-43. DOI: 10.2305/IUCN.CH.2012.PARKS-18-2.SAH.en

KISS A. 2004. Is community-based ecotourism a good use of biodiversity conservation funds? - *Journal of Trends in Ecology and Evolution*, 19(5): 232-237. DOI: 10.1016/j.tree.2004.03.010

KOLAHI M., T. SAKAI, M. KAZUYUKI, M. MAKHDOUM. 2012. Challenges to the future development of Iran's protected areas system. - *Environmental Management*, 50(4): 750-765. DOI: 10.1007/s00267-012-9895-5

KOLAHI M., T. SAKAI, K. MORIYA, M. MAKHDOUM, L. KOYAMA. 2013. Assessment of the effectiveness of protected areas management in Iran: Case study in Khojir national park. - *Environmental Management*, 52: 514–530. DOI: 10.1007/s00267-013-0061-5

MAGURRAN A.E. 1988. *Ecological Diversity and It's Measurement,* Prinston University Press, Princeton, New Jersey.

MAHMOODI J. G.H ZAHEDI AMIRI, E ADELI. R. RAHMANI. 2005. An Acquaintance with the relationship between plant ecological groups and the soil characteristics in a Kelarabad Plain forests (In North of Iran). - *Iranian Journal of Natural Resources,* 58: 351-362. (In Persian)

MARGALEF R. 1985. Ecosystems diversity and connectivity as measurable components of their complication. - In. *The Science and Praxis of Complexity*. The United Nations University, Tokyo, pp. 228-244.

MAY R.M. 1975. Patterns of Species abundance and Diversity. - In: Cody M.L., J.M. Diamonds (Eds.), *Ecology and Evolution of Communities*, Harvard University Press Cambridge, MA, pp. 81-120.

MCCOL S. 2006. Managing for visitor experiences in protected areas: Promising opportunities and fundamental challenges. - *Parks*, 16(2): 3-9.

MENHINICK E.F. 1964. A Comparison of Some Species-Individuals Diversity Indices Applied to Samples of Field Insects. – *Ecology,* 45: 859–861. DOI: 10.2307/1934933

MILLER A., Y. LEUNG, D. LU. 2012. Community-based monitoring of tourism resources as a tool for supporting the convention on biological diversity targets: A preliminary global assessment. - *Parks*, 18(2): 120-131. DOI: 10.2305/IUCN.CH.2012.PARKS-18-2.AM.en

MIRSANJARI M. 2012. Importance of environmental ecotourism planning for sustainable Development. - *OIDA International Journal of Sustainable Development*, 4(2): 85-92.

MITCHELL M., M. LOCKWOOD, S. MOORE, S. CLEMENT. 2015. Scenario analysis for biodiversity conservation: A social ecological system approach in the Australian Alps. - *Journal of Environmental Management,* 150: 69-80. DOI: 10.1016/j.jenvman.2014.11.013

PAUDEL P.K., J.T. HEINEN. 2015. Conservation planning in the Nepal Himalayas: Effectively (re) designing reserves for heterogeneous landscapes. - *Applied Geography,* 56: 127-134. DOI: 10.1016/j.apgeog.2014.11.018

PEET R.K. 1974. The Measurement of Species Diversity. - *Annual Review of Ecology and Systematics,* 5: 285-307.

PICKERING C.M., W. HILL. 2007. Impacts of recreation and tourism on plant biodiversity and vegetation in protected areas in Australia. - *Journal of Environmental Management,* 85(4): 791–800. DOI: 10.1016/j.jenvman.2006.11.021

PICKERING C.M., R.C. BUCKLEY. 2003. Swarming to the summit: Managing tourists at Mt Kosciuszko, Australia. - *Mountain Research and Development,* 23: 230-233.

SMITH A., D. NEWSOME. 2002. An integrated approach to assessing, managing and monitoring campsite impacts in Warren National Park, Western Australia. - *Journal of Sustainable Tourism*, 10(4): 343-359. DOI: 10.1080/09669580208667172

SUN D., D. WALSH. 1998. Review of studies on environmental impacts of recreation and tourism in Australia. - *Journal of Environmental Management*, 53: 323-338. DOI: 10.1006/jema.1998.0200

TURTONS M. 2005. Managing environmental impacts of recreation and tourism in rainforests at the wet tropics of Queensland World Heritage Area. – *Geographical Research*, 43(2): 140-151. DOI: 10.1111/j.1745-5871.2005.00309.x

WUNDER S. 2000. Ecotourism and economic incentives: An empirical approach. - *Journal of Ecological Economy*, 32(3): 465-479. DOI: 10.1016/S0921-8009(99)00119-6

ZARGHI AH., S. HOSSEINI. 2014. Effect of ecotourism on plant biodiversity in Chelmir zone of Tandoureh National Park, Khorasan Razavi Province, Iran - *Journal of Biodiversitas*, 15: 224-228.

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Quercus faginea in the Mounts of Tlemcen (North-west Algeria): State of Knowledge

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Abstract. In this study, we present a summary of the dendrometric characteristics, the microscopic image and the physic-mechanical properties of wood and principally leaves morphology for to show the existence of zeen oak (*Quercus faginea*) population in the far North West of Algeria with specific characters. The morphology of 400 mature leaves taken from 10 trees at the 4 exposures shows that the length of the leaf blade is about 8.568 cm, the width is 4.955 cm, its perimeter about 14.280 cm and its surface area 15.14 cm². The mature leaf is composed of 20 lobes; the length of the six largest lobes is about 3.098 cm and the angles of their ribs 51.352°. The morphological characters studied have relatively high variability between the four aspects. Leaves at southern aspect have the lowest vegetative values. In contrast, at eastern aspect trees have large leaves with vegetative characters developed.

Key words: *Quercus faginea*, wood characteristics, leaf morphology, aspects.

Introduction

The total forest area in the Wilaya of Tlemcen (North West Algeria) amounts to 209 230 hectares, 22.30% of the Wilaya's total area (LETREUCH-BELAROUCI, 1995). This forest rate makes consider the area among the greatest forest zones of the Algerian west territories.

Oaks figure amongst preponderant national forest trees; they are mainly confined to mountainous areas of the Mounts of Tlemcen. If holm oak and at a lesser extent cork oak cover great spreads, zeen oak is recorded only in the South West, when certain conditions of topography (cool valleys), aspect (North East) and coolness are gathered. As for kerm oak, it is a shrub associated with holm oak and cork oak.

Quercus faginea is a deciduous oak which can easily reach height of 15 m. This tree (Fig. 1a & Fig. 1b) carries either a flattened crown when in thin stands or pyramidal crown when in dense stands on a very slender trunk. Its bark (Fig. 1c) is deeply fissured and dark brown colored. The acorns of yearly maturity (Fig. 1d), are slightly enclosed in a cup. Morphologically, the zeen oak of the Mounts of Tlemcen differs from the other varieties of zeen oak with its leaves (Fig. 1e) which are more or less villous on above, parallel secondary nerves and with the presence of intercalated nerves.

State of knowledge includes the following information: *Quercus faginea* in Forestry ambiance; *Quercus faginea* wood and use; Descriptive analysis of morphological parameters; Quantitative analysis of morphological parameters.

Material and Methods

Plant material. The leaves used for the present study come from the zeen oak forest of Moutas hunting reserve, located in the state forest of Hafir about 26 km south-west from the chief town of Tlemcen (Fig. 2).

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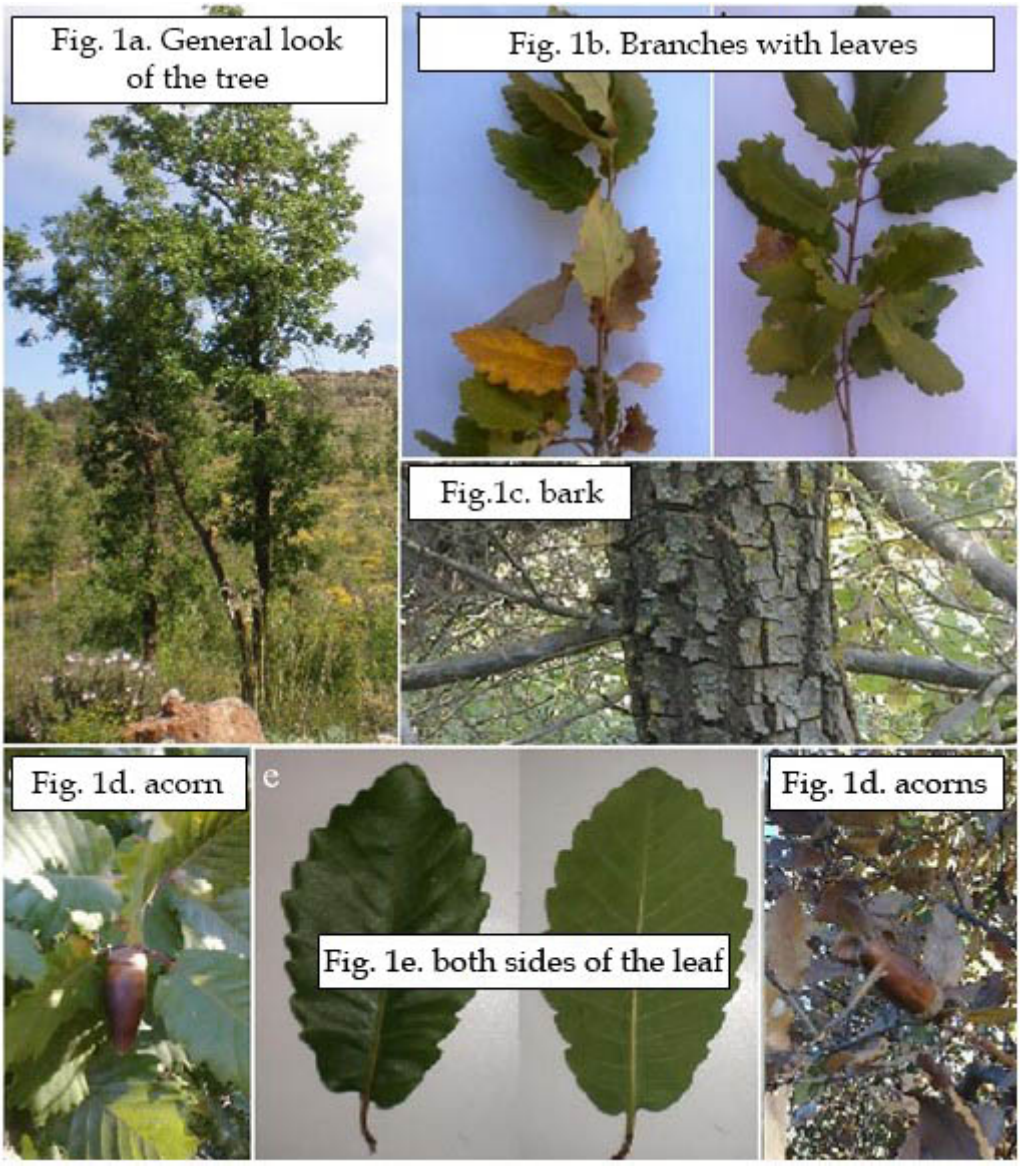

Fig. 1. General traits of zeen oaks in the Mounts of Tlemcen.

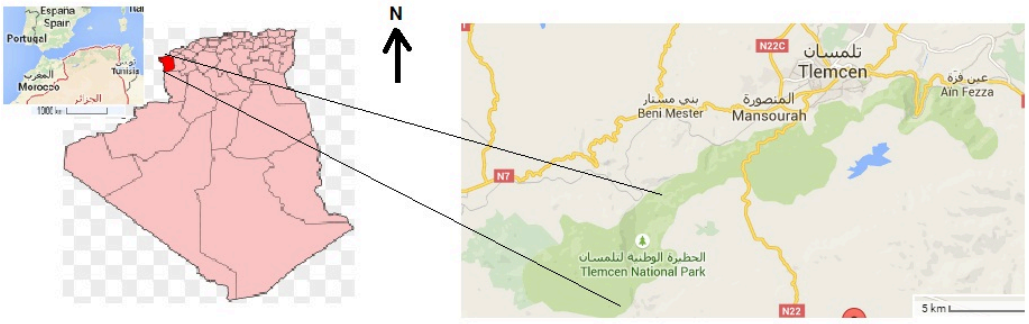

Fig. 2. Location of the study area.

On the deep soils of the valleys of Moutas Hunting Reserve (Fig. 3), zeen oak is associated with holm oak and cork oak, either in the form of isolated trees or in the

form of sparse clusters. It thrives well in the areas relatively well protected from human penetration, either because the ground is too rough or the forest is protected (GAOUAR, 1980).

Fig. 3. Zeen oak in Northern slopes «golden» with holm oak «copse».

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The morphological description is based on the measurement of a great number of quantitative characters linked to leaves. Ten trees have been randomly selected. From each tree and from the four exposures, two branches have been drawn. At the laboratory, the leaves have first been the object of a general description, later from each branch, 5 mature leaves have been the object of a quantitative analysis. On the whole, 400 leaves distributed on the four exposures have been analyzed.

Collecting and techniques measurement. The studied parameters are the length of petiole (cm), the length of leaf-blade (cm), the maximal width of leaf-blade (cm), the length of leaf-blade at the greatest width (cm), the surface of leaf-blade (cm^2), the perimeter of leaf-blade (cm), the number of lobes, the mean length of the six greatest lobes (cm) and the mean angles of veins of the six greatest lobes (Fig. 4).

The collected leaves are put in a plastic bag with a wet paper towel in the dark. This type of conservation keeps the initial shape of the leaves. At the laboratory, the leaves are individually scanned at a scale of « 1/1 ». The obtained images are then processed through a computer software reconfiguration the digital synthesis images (Fig. 5).

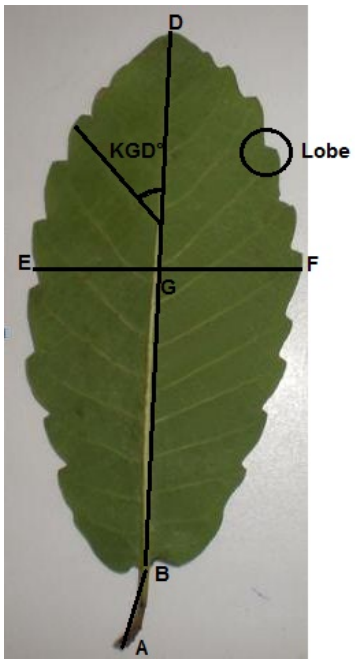

Fig. 4. Localization of morphological parameters.

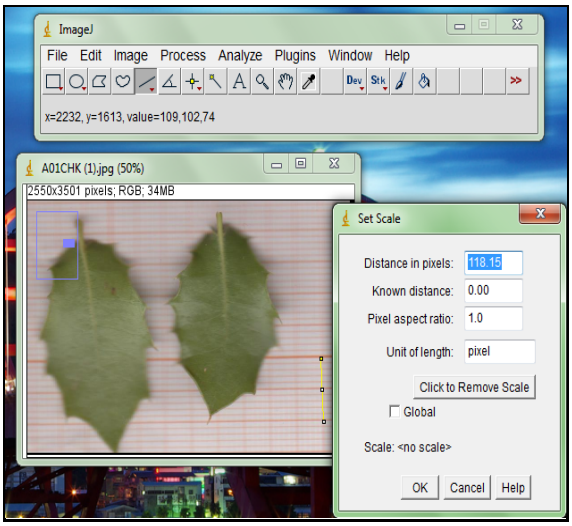

Fig.5. Measurement of quantitative traits by the software (Imag J).

Processing software and image analysis, allows computing the different leaves morphological parameters [imagej.net].

The variability of each morphological parameter in the same exposure and between the exposures is based on an analysis of variance (ANOVA). The correlation between the parameters is

carried out using the Statistica 6.0 software (BERNARD, 2004).

The measurements are realized on leaves called «characteristic» which are adult leaves where the causes of variation due to the growth and to polymorphism are eliminated. We have purposely limited our study to the macroscopical characters excluding anatomical and microscopical criteria.

Table 1 summarizes the measured parameters of the leaf of *Quercus faginea.*

Table 1. Measured parameters of the leaf of *Quercus faginea*

Measured parameters	Codification
length of petiole (AB, cm)	LP
length of leaf-blade (BD, cm).	LL
maximal width of leaf-blade (EF, cm).	LM
length of leaf-blade at the greatest width (BG, cm)	BG
surface of leaf-blade (cm^2)	SU
perimeter of leaf-blade (cm)	PE
number of lobes	NL
mean length of the six greatest lobes (cm)	HL
mean angles of veins of the six greatest lobes	KGD°

Results and Discussion

Quercus faginea in forestry ambiance. When zeen oak stands are mixed with cork oak or holm oak, we remark on the favor of lighting, the existence of zeen clusters seemingly even-aged but not having the same age. Those clusters of some hectares won our interest. We can well imagine a high-forest having the look of an uneven-aged forest treated in even-aged clusters of graduated ages where shall be practiced inside of each of them the classical operations of even-aged high-forests. That shall have as a result an adulatory out-line of very fine appearance and in the same time productive. Here also, the entire question is about applying mixed oak stands management focusing on conservation and enrichment of zeen oak populations (LETREUCH-BELAROUCI, 1995). A dendrometrical study of those zeen oak clusters showed a basal area running to 10-11 m^2/ha with a dominant height of 11m. The mean diameter reaches 20 cm for a density of 400 trees/ha (BERRICHI & BOUAZZAOUI, 2011).

The vegetation surveys in the forest of Hafir show that it's mainly formed with *Quercus suber* L. on siliceous soil to which is sometimes associated zeen oak. In west, holm oak succeeds to cork oak (MAHBOUBI, 1995). In the cork oak forest, the Zeen dominates in the north exposure and in the medium altitudes (LETREUCH-BELAROUCI *et al.*, 2009).

The accompanying flora of zeen oak consists of: *Arbutus unedo, Cratagus oxycantha, Erica arborea, Juniperus oxycedrus, Phillyrea angustifolia, Rosa canina, Lonicira implexa* and *Viburum tinus.* The herbaceous layer is composed of: *Ampelodesma mauritanica, Cistus monspeliensis, Daphnie gnidium, Asparagus acutifolius, Lavandula stoechas, Genista tricuspidata, Ruscus aculeatus,* and *Pteridium aquilinum*.

Quercus faginea wood and use. BERRICHI (2010a) mentioned that the wood of *Quercus faginea* is yellowish brown colored. Sapwood is lighter colored than heartwood; growth rings are visible to the eye discerned by the presence of final wood sheaths. On the microscopic point of view, the description and the quantification of the elements of the ligneous plan, emphasizes the following points. Zeen oak presents a wood with «semi-porous zones», the pores of initial wood are isolated, sometimes joined, round or oval-shaped and of variable size. The pores of final wood have the shape of a flame; they have a smaller size almost uniform. The parenchyma is of apotracheal type with isolated and dispersed cellules, sometimes disposed in chainlets and the paratracheal parenchyma in confluent bands and circumvascular (Fig. 6). In quantitative microscopy, the pores of initial wood have 149.84 µm in diameter, they are qualified «Means» in size. The pores of final wood are «Very Small » and have 22.163 µm in diameter. The sheaths are of mean frequency, running to 10 sheaths at mm^2.

In a synthesis of the physical and mechanical characteristics of *Quercus faginea* wood in the Mounts of Tlemcen realized according to the standard NF B 51-002, BERRICHI (2010b) showed that zeen oak wood have a density of 0.91 kg/dm^3, it is qualified as «heavy».

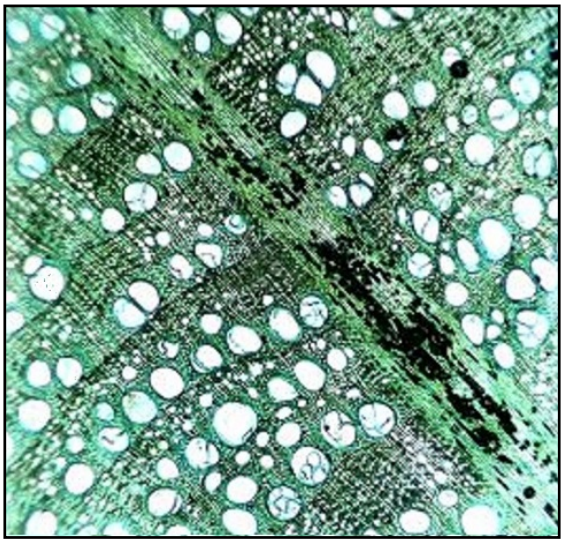

Fig. 6. Cross section of *Quercus faginea* wood.

The total volumetric contraction is less than 10%, it follows that it wood is «low contraction», thus qualified of good dimensional stability, being able to dry before cutting up, fit to wood-peeling and modelling. The resistance to static flexion confirms throughout rear resistance, the use of zeen oak wood as warning wood. If subjected to the resistance of dynamic flexion constraint, the zeen oak wood develops a «good» resistance to shock (0.73 kg/cm^3), this category of wood resists to violent shocks, such as aviation, tools' necks, ski blades, rackets, and uses comprehending vibrations. The tensile strength perpendicular to fibers is 39 kg/cm^2, qualified as «mean to strong resistance», having for origin the strong adherence of fibers. In acceptable dimensions, the zeen oak wood is suitable to common uses in the field of building and carpentry. The strong resistance to splitting (29.53 kg/cm) is due to the fibers tangle. The strong resistance to shearing (163 kg/cm^2) is influenced with thickness of fibrous tissue walls. The «half-hard» wood of zeen oak reflects its aptitude to manufacturing (carpentry and floor-planks making).

MASSAOUDENE *et al.* (2009) put zeen oak wood from the forest of Aït Ghorbi in Kabylie (humid bioclimatic area with annual rainfall varying from 900 to 1 400 mm) in the category of strong contraction woods, responsive to very responsive and half-heavy to heavy, and can provide a good quality wood for cabinet-making, floor-planks making and handycraft if growth constraints are reduced through the creation in the stands of moderate state of competition

Descriptive analysis of morphological parameters. The descriptive morphology of the leaf of *Quercus faginea* reveals an alternated leaf position, a thick leaf-blade, tough and broad with an asymmetrical base and heart-shaped with margins crossed by 6 to 14 pairs of lobes little deep. Young leaves are tomentose then became progressively glabrous. The color of the young leaves is grey reddish-brown, then green bright above, paler and glaucous beneath, conserving traces of indumentum along median vein, and at last yellow brown in fall. Leaf-stalk is dark pink.

Quantitative analysis of morphological parameters. On the quantitative point of view, the obtained results have been the object of statistical analysis to seek the existing variability in a same parameter for a same aspect and between aspects (Table 2).

The analysis of data in Table 2 and on the graphs of Fig. 7 show that the mean length of petiole is 1.386 cm, the longest petioles are in Eastern aspect (1.508 cm), the shortest in Western aspect (1.264 cm). The mean length of leaf-blade is 8.568 cm, the longest leaf-blades are in Eastern aspect (9.349 cm) and the shortest in Northern aspect (8.227 cm). The maximal leaf-blade width is 4.955 cm, the narrowest leaf-blade are in Southern aspect (4.774 cm) and the longest in Eastern aspect (5.186 cm). Leaf-blade's length at the greatest width is 4.427 cm, the longest is at the Eastern aspect (4.978 cm) and the shortest at the Southern aspect (4.231 cm). The mean surface of leaf-blade is 15.14 cm^2, it's more important in Eastern aspect (15.85 cm^2) and less developed in the Southern aspect (11.25 cm^2). The mean perimeter of leaf-blade is 14.280 cm, the longest is at the Eastern aspect and the shortest at the Southern aspect.

The mean angles of veins is 51.352°, this criterion also presents a peculiarity: the highest values are recorded at the Western aspect (KGD° = 52.305). The petiole length (LP), the length of leaf-blade at the greatest width (BG), and the surface of leaf- blade

Table 2. Quantitative analysis of leaf parameters.

Measure-ments	EAST			WEST			NORTH			SOUTH			P
	$\overline{X}$	σ	CV %	$\overline{X}$	σ	CV %	$\overline{X}$	σ	CV %	$\overline{X}$	σ	CV %	
LP	1,508	0,394	26,14	1,264	0,338	26,77	1,438	0,440	30,56	1,334	0,343	25,68	***
LL	9,349	1,477	15,80	8,364	1,723	20,61	8,227	1,576	19,16	8,332	1,210	14,52	***
LM	5,186	0,942	18,16	4,922	1,152	23,41	4,937	1,058	21,44	4,774	0,888	18,61	*
BG	4,978	1,310	26,32	4,260	1,001	23,50	4,238	0,973	22,95	4,231	0,927	21,90	***
SU (cm²)	15,14	5,63	37,19	13,82	5,68	41,10	13,5	5,014	37,15	13,33	4,125	29,46	**
PE (cm)	15,060	3,131	20,79	14,018	3,290	23,47	14,407	2,901	20,13	13,636	2,268	16,63	*
NL	20,62	1,75	8,47	19,87	1,15	5,77	20,5	1,41	6,90	19	1,41	7,44	**
HL (cm)	3,098	0,539	17,41	2,754	0,628	22,81	2,816	0,565	20,06	2,721	0,486	17,85	***
KGD°	49,610	5,782	11,66	52,305	5,704	10,91	52,027	6,087	11,70	51,464	5,693	11,06	**

Legend: X: arithmetical mean; σ: standard deviation; CV %: coefficient of variation. LP: length of petiole; LL: length of leaf-blade; LM: maximal width of leaf-blade; BG: length of leaf-blade at the greatest width; SU: surface of leaf-blade; PE: perimeter of leaf-blade; NL: number of lobes; HL : mean length of the six greatest lobes; KGD: mean angles of veins of the six greatest lobes. « 0.01< P <0.05 » non-significant difference (*), « 0.001< P <0.01 » significant difference (**), « P <0.001 » very significant difference (***).

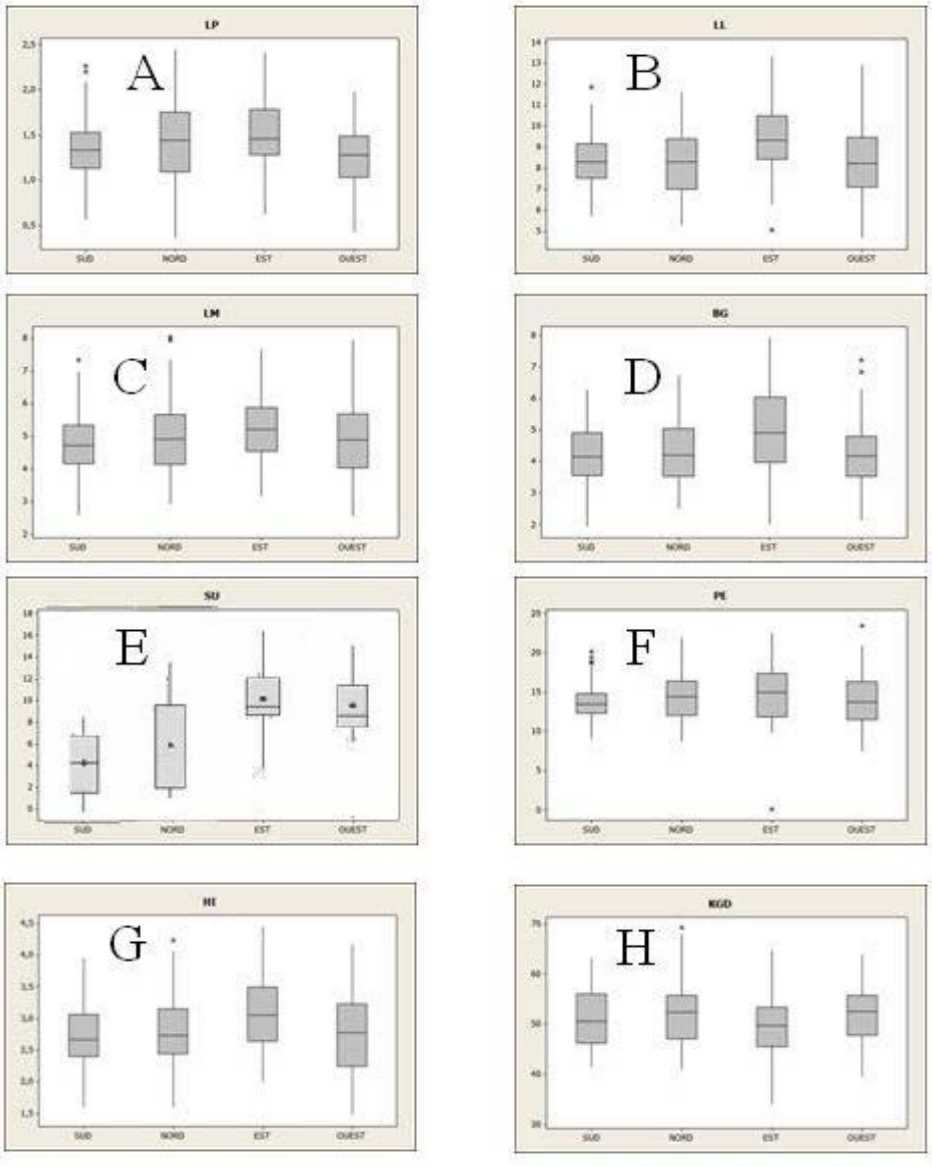

Fig. 7. Graphical presentation of variability of LP (A); LL (B); LM (C); BG (D); SU (E); PE (F); NL (G) and KGD (H).

(SU) present an important scattering around the mean (CV >20%).On the other hand, the lobes number (NL), the mean length of the six greatest lobes (HI) and the mean angles of veins of the six greatest lobes (KGD) are less heterogeneous with CV <10%. The leaves at the Southern aspect have the weakest vegetative values constituted with the smallest leaves. In return, at the Eastern aspect, trees present big sized leaves with very developed vegetative characters.

The results of the variances analysis (ANOVA) of Table 2, present very weak P values (P<0.001). The petiole length, the leaf-blade length, the length of leaf-blade at the greatest width and the mean angles of veins of the six greatest lobes of mature leaves of *Quercus faginea* have a quite high variability among the four aspects, they are very developed at Eastern aspect. Consequently, there is a very high heterogeneity between the four aspects for several characters. The lobes number, the leaf-blade surface and the mean angles of veins of the six greatest lobes have P values included between 0.001 and 0.01 which reveal the existence of a significant difference between aspects.

The analysis of the variance shows a not very significant difference (0.01< P <0.05) between the aspects for the maximal leaf-blade width and its perimeter. Morphological characters of *Quercus faginea* have a quite high variability between aspects. There is a very strong heterogeneity between the four aspects for many characters. The leaves at the Southern aspect have the weakest vegetative values constituted with the smallest leaves. In return, at the Eastern aspect, trees present big sized leaves with very developed vegetative characters. As discussions, the observation can be attributed to the dependence of photosynthetic activity of the effect of the illumination.

Correlation coefficients. The analysis of the Pearson's correlation matrix (Table 3) conducted on the studied characters shows that several characters are correlated between them: surface of leaf-blade is correlated to leaf-blade length (r=0.916), to leaf-blade width (r=0.903), to leaf-blade perimeter (r=0.918) and to the mean length of the six greatest lobes (r= 0.823). The leaf-blade perimeter is correlated to the leaf-blade length (r=0.837) and to the maximal leaf-blade width (r=0.890) and to the mean length of the six greatest lobes (r=0.861). In the same way, the mean length of the six greatest lobes is correlated to the maximal leaf-blade width (r=0.870). With low correlation coefficients, the mean angles of veins of the six greatest lobes (KGD) are not dependent on the other measured morphological characters.

Conclusions

Unfortunately, we do not have sufficiently detailed morphological data for the other oak species to assert with certainty

Table 3. Correlation coefficients between the different leaves' morphological parameters of *Quercus faginea*

	LP	**LL**	**LM**	**BG**	**SU**	**PE**	**NL**	**HL**	**KGD**
LP									
LL	0,46								
LM	0,27	**0,74**							
BG	0,5	**0,77**	0,55						
SU	0,29	**0,70**	**0,70**	0,58					
PE	0,34	0,53	0,51	0,53	**0,9**				
NL	0,321	**0,750**	0,463	0,360	0,499	0,538			
HL	0,36	**0,77**	**0,83**	0,61	**0,74**	0,54	0,45		
KGD	-0,15	0,03	0,33	-0,12	0,19	0,12	-0,14	0,03	

Legend: LP: length of petiole; LL: length of leaf-blade; LM: maximal width of leaf-blade; BG: length of leaf-blade at the greatest width; SU: surface of leaf-blade; PE: perimeter of leaf-blade; NL: number of lobes; HL: mean length of the six greatest lobes; KGD: mean angles of veins of the six greatest lobes.

the specificity of the Mounts of Tlemcen zeen oak with regard to the other oaks. Effectively, when we compiled the bibliographical resources, the only morphological parameters met with were the leaves length and width; they were mentioned with wide intervals taking into account oak leaves polymorphism to enclose the different stages of leaf maturity so as that they could not be profitable for the results interpretation.

The morphological variation of zeen oak in the Mounts of Tlemcen is linked to sampling conditions, aspect namely. We can say that this work reflects the existence of probably unknown zeen oak stands in this area. This «test-approach» of the morphology have to be enlarged to a much bigger sample, concerning the other *Quercus* species and suited with deepest research namely in botany and genetics, and to try to integrate the other biometrical parameters for a better description.

References

BERNARD C. 2004. *Initition à Statistica version 6 française*. Génistat Conseils Inc, Montréal – Canada.

BERRICHI M., A. BOUAZZAOUI. 2011. *Etude histo-morphologique du chêne zeen des Monts de Tlemcen.* Univ. Tlemcen, 113 p.

BERRICHI M. 2010a. *Détermination des aptitudes technologiques du bois de Quercus rotundifolia lamk et possibilités de valorisation.* Université de Tlemcen, 149 p.

BERRICHI M. 2010b. Mechanical and physical characteristics of principal algerian wood. – *Physical and Chemical News*, 51: 136-141.

GAOUAR A. 1980. Hypothèse et réflexion sur la dégradation des écosystèmes forestiers dans la région de Tlemcen. - *Forêt Méditerranéenne,* II(2):131-145.

LETREUCH-BELAROUCI N. 1995. *Réflexion autour du développement forestier: les zones à potentiel de production*. O.P.U. Alger, 69 p.

LETREUCH-BELAROUCI A.M., N. LETREUCH-BELAROUCI, K. BENABDELI, B. MEDJAHDI. 2009. Impact des incendies sur la structure des peuplements de chêne-liège et sur le liège: le cas de la subéraie de Tlemcen (Algérie). - *Forêt Méditerranéenne,* XXX(3) : 231-238.

MAHBOUBI A. 1995. *Contribution à l'étude des formations xérophiles de la région de Tlemcen,* Univ. Tlemcen, 129 p.

MASSAOUDENE M., M. TAFER, A. LOUKKAS, R. MARCHAL. 2009**.** Etude de quelques propriétés physiques du bois de chêne zeen (*Quercus canariensis* Willd) de la forêt des Aït Ghobri (Algérie)**. -** *Bois et Forêts des Tropiques,* C.I.R.A.D. de Montpellier: 39-50.

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Inventory of Pteridophytes on the Territory of "Bulgarka" Nature Park

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Abstract. This study reports data on the diversity of Pteridophyte of the "Bulgarka" Nature Park. Twenty-nine species belonging to the divisions Lycopodiophyta, Equisetophyta and Polypodiophyta were identified, including six new species to the park: *Asplenium onopteris, Dryopteris dilatata*, *Equisetum palustre*, *Huperzia selago*, *Ophioglossum vulgatum* and *Polystichum lonchitis.* Among the identified species the ferns were prevailing. Fifteen species were medicinal plants and eight species have conservation significance. The status of the populations and major threats to the habitats were discussed.

Key words: "Bulgarka" Nature Park, plant diversity, Lycopodiophyta, Equsetophyta, Polypodiophyta.

Introduction

"Bulgarka" Nature Park is included in the system of protected areas in Bulgaria in 2002 to protect, restore and maintain the beech ecosystems and landscapes, typical for the Balkan Mountains. Within the park, located on the northern slopes of the central Balkan range above Gabrovo and Tryavna are included watershed of the upper stream of the Yantra river and the ridge of Shipka and Tryavna Mountain. The highest parts of the Natural Park are "Karadjova tower" peak - 1511 m and "Bedek" peak - 1488 m. The average altitude is 940 meters, at 1200 meters elevation difference. The total area of the research entity is 21,772.163 hectares.

One of the earliest and significant study with specific data from the slopes of "Shipchenska" Balkan Range have been conducted by NEICHEV (1909). The author published a list of more than 1280 species of vascular plants, including 3 horsetail species, 21 fern species and 2 club-mosses species. Data were related to the treeless and deciduous forest belt of Central Balkan Range, between peak "Golyam Kademlya" (the "Triglav Massif") and peak "Bedek" (on the border between Shipchenski and Trevnenski part the Central Balkan Range). As a result, more than 100 new species for the Bulgarian flora have been reported. Each species from the published list is shown with its exact location, its abundance (rarely or very), and general characteristics of the community in which it is found. Studies on Pretidophyte in this region have been performed from KOZHUHAROV (1968). Systematic data on this plant group were collected and summarized in Flora of PR Bulgaria (JORDANOV, 1963), Flora of Bulgaria (STOYANOV *et al.*, 1966), Key to plants in Bulgaria (DELIPAVLOV & CHESHMEDZHIEV,

2003), as well as in Conspectus of the Bulgarian Vascular Flora (ASSYOV & PETROVA, 2006).

Materials and Methods

Inventory of the Pteridophyte was carried out from May to October 2012 and during the spring of 2013 (Fig. 1). A routing method with transect transitions was used. Transects were selected according to the specificities of different floristic groups, peculiarities of the terrain and altitude, aiming to cover maximum area and all typical and representative of the floristic diversity areas from the territory of "Bulgarka"Nature Park. A handheld GPS receiver GARMIN 530 was used for inspection of the localities.

The collected materials were herbarized and identified at the Department of Botany of Plovdiv University "Paisii Hilendarski" using a stereo magnifying glass and identification keys (TUTIN *et al.*, 1993; JORDANOV, 1963; DELIPAVLOV & CHESHMEDZHIEV, 2003). Vaucher specimen (No 059735) from *Huperzia selago* was deposited in the Herbarium of the Agricultural University of Plovdiv (SOA).

Results and Discussion

Twenty-nine species Pteridophyte relating to divisions Lycopodiophyta, Equisetophyta and Polypodiophyta were established during the terrain inventory of the "Bulgarka" Nature Park. The full list of the plant species is presented in Table 1.

Fig. 1. Topographic map of the study area.

Table 1. Taxonomic diversity of the Pteridophyte on the territory of "Bulgarka" Nature Park

DIVISION *LYCOPODIOPHYTA*		
Family	**Genus**	**Species**
Huperziaceae	*Huperzia* Bernh.	*Huperzia selago* (*L.*) Bernh. ex Schrank & C.F.P. Mart.
Selaginellaceae	*Selaginella* Beauv.	*Selaginella helvetica* (*L.*) Spring.

DIVISION *EQUISETOPHYTA*		
Family	**Genus**	**Species**
Equisetaceae	*Equisetum* L.	*Equisetum arvense* L.
		Equisetum palustre L.
		Equisetum ramosissimum Desf.
		Equisetum sylvaticum L.
		Equisetum telmateia Ehrh.
DIVISION *POLYPODIOPHYTA*		
Family	**Genus**	**Species**
Anthyriaceae	*Anthyrium* Roth	*Anthyrium filix-femina* (*L.*) Roth
	Cystopteris Bernh.	*Cystopteris fragilis* (*L.*) Bernh.
Aspidiaceae	*Dryopteris* Adanson	*Dryopteris carthusiana* (*Villar*) H.P. Fuchs
		Dryopteris dilatata (*Hoffm.*) A. Gray
		Dryopteris filix-mas (*L.*) Schott
	Gymnocarpium Newman	*Gymnocarpium dryopteris* (*L.*) Newman
	Polystichum Roth	*Polystichum aculeatum* (*L.*) Roth
		Polystichum lonchitis (*L.*) Roth
		Polystichum setiferum (*Forskål*) Woynar
Aspleniaceae	*Asplenium* L.	*Asplenium adiantum-nigrum* L.
		Asplenium onopteris L.
		Asplenium ruta-muraria L.
		Asplenium septentrionale (*L.*) Hoffm.
		Asplenium trichomanes L.
		Asplenium viride Hudson *Phyllitis scolopendrium* (*L.*) Newman
	Ceterach DC.	*Ceterach officinarum* DC.
	Phyllitis Hill	*Phyllitis scolopendrium* (*L.*) Newman
Hypolepidaceae	*Pteridium* Gled. ex Scop.	*Pteridium aquilinum* (*L.*) Kuhn
Ophioglossaceae	*Botrychium* Swartz	*Botrychium lunaria* (*L.*) Swartz
	Ophioglossum L.	*Ophioglossum vulgatum* L.
Polypodiaceae	*Polypodium* L.	*Polypodium vulgare* L.
Thelypteridaceae	*Phegopteris* (*C. Presl*) Fée	*Phegopteris connectilis* (*Michx*) Watt

Fig. 2. Photo of *Huperzia selago*, „Bulgarka“Nature Park.

Distribution of the species by groups was as follows: 2 species from 2 families belonged to division Lycopodiophyta, 5 species from 1 family - to division Equsetophyta and 22 species from 7 families – to division Polypodiophyta.

Amid all floristic richness in these groups in Bulgaria, 50% of the club-mosses (Lycopodiophyta) families, 47% of the ferns (Polypodiophyta) families and 100% of horsetails (Equsetophyta) families were represented in the Park.

Six new species for the territory of "Bulgarka" Nature Park were established: *Huperzia selago* (Fig. 2), *Equisetum palustre*, *Dryopteris dilatata*, *Polystichum lonchitis*, *Asplenium onopteris* and *Ophioglossum vulgatum*. The conservation significant species *Cystopteris regia (= C. alpina)*, referred by NEICHEV (1909), was not confirmed, although targeted search.

Well represented throughout the park were the populations of the following species: male fern (*Dryopteris filix-mas*), hard shield fern (*Polystichum aculeatum*), soft shield fern (*Polystichum setiferum*), female fern (*Athyrium filix-femina*), fragile fern (*Cystopteris fragilis*), hart's-tongue fern (*Phyllitis scolopendrium*), maidenhair spleenwort (*Asplenium trichomanes*), black spleenwort (*Asplenium adiantum-nigrum*), wall rue (*Asplenium ruta-muraria*), common polypody (*Polypodium vulgare*), bracken or eagle fern (*Pteridium aquilinum*) and field horsetail (*Equisetum arvense*).

Relatively rare, but with stable populations were the species: spinulose woodfern (*Dryopteris carthusiana*), broad bruckler fern (*Dryopteris dilatata*), green spleenwort (*Asplenuim viride*), northern spleenwort (*Asplenuim septentrionale*), branched horsetail (*Equisetum ramosissimum*), great horsetail (*Equisetum telmateia*) and marsh horsetail (*Equisetum palustre*).

With single localities, but in good density were the species: Swiss clubmoss (*Selaginella helvetica*), common moonwort (*Botrychium lunaria*) and adders-tongue fern (*Ophioglossum vulgatum*).

In critical condition with single habitats and single individuals were: northern firmoss *(Huperzia selago)* and wood horsetail (*Equisetum sylvaticum)*.

Identified threats regarding the investigated group plants were mainly loss of the habitats. Real danger of direct and indirect destruction of grasslands in the last few years represent a growing interest in placing wind generators and photovoltaics. There is a wind park within the Nature Park near "Bouzloudja peak", "Atovo padalo" peak, "Karadjova tower" peak, "Bedek" peak, as well as investment interest to build wind turbines near the ridge parts of the massif ("Ispolin" peak, "Tuzlata" peak and "Ostrusha" peak), in close proximity to the park. The construction of ski slope of "Ispolin" peak, situated to the northwest of "Uzana" locality, will damage in a large extent the species and their habitats in the area through the used facilities and related infrastructure.

Rocky habitats were directly threatened by liquidation of the entire area or part of it by building new roads and illegal opening of quarries for aggregates. Threat to forest habitats was carrying out forest-economic events with high intensity. For the wet habitats, the main threat was the change in the hydrological regime.

The threat of habitat loss due to development of the invasive species as Japanese knotweed (*Reynoutria japonica*) and himalayan balsam (*Impatiens grandulifera*) was real for riparian and hydrophilic habitats. Northern firmoss (*Huperzia selago*) felt a negative impact from scots pine (*Pinus sylvestris*), by taking away habitats.

Among the identified species, two plant species (*Equisetum palustre* and *Equisetum ramosissimum*) are included in the IUCN Red List of Threatened Species (IUCN, 2015), category LC - Least Concern. In this category, widespread and abundant taxa are included. According to Bulgarian legislation, the Biological Diversity Act (2002) includes 6 species, while the Medicinal Plants Act (2000) - 15 species (Table 2).

Conclusions

As a result of the field research within the "Bulgarka" Nature Park, twenty-nine species of pteridophytes were recorded,

including six new species to the park: *Asplenium onopteris, Dryopteris dilatata*, *Equisetum palustre*, *Huperzia selago*, *Ophioglossum vulgatum* and *Polystichum lonchitis*. Largest group was the fern plants. More than half of the identified species were medicinal plants and eight species were of conservation significance. The main threats to the study group Pteridophyta were related to habitat loss, the cause of which are the anthropogenic impact and the dissemination of woody and invasive plant species.

Table 2. Conservation significant species and medicinal Pteridophyte species on the territory of "Bulgarka" Nature Park.

Taxon	IUCN	BDA	MPA
Anthyrium filix-femina	-	-	-
Asplenium adiantum-nigrum	-	-	+
Asplenium onopteris	-	-	-
Asplenium ruta-muraria	-	-	+
Asplenium septentrionale	-	-	+
Asplenium trichomanes	-	-	+
Asplenium viride	-	-	-
Botrychium lunaria	-	-	-
Ceterach officinarum	-	-	+
Cystopteris fragilis	-	-	-
Dryopteris carthusiana	-	+	-
Dryopteris dilatata	-	+	-
Dryopteris filix-mas	-	+	+
Equisetum arvense	-	-	+
Equisetum palustre	LC	-	+
Equisetum ramosissimum	LC	-	-
Equisetum sylvaticum	-	-	+
Equisetum telmateia	-	-	+
Gymnocarpium dryopteris	-	-	-
Huperzia selago	-	-	-
Ophioglossum vulgatum	-	-	+
Phegopteris connectilis	-	-	-
Phyllitis scolopendrium	-	-	+
Polypodium vulgare	-	-	+
Polystichum aculeatum	-	+	-
Polystichum lonchitis	-	+	+
Polystichum setiferum	-	+	-
Pteridium aquilinum	-	-	+
Selaginella helvetica	-	-	-

Legend: IUCN (IUCN Red List of Threatened Plants, version 2015.2) – LC (Least Concern); BDA – Biological Diversity Act; MPA – Medicinal Plants Act.

References

ASSYOV B., A. PETROVA (Eds). 2006. *Conspectus of the Bulgarian Vascular Flora: Distribution Maps and Floristic Elements,* Sofia, Bulgarian Biodiversity Foundation, 456 p.

Biological Diversity Act. 2002. Promulgated. - *State Gazzette*, 77, 09.08.2002.

DELIPAVLOV D., I. CHESHMEDZHIEV (Eds.). 2003. *Key to the plants in Bulgaria.* Acad. Press Agrar. Univ., Plovdiv, 591 p. (in Bulgarian)

IUCN. 2015. *The IUCN Red List of Threatened Species.* Version 2015.1. [www.iucnredlist.org]. Downloaded on 01 June 2015.

JORDANOV D. (Ed. princ.). 1963. *Flora Reipublicae Popularis Bulgaricae.* Sofia, Acad. Press, 507 p. (in Bulgarian)

KOZHUHAROV S. 1968. Notes on the chorology of some Bulgarian Pteridophyte (*Pteridophyta). Izvestyia na Botanicheskia Institus (Sofia)*, 18: 111–119. (in Bulgarian)

Medicinal Plants Act. 2000. Promulgated. - *State Gazzette,* 29, 07.04.2000

NEICHEV I. 1909. Materials on the flora of Gabrovo region and Balkan (from Kademlia to Bedek). – *Sbornik s Narodni Umotvorenia, Nauka i Knizhnina,* 24(3): 1-83. (in Bulgarian)

STOYANOV N., B. STEFANOV, B. KITANOV. 1966. *Flora of Bulgaria,* part I, Science and Art, Sofia, 563 pp. (in Bulgarian)

TUTIN T.G., N.A. BURGES, A.O. CHATER, J.R. EDMONDSON, V.H. HEYWOOD, D.M. MOORE, D.H. VALENTINE, S.M. WALTERS, D.A. WEBB (Eds.). 1993. *Flora Europaea.* Vol. 1: Psilotaceae to Platanaceae. Second edition, Cambridge (UK). Cambridge University Press, 581 p.

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Some Ecological and Behavioral Aspects of the Tomato Leaf Miner Tuta absoluta (Meyrick) (Lepidoptera: Gelechiidae)

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Abstract. Preliminary investigations were carried out to determine the insect behavior of *Tuta absoluta* towards different factors. Observations showed that the moth is nocturnal in habits. It is most active at dusk and dawn and rest among leaves of the host plant during the day, showing greater morning-crepuscular activity. It prefers to infest leaves of its host plants followed by sepals, leaf neck and stem. Also, the apical part of the tested plants showed to be more attractive to the females' oviposition compared to the median and basal parts. The best time for mating started in the morning. The insect can discriminate between different host plants. It showed more preference to tomato followed by black nightshade, eggplant, potato and pepper. The larvae are sensitive to light and it prefers the dark zones. The larvae with its taste receptors are able to discriminate between host plants and other chemicals. For instance, it showed great sensitivity to various sugars in varying degrees. The flight range of the moth was determined and it showed the ability to fly for a distance of 0.4 km overnight.

Keywords: *Tuta absoluta*, host preference, behavior, mating, light reaction, flight range.

Introduction

The tomato leaf miner *Tuta absoluta* (Meyrick) became a serious pest to tomato cultivations in Egypt since 2009, where it causes great damage to the crop.Egypt has an appropriate climate for tomato cultivation and the annual production of the crop is 9 204 097 tons of tomato fruits from about 9 000 ha of the cultivated area (MOUSSA *et al*., 2013). So, it is considered as the fifth largest tomato producer in the world (WPTC, 2011).

This insect pest was recorded firstly in many countries of South America (GARICA & ESPUL, 1982). It then invaded Egypt in the nearest governorate to Libya (Mersa-Matrooh) in 2009. By 2010 it had reached Giza, coming well established in all governorates and reaching the border and north part of Sudan in June 2011 (TAMERAK *et al*., 2011; GAFFAR, 2012). No tomato cultivars are entirely resistant to this insect, but not all cultivars are equally susceptible (BORGORNI *et al*., 2003; OLIVEIRA *et al*., 2009; DE OLIVEIRA *et al*., 2012). The larvae attack the tomato plants during all developmental stages causing great losses by attacking leaves, flowers, stems and especially fruits

besides mining their leaves (ESTAY, 2000; TORRES *et al*., 2001)

Tomato (*Solanum lycopersicum*) is considered as the primary host of this pest. However, it can also attack other cultivated Solanaceae plants such as eggplant (*S. melongena*), potato (*S. tuberosum*), pepper (*Capsicum annuum*), sweet pepper (*S. muricatum* L.), tobacco (*Nicotiana tabacum*) and some other non-cultivated Solanaceae (*S. nigrum, S. eleagnifolium*). Also, it infests *Physalis angulata* and *Phaseolus vulgaris, Datura ferox* and some Chenopodiaceae plants such as *Chenopodium album* (VARGES, 1970; GARÎCA & ESPUL, 1982; FERNANDEZ & MONTAGNE, 1990; PORTAKALDALI *et al*., 2013).

In the present study, the behavior of the moth and the larvae of *Tuta absoluta* has been investigated under the laboratory and field conditions.

Materials and Methods

A laboratory culture was maintained on tomato plants as a natural food according to SALAMA *et al*. (2014).

Behavior of adult moths.

Behavior of oviposition. Tomato plants are infested during any developmental stage, with the females ovipositing preferentially on the leaves, sepals and stem.

To study the moth behavior in the field, ten tomato plants were collected randomly from an infested cultivated area of tomato, then transferred to the laboratory. Each plant was divided into three parts; apical, median and lower or basal part. In each part, five leaves were examined (upper and lower surface), leaf neck, stem, sepals, flowers and fruits for estimating the vertical distribution of the eggs on the plant. For studying the behavior in the laboratory investigations, ten potted tomato plants, (45 days old) were exposed to the moths in rearing cages. After egg deposition, the leaves (upper and lower surface), leaf neck and stem were examined to determine the vertical distribution of eggs on different parts of each pot.

Mating. To study the mating process of *T. absoluta*, newly emerged adults of both sexes (1 ♂ : 1 ♀) were kept in transparent glass Petri dishes (15 cm) and each dish contained a moistened filter paper and a cotton piece saturated with 10% honey solution. Morphologically the females are wider and more voluminous than the males; the abdomen is brown in the female and creamy in the male.

Flight range. An attempt has been carried out to determine the flight range of the moth aiming to throw some light on its ability to disperse and fly for long distances searching for nectar. For this purpose, an experiment was carried out in the field (locality of Bernucht, Giza governorate). In this experiment, groups of moths were used for release and were obtained from the laboratory colony. Before release, the moths were separated into two groups, and one group was sprayed with blue and the other one was sprayed with red color as a marking agent. All moths were provided with a diet of 10% honey and moist atmosphere to keep them healthy and active before release. Release was made at sunset (6.45 p.m.) from a fixed release point. After release, recapture of the marked moths from the field was adopted overnight for 2 hours and at different distances from the release point. In each recapture site, a lamp was hanged in the back of a white screen 50×50cm, that was stretched over a stalk, 1.5 meters in height so as to reflect the light of the lamp. Two release sites were determined; the group with blue moths was released 250 meters from the white screen, but 400 meters from the main light trap installed in the field. The group with red marked moths was released 250 meters from the second white screen, but 750 meters from the main light trap.

In each recapture site, a technician was standing so as to collect the moths that were attracted to the light source and rest on the white screen coated with sticky lubricant. Recapture of moths continued for 2 hours. The white screens with the trapped moths were transferred to the laboratory for examination and to sort the marked individuals.

Behavior of larvae.

Preference of different host plants. The orientation of the larvae of *T. absoluta*

towards different host plants was studied in the laboratory. Leaves of tomato, potato, eggplant, pepper and black nightshade were tested. Small discs (2 cm diameter) were taken from the fresh leaves of these plants and placed in a cyclic form in Petri dishes (15 cm) lined with moistened filter paper. Three dishes were used as replicates. Twenty newly hatched larvae were released in the center of each Petri dish and the average number of larvae that settled on each disc was recorded after 1, 2, 3, 4 and 24 hours.

Orientation of the larvae to light. To determine the behavior of the larvae of *T. absoluta* towards light, a Petri dish (12 cm) was used. One half of this dish was covered with black paper to reflect the light, while the second half was exposed to room light. Three dishes were used as replicates. Thirty newly hatched larvae were released in the center of each Petri dish and the average number of larvae in both light and dark zones were recorded after 1, 5, 10, 15 and 30 minutes.

Taste sensitivity of the larvae to sugars. In this investigation, the stimulatory feeding effects of some carbohydrates that might occur in tomato or other host plants of *T. absoluta* have been evaluated to determine the ability of the larvae in discriminating between these compounds. For this purpose, 18 small discs of filter paper (0.5 cm in diameter) were placed in a circular form in a Petri-dish (15 cm in diameter). These discs were impregnated with 0.1 M of 8 tested sugars (2 discs for each sugar and 2 pure discs as a control). These discs were left to dry and sixty newly hatched larvae were released within the Petri-dish containing the discs impregnated with the tested sugars. Counts of larvae that settled on these discs were made after 1,2,3,4 and 24 hours. The experiment was repeated three times.

In all experiments, data obtained were subjected to analysis of variance, one way ANOVA was used (F-test) to compare the results and then differences were considered significant at $P < 0.05$ level using SPSS program.

Results

Behavior of the moth.

Behavior of oviposition. In field investigations, data presented in table (1) indicated that the eggs were recorded on all parts of the plant except flowers and fruits where no eggs were detected. The leaves were more attractive to the females oviposition followed by sepals, leaf neck and stem where the percentages of deposited eggs were 96.45, 2.3, 0.7 and 0.61 %, respectively. The lower leaf surface showed to be more infested than the upper surface and the percentage of deposited eggs was 52.06 and 47.94 %, respectively.

When the plant was divided into three parts, the apical parts showed to be more attractive to the female oviposition compared to the median and basal parts, where the average number of deposited eggs on the apical parts was 49.8 eggs (43.12%) distributed on leaves (96.6 %), leaves neck (1.2 %), stem (1 %) and sepals (1.2 %).

Meanwhile, the average number of deposited eggs on the median parts was 38.9 eggs (33.67 %) distributed on leaves (96.14 %), leaves neck (0.52 %), stem (0.52 %) and sepals (2.82 %). On the other hand, the basal part of the tomato plant was less attractive where the average number of deposited eggs on it was 26.8 eggs (23.2 %) distributed on leaves (96.64 %) and sepals (3.36 %) with no record of eggs on both stem and leaf neck. Statistical analysis show high significant differences ($P<0.05$) in the vertical distribution of the eggs on the plant parts under laboratory conditions.

The laboratory observations (Table 2) showed that the leaves of the apical part of plant were more attractive for moth oviposition than the basal part, where the average number of deposited eggs on the leaves was 88.9 and 57.8 egg, respectively. Also, the upper leaf surface was more attractive than the lower surface. The number of deposited eggs on the upper leaf surface were 54.4±15.29 (61.2%) and 32.5±3.98 (56.23%) and for the lower leaf surface they were 34.5±9.28 (38.8%) and 25.3±2.13 (43.77%) for the apical and basal

plant leaves, respectively. The percentage of total deposited eggs on all plant parts (leaves of apical part and basal part, leaves neck and stem) were 54.9, 35.7, 2.77 and 6.66%, respectively. Statistical analysis show high significant differences (P<0.05, F= 19.3) in the vertical distribution of the eggs on the plant leaves under laboratory conditions.

Table 1. Vertical distribution of *T. absoluta* eggs on tomato plants in the field

Plant part	Average number of deposited eggs	Leaves		Leaf neck	Stem	Sepals	Fruits & Flowers
		Lower surface	Upper surface				
Whole plant	115.5	52.06 %	47.94 %	0.7 %	0.61 %	2.3 %	Zero %
		96.45 %					
Apical part	49.8 (43.12%)[a]	51.98 %	48.02 %	1.2 %	1 %	1.2 %	Zero %
		96.6 %					
Median part	38.9 (33.67%)[b]	52.4 %	47.6 %	0.52 %	0.52 %	2.82 %	Zero %
		96.14 %					
Basal part	26.8 (23.2 %)[c]	52.1 %	47.9 %	Zero %	Zero %	3.36 %	Zero %
		96.64 %					

The values followed by letters mean that the differences were significant at P<0.05.

Table 2. Pattern of oviposition of *T. absoluta* on the tomato plants under laboratory conditions

Deposited eggs / Plant parts	Leaves				Leaf neck	Stem
	Apical part		Basal part			
	Upper surface	Lower surface	Upper surface	Lower surface		
Average number of deposited eggs / plant	54.4 ± 15.29	34.5± 9.28	32.5± 3.98	25.3± 2.13	4.5 ± 2.28[c]	10.8 ± 6.06[c]
	88.9 [a]		57.8 [b]			
% of total deposited eggs on plant parts	61.2 %	38.8 %	56.23 %	43.77%	2.77 %	6.66 %
	54.9 %		35.7 %			

The values followed by the same letters mean that the differences were not significant at P< 0.05.

Mating. Follow up of the mating process showed that the best time for mating started at 7.30 a.m. in the morning. At start of mating, the lower extremity of the male body gets in contact with that of the female. A single mating lasted for 5.14 ±1.15 hours.

Flight range. Counts of recaptured released moths (blue or red) showed a flight range of 250 meters during a period of 2 hours. In the blue marked moths, 3 moths were recaptured after an hour and 42 moths after 2 hours. In the red marked moths, 6 individuals were recaptured after one hour and 24 after 2 hours. In addition, examination of the collected moths by the main light trap (400 meters from the release

point) one day after release, showed that 67 of the blue marked moths were recaptured. So, it appears that the moths of *T. absoluta* have a flight range up to 250 meters during a period of 2 hours after release and 0.4 kilometers overnight. The ability of the moth to fly for a distance of 0.4 kilometers overnight is of great importance in regulating its dispersion and oviposition on different host plants during its life span. Accordingly, the moths after emergence will be able to detect the source of nectar, either from the field where they emerge or from flowering weeds on the borders of cultivations or from other host plants within the limit of their activity in the neighboring areas.

Behavior of larvae.

Preference of different host plants. The orientation of the larvae of *T. absoluta* towards different host plants was studied in the laboratory. Observations (table 3) indicate that hatched larvae were attracted in a descending order to leaves of tomato >black nightshade>eggplant> potato where the average number of oriented larvae was 4.33, 2.33, 2 and 1.33 larvae, respectively, after one hour of hatching. Meanwhile, no larvae were oriented to the discs of pepper leaves. With increase of the exposure time to 24 hours the tomato leaves appeared to be the most attractive host to *T. absoluta* larvae followed by black nightshade, eggplant, potato and pepper, where the percentages of the oriented larvae were 46.65, 20, 18.3, 11.65, and 3.3 %, respectively. Statistical analysis show high significant differences ($P<0.05$, $F= 36.73$) in tomato leaves as a host preferred by the larvae compared to the other hosts under laboratory conditions.

Table 3. Preference of larvae of *T. absoluta* to host plant leaves.

Exposure time / hour	No. of larvae that settled on				
	Tomato	black nightshade	Pepper	Potato	Egg plant
One	4.33±0.47	2.33±0.47	0±0	1.33±0.47	2±0
2	7±0.82	3.66±0.47	0.7±0.47	2.66±0.94	3.66±0.47
3	7.7±0.47	4.33±0.47	1±0.82	2.66±0.94	4.33±0.47
4	9±0.82	4.33±0.47	1± 0	2.33±0.94	4.33±0.47
24	9.33±1.3	4±0.82	0.66±0.47	2.33±0.47	3.66±0.82
% of oriented larvae at 24 hrs.	46.65 % a	20 % b	3.3 % d	11.65 % c	18.3 % bc

Values followed by the same letters mean that the differences were not significant at $P< 0.05$.

Orientation of the larvae to light. Our observations showed that the hatched larvae of *T. absoluta* were sensitive to light and it preferred the dark zone. The data in table (4) showed that, immediately after hatching the larvae were scattered but after 5 minutes the average number of oriented larvae to the dark zone was 8.7±1.7 larvae compared to 4 ± 0.82 larvae in the light zone. The increase of exposure time led to increase the number of larvae attracted to the dark zone, where the average number of larvae attracted to the dark zone was 13.33±2.63 and 18.3±0.47 larvae compared to 6.33±0.95 and 9±0.82 larvae in the light zone after 10 and 15 minutes, respectively. After 30 minutes, the highest number of larvae settled in the dark being 22.7±1.47 (75.66%) compared to 7.33±1.25 (24.43%) in the light zone. Statistical analysis show high significant differences between dark and light zones ($P<0.05$, $F=16.94$).

An experiment was carried out to determine the time required for the newly hatched larvae to penetrate or bore the tomato leaves. Immediately after hatching,

the neonate larvae behave like a borer where it feeds on leaf surface then penetrate within the leaf tissues. The required time for the penetration was about 30 - 37 minutes, where the average number of the penetrating larvae was 26±0.92 (86.66 %) larva after 30 minutes, while all the hatched larvae disappeared completely in the tunnel after 37 minutes.

Taste sensitivity of the larvae to sugars. The stimulatory effects of some carbohydrates that might occur in tomato or other host plants of *T. absoluta* have been investigated to determine the ability of the larvae in discriminating between the tastes of these sugars. The data obtained (table 5) clearly show that the tested sugars can be arranged according to the stimulating effectiveness as follows: monosaccharides: D-fructose = D-glucose > D-galactose > D-mannose, disaccharides: sucrose > D-maltose = D-lactose, polysaccharides: glycerol.

So, the structure of the sugar molecules shows to be effective in stimulation (table 5). The statistical analysis show high significant differences in the number of larvae that settled on sucrose ($P<0.05$, $F=60.9$) compared to the other sugars under laboratory conditions.

Table 4. Orientations of the larvae of *T. absoluta* towards light

Exposure time in minutes	On filter paper		On tomato leaf
	Dark zone	Light zone	
	Mean No. of oriented larvae ± SD		Mean No. of penetrating larvae ± SD
One	All hatched larvae were scattered		0
5	8.7 ± 1.7	4 ± 0.82	0
10	13.33 ± 2.63	6.33 ± 0.95	0
15	18.3 ± 0.47	9 ± 0.82	0
30	22.7 ± 1.47	7.33 ± 1.25	26 ± 0.94
% of oriented larvae at 30 min.	75.66 % [a]	24.43 % [b]	86.66 %

The values followed by letters mean that the differences were significant at $P< 0.05$.

Table 5. Orientation of larvae of *T. absoluta* to sugars

Exposure time/hour	No. of larvae that settled on								
	Sucrose	Fructose	Glucose	Galactose	Mannose	Maltose	Lactose	Glycerol	Control
One	0±0	0±0	0.33 ±0.05	0±0	0±0	0±0	0±0	0±0	0±0
2	3.33 ±0.47	3 ±2.1	4.33 ±0.94	2.33 ±0.47	1.33 ±0.47	0±0	0.33 ±0.04	0±0	0±0
3	3.33 ±0.47	4 ±0.8	5 ±1.4	3.33 ±0.4	2 ±0.82	1±0	1±0	1±0	2 ±0.82
4	8 ±1.4	6.7 ±1.24	8.33 ±0.94	5 ±1.4	5.33 ±0.94	3±0	2.33 ±0.47	2.33 ±0.04	0±0
24	12.33 ±0.47	9 ±1.6	9 ±0.8	5.7 ±0.94	4.33 ±0.47	3±0	3±0.8	0±0	0±0
% of oriented larvae at 24 hrs	20.55% [a]	15% [b]	15% [b]	9.5% [c]	7.22% [cd]	5% [d]	5% [d]	0% [e]	0% [e]

The values followed by the same letters mean that the differences were not significant at $P< 0.05$.

Discussion

Studies on the behavior of oviposition of *T. absoluta* moth in the field indicated that the tomato plants were infested during any developmental stage and the females deposited their eggs on all parts of host plants; leaves, leaf neck, stem and sepals. The leaves were more attractive to females and the lower leaf surface appeared to be more infested than the upper surface. After egg hatching, the larvae of *T. absoluta* penetrated tomato leaves, fed on leaf parenchyma tissues forming irregular leaf mines that got longer and wider as the larvae continued to feed. The apical part of the plant was more attractive to the females compared to the median and basal parts. These observations coincide with those recorded by previous authors (ESTAY, 2000; TORRES *et al.*, 2001; LEITE *et al.*, 2004).

The variation in oviposition site selection and in vertical distribution of eggs on plant parts may be correlated to various factors. TORRES *et al.* (2001) stated that the female lay eggs uniformly on the under and upper side of leaves that are covered with trichomes that provide chemical and mechanical stimuli. Also, PROFFIT *et al.* (2011) demonstrated the essential role of plant volatiles in *T. absoluta* females' host-finding behavior and suggested that the leaf contact significantly increased the number of eggs laid and leaf surface morphology and contact chemicals are important factors in oviposition site selection. Additionally, in agreement with our findings, LEITE *et al.* (1999) found that *T. absoluta* oviposited more on leaves of the apical and median portions than in the basal parts of the tomato plant. The same authors stated that this oviposition behavior could be linked to the lower calcium content of apical leaves, which are tender, compared to middle or basal leaves of the host plant. Furthermore, LEITE *et al.* (2004) demonstrated that there was a preferential deposition of *T. absoluta* eggs on the apical leaves of the tomato plant.

Our observations on the mating behavior showed that the best time for mating was in the early morning at 7.30 a.m. and the mating process lasted for 5.14± 1.15 hours. These observations agree with those of IMENES *et al.* (1990) who studied the biology and behavior of *T. absoluta* in the laboratory and observed that the mating activities started at 7 a.m. and duration of mating took about 4.49 hours. In this concern, HIKEL *et al.* (1991) found that the duration of copula of this insect was variable (2-6 hours). MIRANDA-IBARRA (1999) reported that the greatest number of males was captured in pheromone traps during the period 7 to 11 a.m. suggesting that this is the best time when males are searching for calling females. MARINA *et al.* (2014) stated that mating always began during the first hour of the photophase, and mating pairs took from a few minutes to 6 h 40 min. and 76 % of females laid eggs on the same days they mated. The variation in copulation time may be proportional to complete transfer of the spermatophore from male to the female (OUYE *et al.*, 1965; SETH *et al.*, 2002) or may be to spermatophore size (FRANCO *et al.*, 2011).

The flight range of the moth was determined to shed light on its ability for dispersion and the field observations clearly indicated that it was able to fly up to 250 meters during 2 hours and 400 meters from the release point overnight after release.

As already mentioned, the moth is nocturnal in habits. The newly hatched larvae tend to orient itself and settle in the dark zones. They behave like a borer when it feeds on the leaf surface and then penetrate within the leaf tissues within 30-37 minutes. This coincides with observations of CUTHBERTSON *et al.* (2013) who showed that the first instar larvae of the same species fed on the leaf surface for approximately 82 minutes before becoming fully submerged inside the leaf.

T. absoluta is polyphagous, but it prefers some of its hosts such as tomato. The senses of taste and smell in lepidopterous larvae are important in host plant selection and the acceptance of the larva of *T. absoluta* to a host plant is due probably to chemical volatiles rather than purely physical factors as reported by TORRES *et al.* (2001) and PROFFET *et al.* (2011).

In this concern, BECK (1956) stated that among the numerous compounds that can be extracted from plants are the sugars which occur in appreciable quantities in plant tissues and are known to induce feeding in some phytophagous insects. The larvae of *T. absoluta* with taste receptors located on the mouth parts were able to discriminate between sugars showing more sensitivity to sucrose as compared with D-fructose, D-glucose and D-galactose. A great difference in taste sensitivity to sugars was observed such as D-glucose and D-galactose and also between D-glucose and D-mannose despite slight differences in their configuration. D-mannose and D-galactose are almost equal in stimulating effects although they differ in their structural configuration. Sucrose with α-linkage is superior feeding stimuli, while lactose which lacks α- linkage is weakly stimulating. This shows that the difference in the structure of sugar molecules results in different physiological effects. In this concern, HASSETT *et al.* (1950); DETHIER (1955); KHALIFA *et al.* (1974) reported that sugars with α- linkage were more stimulating than those lacking it and that the response of various insects to carbohydrates shows a spectrum of activity from unresponsiveness to extreme sensitivity. Glycerol from polysaccharides is not stimulating to the larvae. Our preliminary microscopic examination of the larval mouth parts shows the existence of various sensilla or chemoreceptors.

References

BECK S.D. 1956. A bimodal response to dietary sugars by an insect. - *Biological Bulletin,* 110: 219-228.

BORGORNI P.C., R.A. DA SILVA, S.G. CARVELHO. 2003. Leaf mesophyll consumption by *Tuta absoluta* (Meyrick, 1971) (Lepidoptera: Gelechiidae) in three cultivars of *Lycopersicon esculentum* Mill. - *Ciencia Rural,* 33(1): 7-11. DOI:10.1590/S0103-84782003000100002

CUTHBERTSON G.S.A., J. MATHERS, L.F.BLACKBURN, A. KORYCINSKA, L. WEIQI, J.R. JACOBSON, P. NORTHING. 2013. Population development of *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) under simulated UK glasshouse conditions. - *Insects,* 4(2): 185-197. DOI:10.3390/insects4020185

DETHIER V.G. 1955. The physiology and histology of the contact chemoreceptors of the blowfly. - *Quarterly Review of Biology,* 30: 348-371.

DE OLIVEIRA C.M., V.C. DE-ANDRADE JR., W.R. MALUF, I.P. NEIVA, G.M. MACIEL. 2012. Resistance of tomato strains to the moth *Tuta absoluta* imparted by allelochemicals and trichome density. - *Ciência eAgrotecnologia,* 36(1): 45–52. DOI:10.1590/S1413-70542012000100006

ESTAY P. 2000. Polilladel Tomate*Tuta absoluta* (Meyrick). *Investigationes Agropecuarias, Centro Regional de Investigacion La Platina.*Ministerio de Agricultura Santiago Chile. Available online at: [www2.inia.cl].

FERNANDEZ S., A. MONTAGNE. 1990. Preferencia de oviposicion de lashembras y duracion, crecimiento y sobrevivencia de laslarvas de *Scrobipalpula absoluta* (Meyrick) en diferentes Solanaceas. - *Bulletin Entomolology Venezewalla,* 5(13): 100-106.

FRANCO K., A. JAUSET, C.E. CASTAN. 2011. Monogamy and polygamy in two species of mirid bugs: a functional-based approach. - *Journal of Insect Physiology,* 57: 307–315. DOI: 10.1016/j.jinsphys.2010.11.020

GAFFAR S. 2012. Relative comparison between parasitization efficiency of three *Trichogramma* species versus eggs of tomato leaf miner moth, *Tuta absoluta* (Meyrick) on tomato greenhouse in Egypt. - *The Eleventh Report of Agriculture Development Research 27-30 March, 2012. Ain Shams Univ., Faculty of Agriculture:* 168-169.

GARÎCA M.F., J.C. ESPUL. 1982. Bioecology of the tomato moth (*Scrobipalpula absoluta*) in Mendoza, Argentine

Republic. - *Revista de Investigaciones Agropecuarias*, 17(2): 135-146.

HASSET C.C., V.G. DETHIER, J. GANS. 1950. A comparison of nutritive values and taste thresholds of carbohydrates for the blowfly. - *Biological Bulletin Wood's Hole,* 99: 446-453.

HICKEL E.R., E.F. VIELA, J.O. GOMESDE LIMA, T.M. CASTREDELLA LUCIA. 1991. Comportamiento de acasalmento de *Scrobipalpula absoluta* (Lepidoptera: Gelechiidae). - *Pesquisa Agropecuaria Brasilia,* 26(6): 827- 835.

IMENES S.D., M.A. UCHO-FERNANDEZ, T.B. CAMPOS, A.P. TAKEMATSU. 1990. Aspectosbiologicos e comportamentais da traca-do-tomaterio *Scrobipalpula absoluta* (Meyrick) (Lepidoptera: Gelechiidae). - *Arquivos do Instituto Biológico* (São Paulo, Brazil*),* 57(1-2): 63-68. DOI: 10.1590/S0085-56262009000300021

KHALIFA A., H.S. SALAMA, N. AZMY, A. EL-SHARABY. 1974. Taste sensitivity of the cotton leaf worm, *Spodoptera littoralis* to chemicals. - *Journal of Insect Physiology*, 20(1): 67-76. DOI: 10.1016/0022-1910(74)90124-3

LEITE G. L. D., M. PICANCO, A. AZEVEDO, A. H.R. GONRING. 1999. Efeito de tricomas, aleloquímicos e nutrientesnaresistência de *Lycopersicon hirsutum* à traça-do-tomateiro. *Pesquisa Agropecuaria Brasilia,* 34: 2059–2064.

LEITE G.L. D., M. PICANCO, G.N. JHAM, F. MARQUINI. 2004. Intensity of *Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae) and *Liriomyza* spp. (Diptera: Agromyzidae) attacks on *Lycopersicum esculentum* Mill. leaves. - *Ciência e Agrotecnologia,* 28: 42–48. DOI: 10.1590/S1413-70542004000100005

MARINA S.L., A. RAMON, E. MATILDE. 2014. Mating behavior of female *Tuta absoluta* (Lepidoptera: Gelechiidae): polyandry increases reproductive output. - *Journal of Pest Science,* 87: 429–439. DOI:10.1007/s10340-014-0576-4

MIRANDA-IBARRA E. 1999. Fluctuacion poblacional, ritmodiario de vuelo de machos y eficacia de biopesticidas en polilla Del tomateTuta absoluta (Meyrick) en cultivo del tomate de otoñobajoinvernadero en la zona de. - *Quillota Universidad Iberoamericana de Ciencias y Tecnologia,* 19: 672.

MOUSSA S., F. BAIOMY, A. SHARMA, F. EID EL-ADL. 2013. The status of tomato leaf miner; *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in Egypt and potential effective Pesticides. - *Academic Journal of Entomology,* 6(3): 110-115. DOI:10.5829/idosi.aje.2013.6.3.75130

OLIVEIRA F.A., D. J. DA SILVA, G.L.D. LEITE, G. N. JHAM, M. PICANCO. 2009. Resistance of 57 greenhouse-grown accessions of *Lycopersicon esculentum* and three cultivars to *Tuta absoluta* (Meyrick). (Lepidoptera: Gelechiidae). - *Science Horticulture,* 119: 182–187. DOI:10.1016/j.scienta.2008.07.012

OUYE M.T., R.S. GARICA, H.M. GRAHAM, D.F. MARTIN. 1965. Mating studies on the Pink Bollworm, *Pectinophora gossypiella* (Lepidoptera: Gelechiidae), based on presence of spermatophores. - *Annals Entomological Society of America,* 58: 880–882. DOI:10.1093/aesa/58.6.880

PORTAKALDALI M., S. OZTEMIZ, H. KUTUK. 2013. A new host plant for *Tuta absoluta* Meyrick (Lepidoptera: Gelechiidae) in Turkey. - *Journal of Entomological Society,* 15(3): 21-24.

PROFFIT M., G. BIRGERSSON, M. BENGTSSON, J.R. REIS, P. WITZGALL, L. ERALDO. 2011. Attraction and oviposition of *Tuta absoluta* females in response to tomato leaf volatiles. - *Journal of Chemical Ecology,* 37: 565-57. DOI: 10.1007/s10886-011-9961-0

SALAMA H. S, M. FOUDA, I. A. ISMAIL, I. EBADA, I. SHEHATA. 2014. Life table parameters and fluctuations in the population density of the moth *Tuta absoluta* (Meyrick) - (Lepidoptera: Gelechiidae). - *Current Science International,* 3(3): 252-259.

SETH R.K., J.J. KAUR, D.K. RAO, S.E. REYNOLDS. 2002. Sperm transfer during mating, movement of sperm in the female reproductive tract, and sperm precedence in the common cutworm *Spodoptera littoralis*. - *Physiological Entomology,* 27: 1-14.

TAMERAK S.A. 2011. The status of *Tuta absoluta* in Egypt. *EPPO/IOBC/ FAO/NEPPO Joint international symposium on management of Tuta absoluta (tomato borer, Lepidoptera: Gelechiidae).* In collaboration with the IRAC and IBMA Agadir, Morocco, November pp. 16-18.

TORRES J.B., C.A. FARIA, W.A. EVANGELISTA, D. PRATISSOL. 2001. Within-plant distribution of the leaf miner *Tuta absoluta* (Meyrick) immatures in processing tomatoes, with notes on plant phenology. - *International Journal of Pest Management,* 47(3): 173–178. DOI:10.1080/02670870010011091

VARGES H. 1970. Observaciones sobre la biología y enemigos naturales de la polilla del tomate, *Gnorimoschema absoluta* (Meyrick). – *Idesia*, 1: 75-110.

WPTC. 2011. *Report of world processing tomato council.* 10 p. Available at: [http://www.wptc.to/releases-wptc]

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Overwintering Site Fidelity in the European Pond Turtle (Emys orbicularis) in Western Poland

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Abstract. The location of overwintering sites of six male and six female European pond turtles (*Emys orbicularis*) were studied using radiotelemetry in Western Poland, over a period of four consecutive seasons. Most of the studied individuals overwintered in the same area during the research; most distances between two consecutive overwintering sites were 0–25 m. However, changes related to the overwintering area were observed, and in such cases the distance between overwintering sites on two consecutive seasons could exceed 2 km. These results can support an efficient conservation strategy of the turtle population.

Keywords: European pond turtle, hibernation, radiotelemetry, temperature.

Introduction

Data on habitat use by animals is crucial for protection of the animal species (e.g., PULLIN, 2004; STEEN *et al.*, 2012). Many animals use similar sites over the years. However, conservation of freshwater turtles depends on the quality and protection of aquatic, as well as surrounding terrestrial habitats (e.g., BURKE *et al.*, 2000; SEMLITSCH & BODIE, 2003; CADI *et al.*, 2008; MITRUS, 2010). The European pond turtle *Emys orbicularis* (L., 1758) is an endangered species in many parts of its distribution area (FRITZ, 2003). For some populations, accurate data is available on nesting area locations (e.g., MITRUS, 2006; NAJBAR & SZUSZKIEWICZ, 2007; BONA *et al.*, 2012) and habitat use (e.g., MEESKE & MÜHLENBERG, 2004; CADI *et al.*, 2008). However, for the larger part of distribution range including central Europe, the absence of data on overwintering areas hampers the development of an efficient protection strategy; indeed, the non protection of seasonal habitats (e.g., overwintering areas) could lead to extinction of a population (cf. CADI *et al.*, 2008).

In this study, we present data on overwintering sites used by the European pond turtle in Western Poland. We tested whether overwintering areas were different for females and males, and if individuals showed overwintering site fidelity. Such data are important for application to wetland conservation and management of the turtle population.

Material and Methods

The research area is situated in Western Poland (Fig. 1), several kilometres far from the mouth of the Ilanka River – a tributary of the Odra River. The European pond turtle is observed particularly in a channel that is approximately 2,500 m long and 7–10 m wide, see Fig. 2), and also in its small tributaries (100–250 m long & 5–15 m wide). In the channel, the flowing is very slow, with stagnant water in places. The bottom of the studied basins is covered with a thick layer of sediment. The Ilanka River flows in parallel with the channel, with significantly faster flowing (1.76 m^3/s) (NAJBAR, 2008).

Fig. 1. Location of the study area in Western Poland.

During the research, we monitored six females and six males by using radiotelemetry (straight carapace length SCL: 152.3–197.0 mm, plastron length PL: 141.3–194.1 mm, body mass BM: 600–1100 g for females, and SCL: 143.0–167.3 mm, PL: 131.0–146.4 mm, BM: 445–660 g for males). Turtles were collected during August–September 2011, and transmitters were glued to their carapaces. We used 10–15 g high frequency (VHF) radio transmitters (type RI-2B, Holohil Systems, Ltd., Ontario, Canada) and ASK-032/P directional antennas connected to an ICOM IC-R20 portable receiver. We also used specially designed transmitters weighted 8–16 g. Turtle positions were tracked two to six times per month from autumn to spring, which is adequate considering the extreme sedentariness of hibernating the European pond turtles (cf. e.g., NOVOTNÝ *et al.*, 2004; THIENPONT *et al.*, 2004; CADI *et al.*, 2008), during four consecutive overwintering seasons (2011/12 to 2014/15).

The accuracy range of site locations was within ±5 m. In addition, water and sediment temperature were monitored at one-hour intervals. We used AZ Instruments data loggers (type 8828) placed in waterproof containers. The data loggers were positioned in the water, several to a dozen centimetres above the sediment layer (i.e. 35–50 cm below water level), and inside the sediment layer (at a depth of 50–65 cm); thickness of sediment in the areas is a. 2–3 m.

Results and Discussion

We collected data on three to four overwintering sites per turtle, during the four above-mentioned consecutive seasons. Although during spring and summer turtles were observed everywhere along the Ilanka River channel, in winter they were detected in only two areas, most of the radio-tracked turtles overwintered at the eastern part and at the end of the channel (Figs 2-3). Females and males overwintered in the same areas (Figs 2-3). Most individuals (four of the six females, and five of the six males) overwintered in the same area each year; distances between two consecutive overwintering locations were 0–15 m for females (mean 8 m, n=11 distances for four individuals), and 0–25 m for males (mean 10 m, n=14 distances for five individuals).

Only three turtles changed their overwintering area (Figs 3-4). For example, female No. 12 showed a strong site fidelity between 2011/12 and 2012/13 (distance ~15 m), then moved ~1,940 m from this site in 2013/14, and moved back ~5 m from the first site in 2014/15 (Fig. 4). For female No. 21 the distances between sites used in 2011/12 — 2012/13 and 2012/13 — 2013/14 were 10 m and 20 m respectively, but between 2013/14 and 2014/15 the distance was ~2,275 m (Figs 3-4).

During overwintering period (mid-November — February 2013/14), the average water temperature was 3.6–7.6°C, and sediment temperature was 6.1–7.9°C (Fig. 5).

Daily temperature changes were 0.0–3.2°C in water and 0.0–1.9°C in sediments for season 2013/14. In other seasons the average temperatures and daily temperature changes were similar.

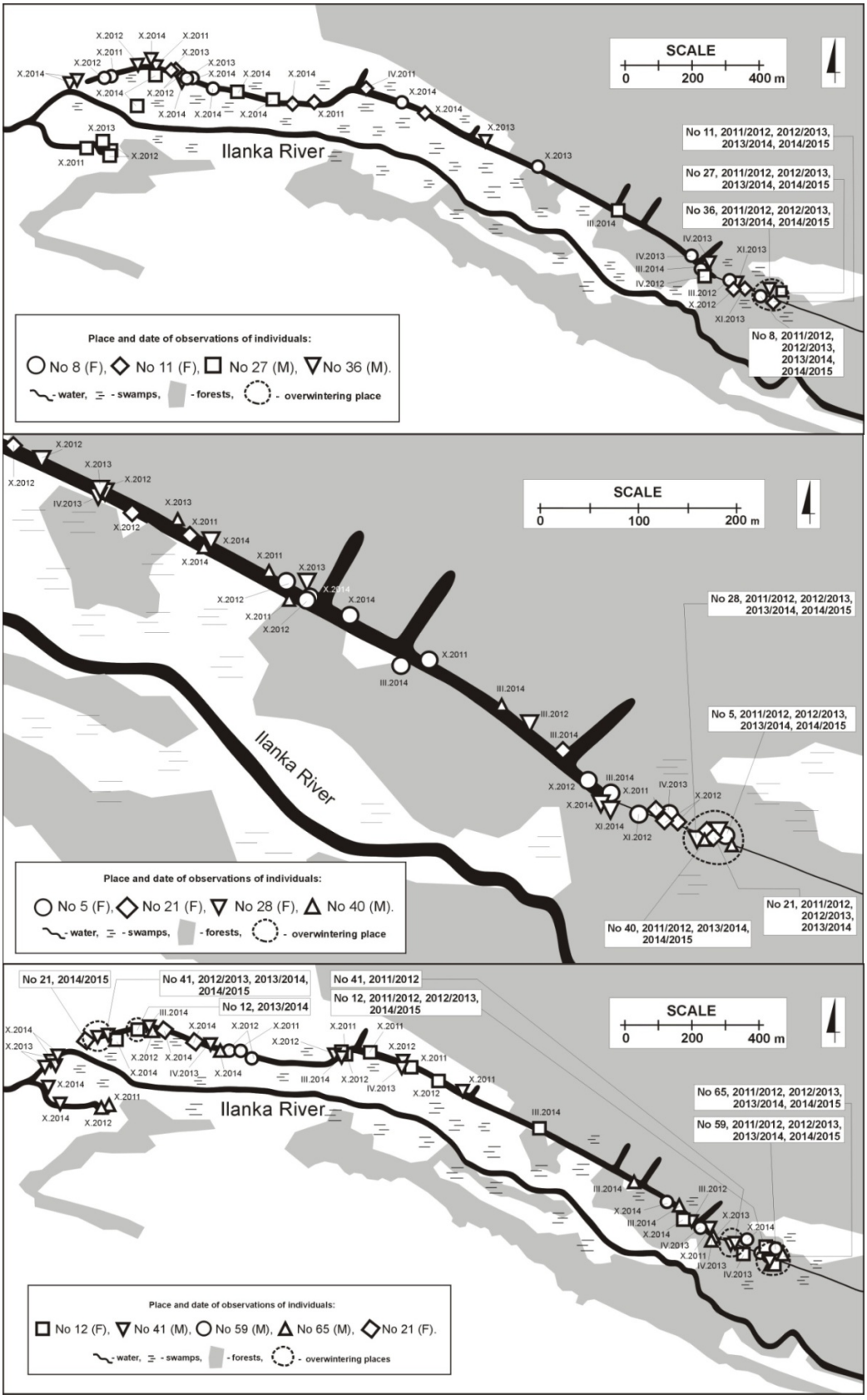

Fig. 2–4. Location of overwintering sites of the adult European pond turtles (*Emys orbicularis*) in Western Poland, during four consecutive seasons 2011/2012 — 2014/2015.

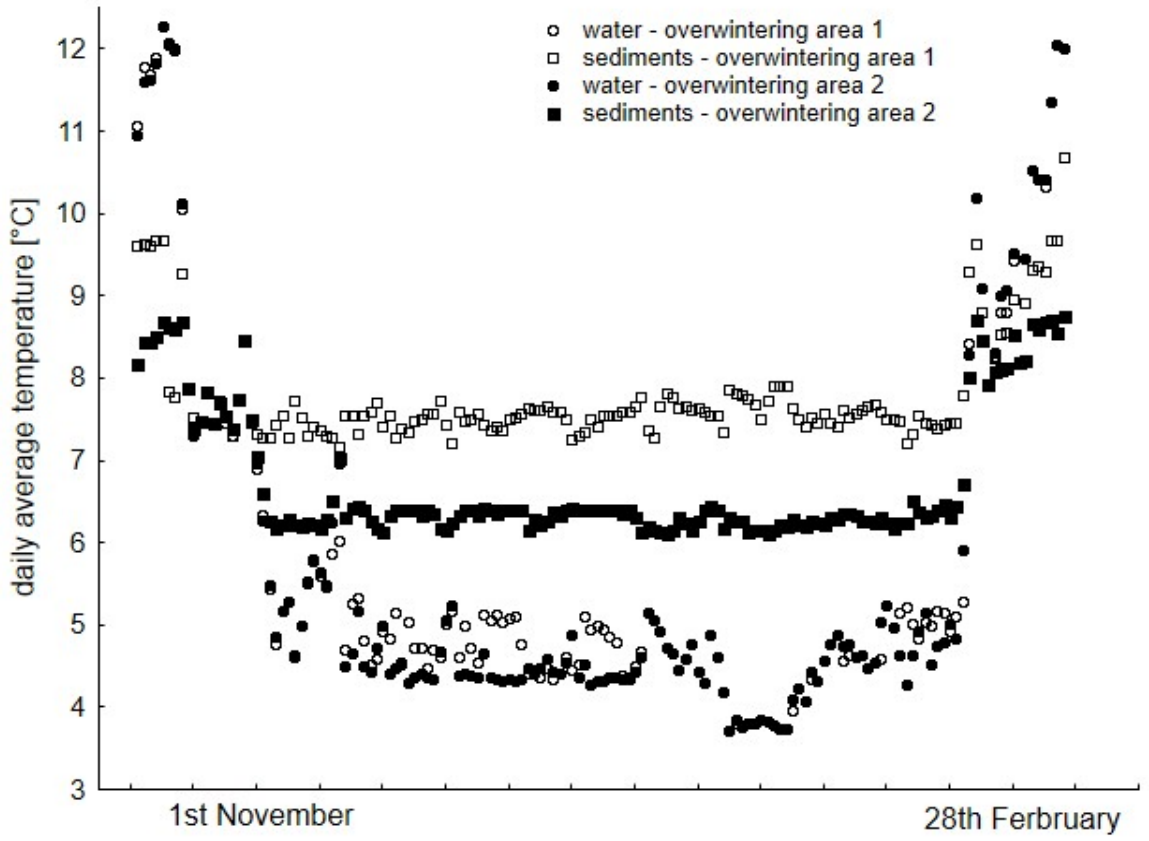

Fig. 5. Average daily water and sediments temperature in the overwintering sites of the European pond turtles (*Emys orbicularis*) in 2013/14.

Underwater overwintering in the European pond turtle is well documented (e.g., NOVOTNÝ *et al.*, 2004; ULTSCH, 2006; CADI *et al.*, 2008; NAJBAR, 2008), especially under cold and temperate climates; our results show that Poland is no exception. In the present study we found that most of the twelve radio-tracked individuals overwintered in the same small area. Our unpublished observations confirm that more turtles from the studied population overwintered in the same area. Thus, the Ilanka river channel extremity portions are of crucial importance for the population. Destroying such area during winter (e.g., during restoration of the irrigation system) could cause the mortality of many individuals, which may be dangerous for the population of this long-living species (BROOKS *et al.*, 1991; CONGDON *et al.*, 1993). Thus, precise data on the location of such overwintering areas could be crucial for the protection of populations, especially small ones.

Our data had been obtained from adult individuals only; we have no data on overwintering sites of hatchlings and juveniles. We found that in the studied population males and females overwintered together. Similar data were presented by CADI *et al.* (2008) for the turtles in France. We suppose that such gregariousness might be beneficial for the turtle by facilitating courtship, which occurs soon after overwintering.

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References

BONA M., M. NOVOTNÝ, S. DANKO, A. BUREŠOVÁ. 2012. Nest site fidelity in the Slovakian population of the European pond turtle *Emys orbicularis*. – *Amphibia-Reptilia*, 33(2): 207-213. DOI: 10.1163/156853812X636457

BROOKS R.J., G.P. BROWN, D.A. GALBRAITH. 1991. Effects of a sudden increase in natural mortality of adults on a population of the common snapping turtle (*Chelydra serpentina*). - *Canadian Journal of Zoology*, 69(5): 1314–1320. DOI: 10.1139/z91-185

BURKE W.J., J.E. LOVICH, J.W. GIBBONS. 2000. Conservation of freshwater turtles. - In: Klemens M.W. (Ed.): *Turtle Conservation*. Washington, Smithsonian Institution Press, pp. 156–179.

CADI A., M. NEMOZ, S. THIENPONT, P. JOLY. 2008. Annual home range and movement in freshwater turtles: management of the endangered European pond turtle (*Emys orbicularis*). - *Revista Española de Herpetología*, 22: 71–86.

CONGDON J.D., A.E. DUNHAM, R.C. VAN LOBEN SELS. 1993. Delayed sexual maturity and demographics of Blanding's turtles (*Emydoidea blandingii*): implications for conservation and management of long-lived organisms. - *Conservation Biology, Hoboken*, 7(4): 826–833.

FRITZ U. 2003. *Die Europäische Sumpfschildkröte*. Supplement der Zeitschrift für Feldherpetologie No. 1, Bielefeld, Laurenti-Verlag.

MEESKE A.C.M., M. MÜHLENBERG. 2004. Space use strategies by a northern population of the European pond turtle, *Emys orbicularis*. - *Biologia, Bratislava*, 59(Suppl.): 95–101.

MITRUS S. 2006. Fidelity to nesting area of the European pond turtle, *Emys orbicularis* (Linnaeus, 1758). - *Belgian Journal of Zoology*, 136(1): 25–30.

MITRUS S. 2010. Is the European pond turtle *Emys orbicularis* strictly aquatic? – Habitats where the turtle lives in central Europe. - *Acta Herpetologica*, 5(1): 31–35.

NAJBAR B. 2008. *Biologia i ochrona żółwia błotnego (*Emys orbicularis*) w zachodniej Polsce*. Zielona Góra, Oficyna Wydawnicza Uniwersytetu Zielonogórskiego.

NAJBAR B., E. SZUSZKIEWICZ. 2007. Nest-site fidelity of the European pond turtle *Emys orbicularis* (Testudines: Emydidae) in western Poland. - *Acta Zoologica Cracoviensia*, 50A(1-2): 1–8. DOI: 10.3409/000000007783995417

NOVOTNÝ M., S. DANKO, P. HAVAŠ. 2004. Activity cycle and reproductive characteristics of the European pond turtle (*Emys orbicularis*) in the Tajba National Nature Reserve, Slovakia. - *Biologia, Bratislava*, 59(Suppl.): 113–121.

PULLIN A.S. 2004. *Biologiczne podstawy ochrony przyrody*. Warszawa, Wydawnictwo Naukowe PWN.

SEMLITSCH R.D., J.R BODIE. 2003. Biological criteria for buffer zones around wetlands and riparian habitats for amphibians and reptiles. - *Conservation Biology*, 17(5): 1219–1228. DOI: 10.1046/j.1523-1739.2003.02177.x

STEEN D.A., J.P. GIBBS, K.A. BUHLMANN, J.L. CARR, B.W. COMPTON, J.D. CONGDON, J.S. DOODY, J.C. GODWIN, K.L. HOLCOMB, D.R. JACKSON, F.J. JANZEN, G. JOHNSON, M.T. JONES, J.T. LAMER, T.A. LANGEN, M.V. PLUMMER, J.W. ROWE, R.A. SAUMURE, J.K. TUCKER, D.S. WILSON. 2012. Terrestrial habitat requirements of nesting freshwater turtles. - *Biological Conservation*, 150(1): 121–128. DOI: 10.1016/j.biocon.2012.03.012

THIENPONT S., A. CADI, R. QUESADA., M. CHEYLAN. 2004. Overwintering habits of the European pond turtle (*Emys orbicularis*) in the Isere department (France). - *Biologia, Bratislava*, 59(Suppl.): 143–147.

ULTSCH G.R. 2006. The ecology of overwintering among turtles: where turtles overwinter and its consequences. - *Biological Reviews*, 81: 339–367. DOI: 10.1017/S1464793106007032

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Sex and Size Structure of Roach (Rutilus rutilus) and Bleak (Alburnus alburnus) Populations in Zhrebchevo Dam

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Abstract. The purpose of the present study is to analyze the sex and size structure of roach (*Rutilus rutilus*) and bleak (*Alburnus alburnus*) populations from carp family (Cyprinidae) in Zhrebchevo Dam. The survey was conducted in February 2013. The main task of the Dam visit was to collect representatives of all fish species active in the season and caught by the fishermen. In order to obtain a representative samples of fish, was taken specimen of each species, fishermen had caught. Were got 26 sexually mature roach (7♂ and 19♀) and 27 sexually mature bleak (12♂ and 15♀). A specific feature of roach sex structure is the bigger number of females (73.08%) than males (26.92%) in the population. In the bleak (*Alburnus alburnus*) population the number of males and females is almost equal with a small predominance of the females (55.55%) over the males (44.45%). The analysis of the size structure of roach and bleak populations inhabiting Zhrebchevo Dam indicates that males are relatively smaller than females and these differences apply with accuracy of ($P \leq 0.001$) for the total body length and with accuracy of ($P \leq 0.01$) for the live weight of the examined fish species. The trend is the same within the bleak population where the differences apply with accuracy of ($P \leq 0.01$) for the total body length and with accuracy of ($P \leq 0.001$) for the live weight. Bleak's yield is 88% which is higher than the one of the roach - 16%.

Key words: population structure, roach, bleak, *Rutilus rutilus*, *Alburnus alburnus*.

Introduction

The carp family (Cyprinidae) is the richest one of freshwater species, inhabiting European water basins (KARAPETKOVA & ZHIVKOV, 2010). Roach and bleak are ones of the most common and widely spread fish species in Europe (BRYLIŃSKA, 2000). They inhabit almost every type of water basin - from large lakes and dams, coastal brackish lagoons and rivers, to micro dams and ballast pits (RACZYŃSKI *et al*., 2008). Within the Republic of Bulgaria they are present in almost every water basin – in the Danube River and the downstream of its tributaries, in the dams: Dospat, Batak, Ovcharitsa, Koprinka, Zhrebchevo and many others.

As a result of the increased fishing activity, the density of the fish populations in the highly exploited water basins could be significantly decreased, could lead to a break into the food chain and even to extinction of some species. That occurs in most of the water basins in Bulgaria, including in the biggest artificial dam in the country – Zhrebchevo, which is not an exception.

The overfishing or the selective fishing of certain species or size (age) groups leave the other species and groups, insufficiently used. With poor management and low control over the fishing activity in the dams, lakes and rivers, some negative changes in

the fish stocks could happen (LEOPOLD & BNIŃSKA, 1987), which will also affect the biological features of the highly exploited fish populations (like the carp family, including roach, bleak, bream and crucian carp).

The growth is one of the most important features of the living creatures. There are many definitions of growth, but still it could be defined as a change or a development of a community or a single organism for a certain time period (GUNEL, 1978). Fishes grow in length and increase their weight by the end of their life. The assessment of their age and growth rate is necessary from theoretical and practical point of view. All studies show that females from Carps family grow faster, than males (WIĘSKI & ZAŁACHOWSKI, 2000).

The purpose of the present study is to analyze the sex and size structure of roach (*Rutilus rutilus*) and bleak (*Alburnus alburnus*) populations from carp family (Cyprinidae) in Zhrebchevo Dam.

Material and Methods

The Zhrebchevo Dam is located in Southeastern Bulgaria and its geographic coordinates are 42° 36′ 56″ N, 25° 51′ 33″. Its surface area is 25 km^2 and the maximum depth is 50.50 m. Its waters have been used as a source of irrigation and as a place for recreation. There are more than 15 freshwater fish species, including roach and bleak.

The survey was conducted in February 2013. The main task of the Dam visit was to collect representatives of all fish species active in the season and caught by the fishermen. During the season observed, because of the wintering, fishes are grouped in some specific areas in the water basins which areas form also the places of sampling. The samples were collected from the farm cages of company "Forest Group" Ltd., the town of Shivachevo, in the "Zhaltata stena" region, near the village of Panicherevo, the municipality of Gurkovo. (Fig. 1).

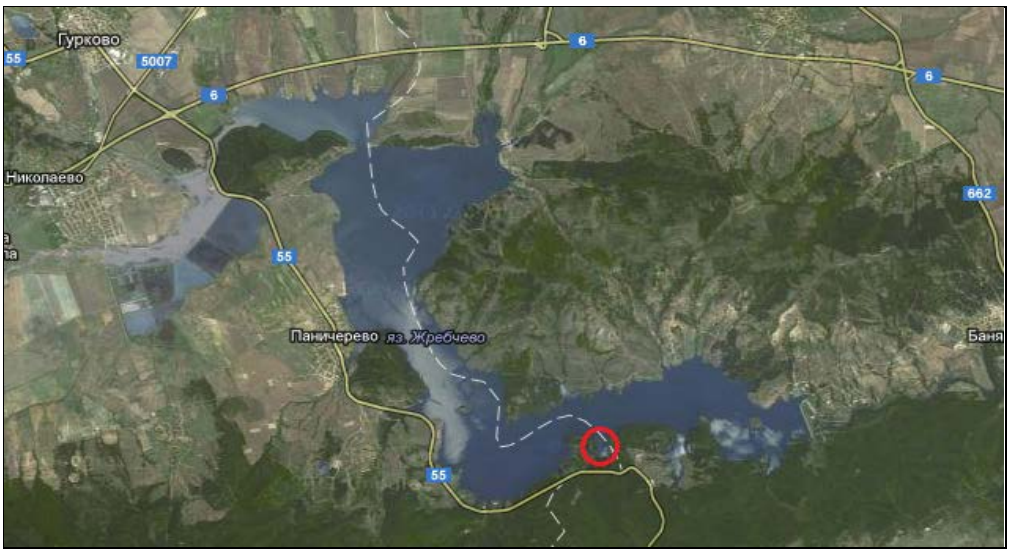

Fig. 1. Map of Zhrebchevo Dam

In order to obtain a representative samples of fish, was taken specimen of each species, fishermen had caught. Were got 26 sexually mature roach (7♂ and 19♀) and 27 sexually mature bleak (12♂ and 15♀). During the collection process, the samples of each species were put in polyethylene bags with labels, indicating the place and date of collection. All collected and labeled samples were transported to the laboratory in a fridge bag, full of ice (GEORGIEV *et al.*, 2003; MATEV & GEORGIEV, 2007).

The sex of the fishes was defined in the lab and the total body length (longitudo totum corporis-L, mm), the standard body length (longitudo corporis-l, mm), the trunk length (T, mm), the head length (longitudo capitis-C, mm), the body height (altitudo

corporis maxima-H, mm), the body width (latitudo corporis-D, mm) and the circumference (O, mm) were measured with accuracy up to 1 mm. The body measurements of the roach and bleak were conducted, according to Pravdin's scheme, proposed in 1966 for measuring of carp species. The live weight of the fishes (W, g) was weighed, using an electronic scale, with accuracy up to 0,1g so was the yield (%). The linear measurements (mm) were carried out, using a measuring board, a triangle and a tape.

The Statistical processing of the data was made, using software Statistica 7 (STATSOFT INC., 2004).

Results and Discussion

A specific feature of the sex structure of roach population, shown on Fig. 2 is the bigger number of females (73.08%), than males (26.92%) in the population. In the bleak (*Alburnus alburnus*) population, the number of males and females is almost equal, with a small predominance of the females (55.55%) over the males (44.45%). The trend in both studied populations supposes an increase, dynamic changes and growth of the number of the respective individuals. The examined sex structures of roach and bleak populations in Zhrebchevo Dam is in compliance with the values, defining the size structure of the roach populations in "Modrac" lake in Bosnia and Herzegovina, obtained by ADROVIC *et al.* (2009).

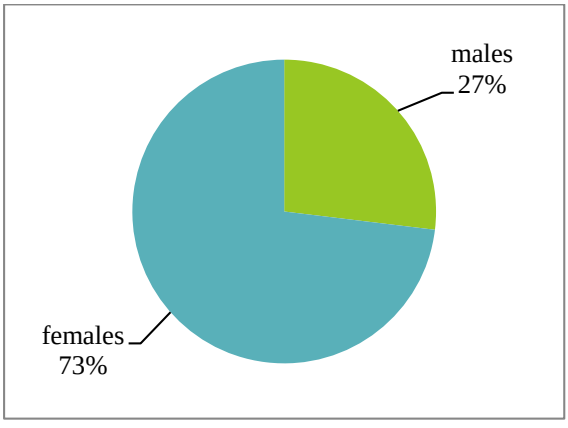

Fig. 2 Sex structure of roach population in Zhrebchevo Dam

The average body measurements of roach (*Rutilus rutilus*) population, inhabiting Zhrebchevo Dam are presented in Table 1. The total body length of the studied roach is 206.90±22.20 mm and the respective values vary between 155-258 mm. The longest body height is 64.20±8.40 mm, with a variation between 45 and 85 mm. The largest body width is 28.00±4.40 mm, where the minimum is 20 mm and the maximum - 38 mm. The average live weight of the roach is 127.15±43.70 g, where the minimum is 44 g and the maximum is 250 g. The yield obtained by the roach population is 72.19±2.85%.

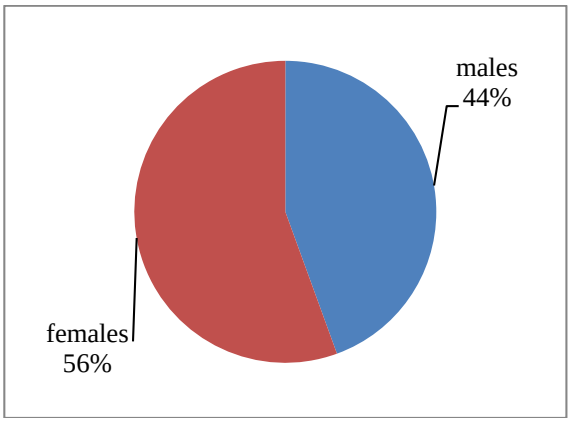

Fig. 3 Sex structure of bleak population in Zhrebchevo Dam

The linear measurements of the males in the roach population are significantly smaller, than those of the females (Table 1). Male's total body length is 16.22% smaller, than the one of the females and these differences apply with accuracy of (P≤0.001). The same is valid for the standard body length, the trunk length, the body height and circumference. Males' live weight is 64.50% lower, but their yield is approximately 4% bigger, than the one of the females with accuracy of (P≤0.01).

The data presented in Table 1 show that the studied body measurements and their average values are within the range, observed also and reported by other authors with no significant deviations. The results of the present study are comparable to those of ADROVIC *et al.* (2009), who studied the roach

population in "Modrac" lake (Bosnia and Herzegovina) and of MARKOVIC *et al.* (1996), who studied the roach population in Western Morava River (Serbia).

Table 1. Body measurements of roach (*Rutilus rutilus*) populations in Zhrebchevo Dam

Parameters	**n**	**Average for population Mean±SD**	**n**	**Males Mean±SD**	**n**	**Females Mean±SD**
Total body length, mm	26	206.90±22.20	7	185.00±19.24	19	215.00±17.49***
Standard body length, mm	26	169.70±18.20	7	151.29±18.24	19	176.47±12.93***
Trunk length, mm	26	87.20±10.00	7	76.00±7.39	19	91.37±7.38***
Head length, mm	26	35.30±3.60	7	32.14±3.58	19	36.42±2.85**
Body height, mm	26	64.20±8.40	7	55.86±6.79	19	67.32±6.77***
Body width, mm	26	28.00±4.50	7	24.57±3.41	19	29.32±4.91*
Circumference, mm	26	142.70±18.70	7	124.4±14.80	19	149.37±15.31***
Live weight, g	26	127.15±43.73	7	86.42±30.88	19	142.16±38.16**
Live weight without scales, internal organs and gills, g	26	91.58±31.34	7	64.85±23.61	19	101.42±28.25**
Yield, %	26	72.19±2.85	7	74.94±2.63	19	71.18±2.24**

*** P≤0.001; ** P≤0.01; * P≤0.05.

The average body measurements of bleak (*Alburnus alburnus*) population, inhabiting Zhrebchevo Dam are presented in Table. 2. Bleak's total body length is 156.60±7.00 mm and the respective values vary between 145-170 mm. The longest body height is 34.80±1.60 mm, with a variation between 30 and 37 mm. The largest body width is 15.40±0.90 mm, where the minimum is 13 mm and the maximum - 17 mm. Bleak's average live weight is 32.63±4.73 g, where the minimum is 23 g and the maximum is 42 g. The yield obtained from bleak's population is 88.00±2.26%.

The differences in the body measurements of bleak's population from Zhrebchevo Dam are relatively smaller, than the ones from the roach population (Table 2), but still males remain smaller, than females. Males' total body length is 5.14% smaller, than the one of the females and the differences apply with accuracy of (P≤0.01). The same is valid for the standard body length and the trunk length. Males' live weight is 18.10% lower with accuracy of (P≤0.001). In view of the yield, males' predominance is not as distinctive as it is in the roach population. It's less than 1%.

Table 2. Body measurements of bleak (*Alburnus alburnus*) population in Zhrebchevo Dam

Parameters	n	Average for population Mean±SD	n	Males Mean±SD	n	Females Mean±SD
Total body lenght, mm	27	156.60±7.00	12	152.25±5.89	15	160.07±5.81**
Standard body length, mm	27	131.00±7.20	12	126.92±6.30	15	134.27±6.33**
Trunk length, mm	27	55.40±4.10	12	52.92±3.18	15	57.47±3.58**
Head length, mm	27	25.70±1.30	12	25.33±0.98	15	26.00±1.41
Body height, mm	27	34.80±1.60	12	34.67±1.61	15	34.93±1.67
Body width, mm	27	15.40±0.90	12	15.00±0.95	15	15.73±0.70*
Circumference, mm	27	75.50±5.20	12	73.17±4.59	15	77.40±4.93*
Live weight, g	27	32.63±4.73	12	29.50±3.61	15	35.13±4.03***
Live weight without scales, internal organs and gills, g	27	28.70±4.20	12	26.08±3.09	15	30.80±3.84**
Yield, %	27	88.00±2.26	12	88.49±1.92	15	87.61±2.49

*** P≤0.001; ** P≤0.01; * P≤0.05.

The results for bleak's total body length and live weight, compared with those of RAIKOVA-PETROVA (2009) (L=130 mm and W=19 g) from the study of the "Chepintsi" ballast pit show that bleak, collected from Zhrebchevo Dam have much bigger size.

The analysis of the size structure of roach and bleak populations, inhabiting Zhrebchevo Dam indicates that males are relatively smaller, than females and these differences apply with accuracy of (P≤0.001) for the total body length and with accuracy of (P≤0.01) for the live weight of the examined fish species. The trend is the same within the bleak population, where the differences apply with accuracy of (P≤0.01) for the total body length and with accuracy of (P≤0.001) for the live weight.

Bleak's yield is 88% which is higher, than the one of the roach - 16%.

Conclusions

A specific feature of roach sex structure is the bigger number of females than males in the population. In the bleak population the number of males and females is almost equal with a small predominance of the females over the males.

The analysis of the size structure of roach and bleak populations inhabiting Zhrebchevo Dam indicates that males are relatively smaller than females.

With regard to the ecological importance of the bleak and roach, which are the main target species of the fishing in Zhrebchevo Dam, especially during the winter and spring season, more attention should be paid to the study of their ecological features. More attention deserves also the meat quality since a significant part of the catches are being consumed. Roach and bleak in Zhrebchevo Dam, just like many other fish species in Bulgaria, have not been studied enough in this aspect.

The further researches should pay more attention to these and other fish species due to their environmental and general features. In order to obtain more accurate information, some additional studies should be performed with a focus on the morphology, nutrition, growth and meat quality of these species.

References

ADROVIC A., R. ŠKRIJELJ, I. SKENDEROVIC. 2009. Ecological Characteristics of the Roach (*Rutilus rutilus* L.) and Bream (*Abramis brama* L.) in the Reservoir of the Lake Modrac. - *Acta Agriculturae Serbica*, XIV(27): 23-33. UDC: 597.551.2+597.556.331.1](497.6)

BRYLIŃSKA M. 2000. *Freshwater Fishes of Poland*. Wyd. Nauk. PWN, Warszawa. (In Polish).

GEORGIEV D., M. KOSTADINOVA, A. GEORGIEV. 2003. Land snails in the transmission of protostrongylids on pastures in Southern Bulgaria: variability of infection levels related to environmental factors. - *Acta Parasitologica*, 48(3):208-217.

GUNEL H. 1978. *In a Tree and Forest Growth and Mathematical Models of Growth*, pp. 141. D.U. Publish No. 2408, Faculty No. 254, Istanbul, Turkey.

KARAPETKOVA M., M. ZHIVKOV. 2010. *The fishes in Bulgaria. „Gea-Libris"* Publishing house – Sofia (In Bulgarian).

KOYUN M., U. KARADAVUT. 2010. Sex-related Growth Performance of Bleak (*Alburnus alburnus*). - *International Journal of Agriculture & Biology*, 12(4):629–631. DOI: 10–013/DJZ/2010/12–4–629–631

LEOPOLD M., M. BNIŃSKA. 1987. Evaluation of angling pressure against the stocks of particular fishes in Poland's waters – consequences for the economy. - *Rocz. Nauk. Rol. H.*, (101) 2: 43–69. (In Polish).

MARKOVIC G., P. SIMONOVIC, S. SIMOVIC. 1996. Linear growth and some ecological characteristics of roach *Rutilus rutilus* (L. 1758) in Zapadna Morava River (Serbia. Yugoslavia). - *Hydrobiologia* Sofia, 40: 81-87.

MATEV I., D. GEORGIEV. 2007. *Ecology and environmental protection.* SD "Kontrast", pp. 57-144.

PRAVDIN I.F. 1966. *Manual for the study of fishes.* Publishing House «Food Industry» Moscow.

RACZYŃSKI M., P. CZERNIEJEWSKI, M. WITKOWSKA, B. KIRIAKA. 2008. Age and growth rate of roach (*Rutilus rutilus* L.) from 3 lakes used for recreational fishing. - *Teka Kom. Ochr. Kszt. Środ. Przyr.* – OL PAN, 5A: 106–116.

RAIKOVA-PETROVA, G., I. LIEV, M. PETROV. 2009. Growth Rate and Fecundity of Bleak (*Alburnus alburnus* L.) in the Sant-Pit Lake Chepintsi (Bulgaria). - *Biotechnology & Biotechnological Equipment*, 23/2009 Se. Special Edition: 212-216. DOI: 10.1080/13102818.2009.10818403

STATSOFT INC. 2004. STATISTICA (data analysis software system), version 7. Available at: [www.statsoft.com]

WIĘSKI K., W. ZAŁACHOWSKI. 2000. Growth of roach *Rutilus rutilus* (L.) in the River Odra estuary. - *Acta Ichthyologica et Piscatoria*, XXX(1): 3-17.

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A Study on the Influence of Sludge WWTP from the Paper Industry on Growth and Development of Zea mays (Poaceae)

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Abstract. The sludge, which is produced from wastewater treatment facilities features concentration of harmful substances, including heavy metals. Therefore, before being used in agriculture, it is necessary to process the sludge in order to meet the requirements of the regulation concerning sludge utilization. The purpose of this study was to explore the possibility of growing corn using sewage sludge from the paper industry. A two-year experiment was performed with „Kneja 613" variety, which was grown in the field and fertilized by WWTP sludge, two standards - 1000 and 1500 kg/dka. The experiment was displayed on alluvial soil near the town of Stamboliyski (Southern Bulgaria). The following properties were monitored: germination, third and fourth leaves growth phase, phase of fifth and sixth leaves growth, stem thickness, number of the cobs and cob length. The results indicate the dependence of the amount of the deposited precipitate. The growth and development of plants grown at fertilization with 1500 kg/dka sludge showed much higher values of biometric properties than the control.

Key words: sludge, WWTP, wastewater, paper industry, corn.

Introduction

Nowadays sludge treatment in the Republic of Bulgaria is mainly carried out through its regulated or sometimes unregulated disposal. The sludge always brings risks for the environment and human's health when relevant measures for sludge dewatering, stabilizing, storage and/or utilization are not taken (MOEW, 2011). Sewage sludge (biosolids) is a by-product of the treatment of municipal wastewater. As a result of the implementation in 2005 of the Urban Waste Water Treatment Directive 91/271/EEC, the generation of sewage sludge has increased significantly. In Europe, the total amount of sludge generated by urban waste water treatment plants has increased from 5.5 million (1992) to 10 million tons dry matter in 2007 (CARBONELL *et al.*, 2009).

The sludge itself can be valuable organic supplementary reserve, which can find a wide application in agriculture for improving soil qualities and land reclamation as well. However, the sludge, which is produced from wastewater treatment facilities, features concentration of harmful substances, including heavy metals. Therefore, before being used in agriculture, it is necessary to process the sludge in order to meet the requirements of the regulation concerning sludge utilization.

The objective of this study was to analyze the possibilities for corn farming helped with sludge of the paper industry.

Material and Methods

A two-year experiment was performed with „Kneja 613" variety, which was grown in the field and fertilized by waste water treatment plant (WWTP) sludge. The used sludge quantities were decided after careful examination of the Bulgarian Regulation for Sludge Treatment and Methods of Utilization in Farming, approved with Ministerial Order 339/12.14.2004 (BAFS, 2004).

The sludge analysis was carried out in the laboratory of the Executive Environment Agency (ExEA) in the city of Plovdiv, Bulgaria. The experiment was executed in two variants, four times each, with a test sample in alluvial soils. Twelve test fields of 50 m², with a distance of 50 cm between them were used. Before the corn sowing the soil was prepared. It was ploughed deeply and harrowed.

Variants:

- Variant I - Control (without use of sludge)
- Variant II - 1000 kg/dka sludge
- Variant III - 1500 kg/dka sludge

Second harrowing was carried out after the sludge was implemented in to the soil. The test fields ware arranged in rows with a 75 cm distance between them. Two corn kernels were planted at a depth of 6-8 cm at every 20 cm along the rows. The following properties were monitored: germination, third and fourth leaves growth phase, phase of fifth and sixth leaves growth, stem thickness, number of the cobs and cob length. The plants were earthed up twice and watered seven times during the vegetation period. The experimental soil was put to analysis in the Agricultural Chemistry and Soil Science Department at Agricultural University of Plovdiv. The following analysis methods were applied to it:

- Mechanical composition analysis by means of FRITISH vibratory sieve shaker
- pH in H_2O – potentiometric ph measurement
- Humus content by the method of Turin
- K - determined in salty acid-based extraction of 2n HCL
- Movable phosphates were determined by Egner-Riem method (DL-method)
- Ammonium and nitrate N in an extract of 1% KCL
- Determining carbonate concentration level by Schibler

Results and Discussion

The results on the chemical analysis of the activated WWTP sludge are presented in Table 1.

Table 1. Results on the hemical analysis of the activated WWTP sludge.

Parameter	Value	Permissible values
pH	8.07	>7.4
Organic substance	71.69%	-
Solid substance	42.58%	-
Escherichia coli	0.1 g	> 1 g
Salmonella spp.	not available	not allowed in 20 g
Clostridium perfringens	0.001 g	> 1 g
Cd	0.46 mg/kg solid substance	30.00 mg/kg solid substance
Cu	1.6 mg/kg solid substance	1600.00 mg/kg solid substance
Ni	6.13 mg/kg solid substance	350.00 mg/kg solid substance
Pb	6.15 mg/kg solid substance	800.00 mg/kg solid substance
Zn	50 mg/kg solid substance	3000.00 mg/kg solid substance
Hg	0.05 mg/kg solid substance	16.00 mg/kg solid substance
Cr	7.46 mg/kg solid substance	500.00 mg/kg solid substance
As	< 0.05 mg/kg solid substance	25.00 mg/kg solid substance
Nitrogen /common form/	11.38 mg/kg solid substance	-
P /P_2O_5/	1 mg/kg solid substance	-
K /common form K_2O/	340 mg/kg solid substance	-
polycyclic aromatic hydrocarbons	< 0.01 mg/kg solid substance	6.20 mg/kg solid substance
Polybrominated biphenyls	< 0.005 mg/kg solid substance	1.0 mg/kg solid substance

The analysis prove that the values did not exceed the regulated permissible values; moreover they were far below them. According to LOGAN *et al.* (1997) the high content of organic matter and substantial N and P concentrations suggest that the sludge can be used as a fertilizer in agriculture or as a regenerator for soil. In fact, decomposition of organic manures produces some organic acids such as fulvic, humic and carbonic acid, which lead to solubilize soil nutrients and increase their availability and supply for plant uptake (DAHDOH & EL-HASSANIN, 1993).

Table 2 presents the results on the physical and chemical analysis on the soil for discharge of the first and second year.

During the second year an increase of the macro elements content in the soil was observed. This increase was probably due to the introduced activated sludge. Many studies have demonstrated the positive effect that sewage sludge or sludge compost application has on corn, as well as other forage yields and soils (CATROUX *et al.*, 1981; HORNICK *et al.*, 1984; DAVIS *et al.*, 1985; WARMAN, 1986; TIFFANY *et al.*, 2000**)**. During the corn farming the germination was registered on the 5th day after the corn planting.

Table 3 presents the number of the germinated corn kernels for the two years test period. The results in the table show that Variant III had most germinated corn kernels, followed by Variant II. The least number of germinated corn kernels showed the test sample.

The increased number of germinated seeds show the positive effects of the offered sludge amounts. As stated by (HORNICK *et al.*, 1984) in their study the higher values in the second year are associated with nutrients accumulation in the soil. In addition, as the sludge tend to absorb more moisture from the soil, the corn kernels, which were planted in the test fields containing more sludge germinated faster.

The 3rd and 4th leaf growth phase results on the 15th day after the kernel planting are presented in Table 4. On the 20th day after the kernel planting an observation on the average growth phase of the plants and their height was carried out (Table 5).

Table 2. Results on the physical and chemical analysis of the soil.

Soil type	Moisture %	Humus %	Nitrogen /common form/ %	$CaCO_3$, %	pH in H_2O	Depth, sm	Nitrogen /mineral form/ $NH_4 + NO_3$ mg/kg	P_2O_3 mg/100g	K_2O mg/100 g
Alluvial meadow soil - 1st year	4.48	1.7	0.25	7.48	7.8	A_I 0 - 10	13.4	12.4	26
Alluvial meadow soil - 2nd year	5.12	1.9	0.30	7.37	7.9	A_I 0 - 10	14.2	12.6	27.1

Table 3. Results on germinated corn kernels.

Variant	% germinated corn kernels		% compared to the test sample	
	1st year	2nd year	1st year	2nd year
Variant I	60	85	100	100
Variant II	80	98	134	112
Variant III	95	100	158	118

The results show that the corn planted in the test sample soil was in the 4th leaf growth phase. During the first year 20% of the corn plants of Variant II were in the 5th leaf growth phase. During the second year of the experiment, the percentage of the corn plants in the 5th leaf growth rose with 10. Variant III had highest percentage of plants in the phase of 5th-6th leaf growth - 55% in the first year and 60% in the second year, respectively. Upon the sludge implementation the plants' growth was faster in both years. In Variant III for both years the emergence of 5th - 6th leaf considerably exceeded the phase of 3rd - 4th leaf. The results for the plant growth observed on the 30th day were relative to the ones for the phase of germination. Illustrative are the results of the second year – the increase in Variant II is with 1.6 cm and in Variant III – with 3.9 cm compared with the control.

After the corn harvests, carried out on 31.08.2013 and on 20.09.2014, the following results were obtained - stem height, stem thickness, cob length, number of cobs. Figure 1 shows that the parameters for plant growth of Variant III are much better than the parameters of the test sample variant.

From the results on the average stem height it is notable that the highest plants were from Variant III. The growth for the first year was with 20 cm more and for the second – with 25 cm, respectively. The results on the stem thickness also show the same trend. Once again the highest values are reported in Variant III during the first and second year. After harvesting the cob growth was determined. Similarly, the registered growth was bigger in Variant III compared with the control – 6 cm for the second year. In terms of the average number of cobs the increase was with 0.5 numbers for Variant II during both years. For Variant II this number increased with 0.5 for the first year and with 1 for the second, respectively. In economic point of view, the number of cobs of a single corn plant is the most important parameter. According to FERNANDEZ-LUQUENO *et al*. (2009) the increasing mass of straw in the second year is comparable to the first year as a result of the already high supply of N; when water supply is adequate, high levels of N can over-stimulate plant growth, and thus biomass accumulation.

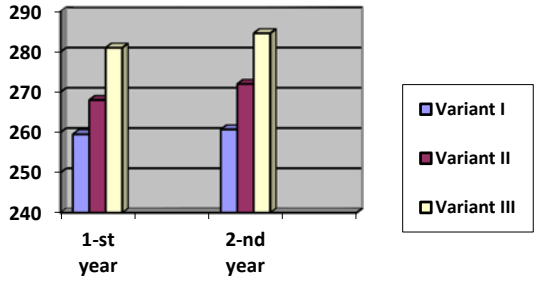
Overall, the present study does not include results on the harvest data. Therefore, further research in this particular area should be carried out in order to get better data on the possibilities to use paper industry sludge in agriculture.

Table 4. Results on the third and fourth leaf growth phase - the 15th day after the kernel planting.

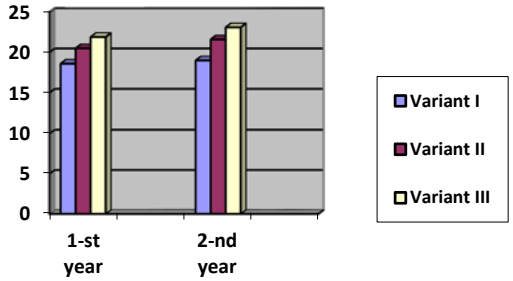
Variant	% plants third and fourth leaf growth phase	
	1st year	2nd year
Variant I	90	87
Variant II	95	98
Variant III	100	100

Table 5. Results on the prevailing development phase.

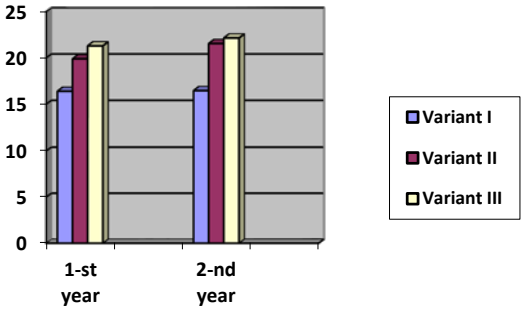
Variant	% prevailing growth phase		Plant height (cm)	
	1st year	2nd year	1st year	2nd year
Variant I	100% - 3rd —4th leaf	100% - 3rd —4th leaf	28.10	28.75
Variant II	80% - 3rd —4th leaf 20% - 5th —6th leaf	70% - 3rd —4th leaf 30% - 5th —6th leaf	29.55	30.35
Variant III	45% - 3rd —4th leaf 55% - 5th —6th leaf	40% - 3rd —4th leaf 60% - 5th —6th leaf	31.65	32.65



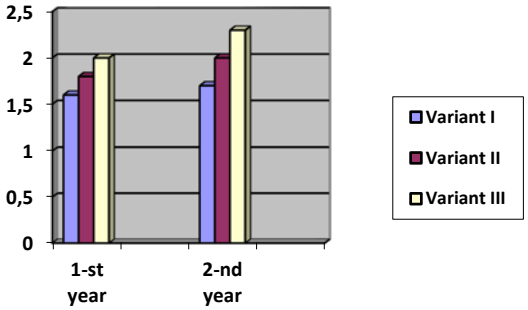
a. Stem height /cm/



b. Stem thickness /mm/



c. Cob length /cm/



d. Number of cobs

Fig. 1 (a, b, c, d). Plant biometrical parameters.

Conclusions

On the ground of the obtained results of the agricultural experiment carried out with „Kneja 613" variety, grown in the field and fertilized by WWTP paper industry sludge, we can conclude:

1. It was confirmed for the first time the opportunity of corn farming in fields fertilized by sludge produced by paper industry wastewater plant.
2. It was found out that the corn fertilized with 1500 kg/dka sludge grew faster.
3. The plants grown in the soil treated with higher sludge content had faster growth and development.
4. Under these conditions the plants were higher with thicker stems, cob length and number.

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References

BAFS. 2004. Regulation for sludge treatment and methods of utilization in farming, Issue 112/12.23.2004. Bulgarian Agency on Food Safety, Sofia. Available at: [babh.government.bg] (In Bulgarian)

CARBONELL G., J. PRO, N. GOMEZ, M.M. BABIN, C. FERNANDEZ, E. ALONSO, J.V. TARAZONA. 2009. Sewage sludge applied to agricultural soil: ecotoxicological effects on representative soil organisms. – *Ecotoxicology and Environmental Safety*, 72: 1309–1319. DOI:10.1016/j.ecoenv.2009.01.007

CATROUX G., P. L'HERMITE, E. SUESS. 1981. *The Influence of Sewage Sludge Application on Physical and Biological Properties of Soils*. D. Reidel Publishing Company, Boston, MA.

DAHDOH M.S.A., A.S. EL-HASSANIN. 1993. Combined effects of organic source, irrigation water salinity and moisture level on the growth and mineral composition of barley grown on calcareous soil. - *Desert Institute Bulletin*, 43: 123–138.

DAVIS R.D., H. HAENI, P. L'HERMITE. 1985. *Factors Influencing Sludge Utilization Practices in Europe*. Elsevier Applied Science Publishers, London.

FERNANDEZ-LUQUENO F., V. REYES-VARELA, C. MARTINEZ-SUAREZ, G. SALOMON-HERNANDEZ, J. YANEZ-MENESES, J.M. CEBALLOS-RAMIREZ, L. DENDOOVEN. 2009. Effect of different nitrogen sources on plant characteristics and yield of common bean (*Phaseolus vulgaris* L.). - *Bioresource Technology* 101: 396–403. DOI:10.1016/j.biortech.2009.07.058

HORNICK S.B., L.J. SIKORA, S.B. STERRETT, J.J. MURRAY, P.D. MILNER, W.D. BINGE, D. COLACICCO, J.F. PARR, R.L. CHANEY, G.B. WILLSON. 1984. Utilization of sewage sludge compost as a soil conditioner and fertilizer for plant growth. - In: *USDA ARS, Ag Info. Bull. No. 464. US Government, Printing Office,* Washington, DC, p. 32.

LOGAN T.J., B.J.LINDSAY, L.E. GOINS & J.A. RYAN. 1997. Field assessment of sludge metal bioavailability to crops: Sludge rate response. - *Journal of Environmental Quality* 26(2): 534-550. DOI:10.2134/jeq1997.00472425002600020027x

MOEW. 2011. Report of the expert group on the WWTP sludge treatment. Ministry of Environment and Waters, Sofia. Available at: [moew.government.bg] (In Bulgarian)

TIFFANY M.E., L.R. MCDOWELL, G.A. O'CONNOR, H. NGUYEN, F.G. MARTIN, N.S. WILKINSON, E.C. CARDOSO. 2000. Effects of pasture applied biosolids on forage and soil concentrations over a grazing season in North Florida. 1. Macrominerals, crude protein, and in vitro digestibility. - *Communications in Soil Science and Plant Analysis* 31: 201–213. DOI:10.1080/00103620009370430

WARMAN P.R. 1986. Effects of fertilizer, pig manure, and sewage sludge on timothy and soils. - *Journal of Environment Quality* 15: 95–100. DOI:10.2134/jeq1986.00472425001500020001x

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Zinc Biosorption by Waste Streptomyces fradiae Biomass: Equilibrium and Kinetics

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Abstract. Waste *Streptomyces fradiae* biomass from pharmaceutical industry was successfully used for Zn(II) removal from aqueous solutions. In the present study process parameters (initial pH of the solution, amount of biomass, initial metal concentration, stirring speed and contact time) and their influence on Zn(II) biosorption were investigated and optimized. Langmuir and Freundlich adsorption isotherms were used to describe sorption behavior between the waste biomass and the Zn ions. The biosorption process was better described by the Langmuir adsorption isotherm with 61.09 mg g^{-1} maximum adsorption capacity. Lagergren and Ho models were used to analyze the kinetic data. Ho model fitted better to the experimental results.

Key words: *Streptomyces fradiae,* biosorption, zinc, waste biomass, adsorption isotherms.

Introduction

Biosorption is an innovative technology for removal and separation of heavy metals from aqueous solutions. The search of low-cost sorbents for heavy metals is still an aim for the modern science. Microbial biomasses from industrial biotechnologies for production of different bioproducts, in particular antibiotics, are cheap and abundant byproduct that can be used as sorbent for heavy metal removal from wastewaters. By application of dead microbial mycelium for wastewater treatments two ecological problems can be solved. From one point of view the disposal of large amounts of waste biomasses is eliminated or decreased to a minimum. From another point of view a new and economically effective technology for purification of industrial waters contaminated with heavy metals is developed.

The biosorption is considered as an inexpensive and effective alternative to known technologies for heavy metal removal from wastewaters that offers some advantages, over traditional methods for metal removal, like low cost of the biosorbents, high-efficiency, no nutrient need, sludge minimization, regeneration of the biosorbents and the possibility for metal recovery (MACEK & MACKKOVA, 2011; ABBAS & SWADI, 2013). The biosrption is also a rapid process – in order of seconds or minutes (ATKINSON *et al.*, 1998).

Zinc is an essential microelement that takes part in different metalloenzymes, but

in higher concentrations it can become toxic to humans and can give rise to serious poisoning cases. It is also on Environmental Protection Agency's list of priority pollutants (US EPA, 2009). The amount of Zn(II) in the drinking water should not exceed 3 mg dm^{-3} (WHO, 2008).

In the recent years many new biosorbents for Zn(II) removal were studied from agricultural wastes like rice husk (VIEIRA *et al.*, 2012) and sawdust (SHUKLA & PAI, 2005; MISHRA & TADEPALLI, 2014) to microorganisms like bacteria (MAMERI *et al.*, 1999; ÖZDEMIR *et al.*, 2009), algae (ZHOU *et al.*, 2011) fungi (DHANKHAR & HOODA, 2011) and yeast (HAMZA *et al.*, 2010).

Waste *Streptomyces fradiae* biomass obtained from tylosine production is a by-product that can be used as a low cost sorbent for Zn(II) removal from dilute aqueous solutions. *Streptomyces fradiae* is a gram-positive bacterium. The gram-positive bacteria are considered as sorbents with higher metal binding capacity than the gram-negative, owing to their different composition of the cell wall (GOURDON *et al.*, 1990; TARANGINI & SATPATH, 2009; NAJA & VOLESKY, 2011). The waste biomass may have some disadvantages, such as: the quality of the product might be variable and raw biomass may contain residual chemicals that could influence metal binding (NAJA & VOLESKY, 2011).

The aim of present study was to evaluate Zn(II) removal potential of caustic treated waste *Streptomyces fradiae* biomass. Influence of different parameters (pH, biomass amount, initial metal concentration, stirring speed and contact time) on the biosorption capacity was investigated. Langmuir and Freundlich adsorption isotherms were used to describe the biosorption equilibrium and pseudo-first and pseudo-second order equations were used to analyze the kinetic data.

Materials and Methods

Preparation of biosorbent and working solutions. For enhance biosorption performance the waste Streptomyces fradiae biomass was treated with 1M NaOH. The preparation of the biosorbent is described in our previous work (KIROVA et al., 2012). All working solutions were prepared daily from 1000 mg dm^{-3} Zn(II) stock solution prepared from $Zn(NO_3)_2.6H_2O$ (Merck). The desired pH of the working solutions was made with an appropriate amount of 0.1 M HNO_3 or 0.1 M NaOH.

Biosorption experiments

The biosorption was carried out in Erlenmeyer flasks containing 100 cm^3 of the metal solution with desired concentration, pH, amount of biosorbent, temperature, stirring speed. After the biosorption process, the biosorbent was separated from the solution by centrifugation. The remaining concentration of the metal ions in the solution was determined with PAR (5.10^{-3} mol dm^{-3}) as described by BARNARD & FKASHKA (1972). To calculate the metal uptake equation 1 was used.

$$q = \frac{(C_i - C_f)\,V}{W} \qquad (1)$$

where, C_i and C_f – initial and final metal concentration, mg dm^{-3}; V – volume of the solution, dm^3; W – amount of biosorbent, mg; q – metal uptake, mg g^{-1}.

The removal of the metal ions was found using equation 2.

$$R = \left[\frac{(C_o - C_f)}{C_o}\right].100,\% \qquad (2)$$

Influence of pH. The impact of the initial pH of the solution on the biosorption process was examined in the pH range from 2.0 to 6.0 at other optimal process conditions.

Influence of biomass concentration. The influence of the amount of biomass on the biosorption process was studied from 0.5 to 4 g dm^{-3} at pH 5.0, 50 mg dm^{-3} initial metal concentration, 300 rpm agitation speed and 120 min of contact time.

Influence of initial metal concentration. At pH 5.0, a biomass concentration of 1 g dm^{-3}, 300 rpm and 120 min of contact time the influence of the initial concentration on the metal uptake was examined. The concentration of the metal ion was varied from 10 to 200 mg dm^{-3}.

Influence of stirring speed. At optimal process conditions the effect of stirring speed on the biosorption process was studied. The stirring speed was varied from 50 to 350 rpm.

Influence of contact time. The influence of the contact time on the biosorption equilibrium and metal uptake was also examined. The initial concentrations of the Zn(II) were 25, 50 and 100 mg dm^{-3}. The amount of biomass was 1 g dm^{-3}, initial pH 5.0 of solutions and a stirring speed of 300 rpm. The experiments were carried out for different time intervals and the remaining concentrations of Zn(II) were determined.

Biosorption isotherms

For description of the biosorption process Langmuir and Freundlich adsorption isotherms were used. The biosorption of the Zn(II) ions was carried out in solutions with varying initial metal concentrations from 10 to 200 mg dm^{-3}. The experimental results were analyzed with the linearized forms of the Langmuir (equation 3) and Freundlich (equation 4) adsorption isotherms (VOLESKY, 2004):

$$\frac{C_e}{q_e} = \left(\frac{1}{q_m}\right) C_e + \left(\frac{1}{q_m b}\right) \qquad (3)$$

$$lg\, q_e = lg\, K_F + \left(\frac{1}{n}\right) lg C_e \qquad (4)$$

where: C_e – equilibrium metal concentration, mg dm^{-3}; q_e – equilibrium metal uptake, mg g^{-1}.

The maximum biosorption capacity q_m (mg g^{-1}) and Langmuir's constant b (dm^3 mg^{-1}) were determined from the linear plot of equation 3, obtained by plotting C_e / q_e versus C_e.

K_F – empiric constant linked to the maximum biosorption capacity (mg g^{-1} (mg $dm^{-3})^{-1/n}$), and n – constant related with the affinity between biosorbent and metal ions were determined from the linear relationship of lg q_e versus lg C_e from equation (4).

Kinetic modeling

The linear form of the Lagergren equation (WANG & CHEN, 2009) was presented as:

$$lg\,(q_e - q_t) = lg\, q_e - \left(\frac{k_1}{2{,}303}\right) t \qquad (5)$$

where, q_e and q_t – biosorption capacity at equilibrium and in the moment of time t (mg g^{-1}); k_1 – rate constant for pseudo-first order reactions (min^{-1}).

The linear form of the Ho equation (WANG & CHEN, 2009) was presented as:

$$\frac{t}{q_t} = \left(\frac{1}{k_2 q_e^2}\right) + \left(\frac{1}{q_e}\right) t \qquad (6)$$

where, k_2 is the pseudo-second order rate constant (g $mg^{-1}min^{-1}$).

From equations 5 and 6 the metal uptake at equilibrium and the kinetic constants of the process were found.

Results and Discussion

Influence of pH

The pH of the solutions plays a major role in the biosorption process. The charge of metal ions in the solution and the availability of active sites for heavy metals attraction onto the surface of biosobent depends mainly onto pH of the working solution. With the increasing of the pH from 2.0 to 6.0 the metal uptake and removal also increased (Fig. 1).

The low removal and uptake at pH 2.0 could be explained with the competition between the protons and the metal cations in solution for the adsorption sites on the biomass surface. The FTIR of the chemically treated biomass confirmed the presence of free hydroxyl and carboxyl groups on the surface of the biosorbent (KIROVA et al., 2012). When deprotonated carboxyl and hydroxyl groups are negatively charged and can bind positively charged zinc ions. With the increasing of the pH of the solution more functional groups on the cell wall are deprotonated and therefore provide more negatively charged groups for the Zn(II) biosorption (MAMERI *et al.*, 1999; KUJAN *et al.*, 2005; SAHMOUNE & LOUHAB, 2010). All further experiments were conducted at pH 5.

Influence of biomass concentration

The amount of the biosorbent also influenced the metal uptake and removal of

the metal ions. With the increasing of the amount of the biosorbent, the number of the available sites for biosorption also increases, but the metal uptake per gram of biomass decrease (ESPOSITO *et al.*, 2001). With the increasing of the biomass dosage from 0.5 to 4.0 g dm^{-3} the metal uptake decreased from 50.32 to 6.79 mg g^{-1} (Fig. 2).

When the concentrations of the sorbent are too high it is impossible for metal ions to bind to all available active sites and that leads to low metal uptake (GADD *et al.*, 1988). The agglomeration of the biosorbent particles which decreased the contact surface and the active sites could explain the low metal uptake. Similar conclusions were made (SELATNIA *et al.* 2004a, 2004b) when other waste *Streptomyces* biomasses are used as biosorbents for metal ions.

Influence of initial metal concentration

To study the influence of the initial concentration on the biosorption performance the initial metal concentrations of the solutions were raised from 10 to 200 mg dm^{-3}. The obtained results are shown in Fig. 3.

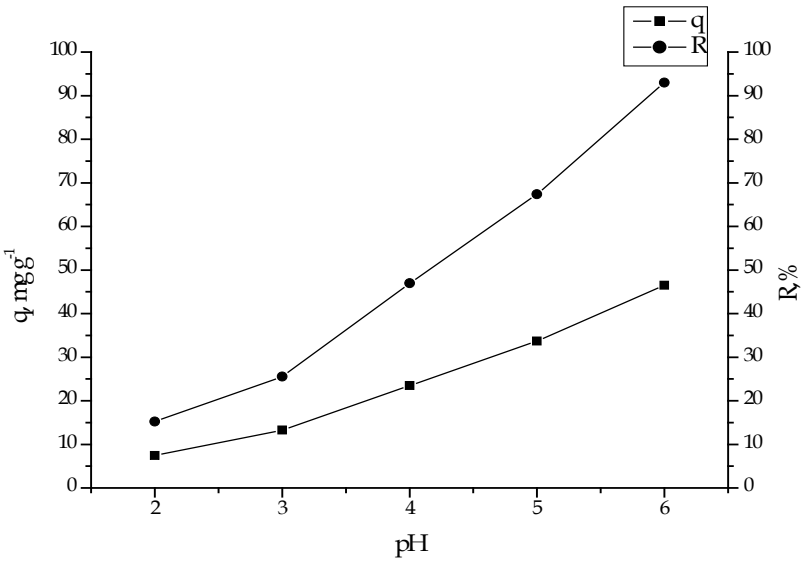

Fig. 1. Influence of pH on Zn(II) metal uptake and removal by waste *Streptomyces fradiae* biomass

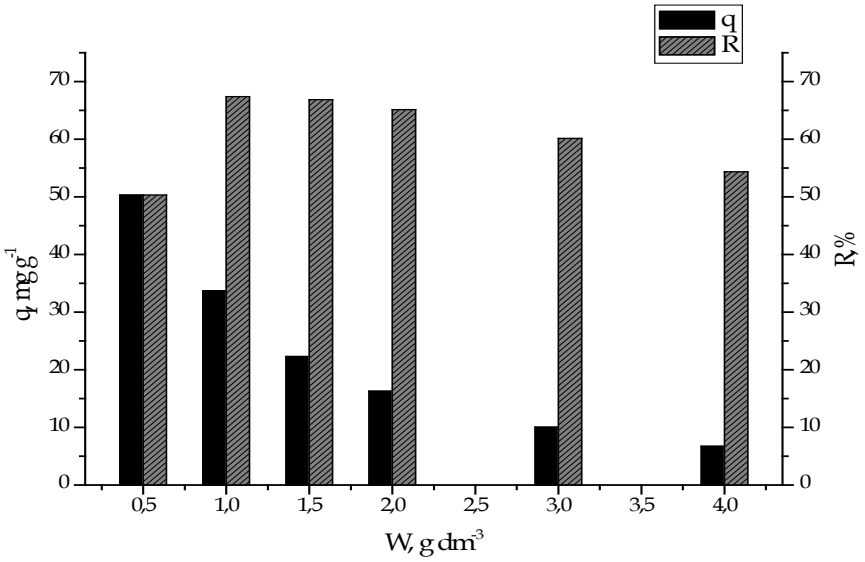

Fig. 2. Influence of the biomass concentration on Zn(II) uptake

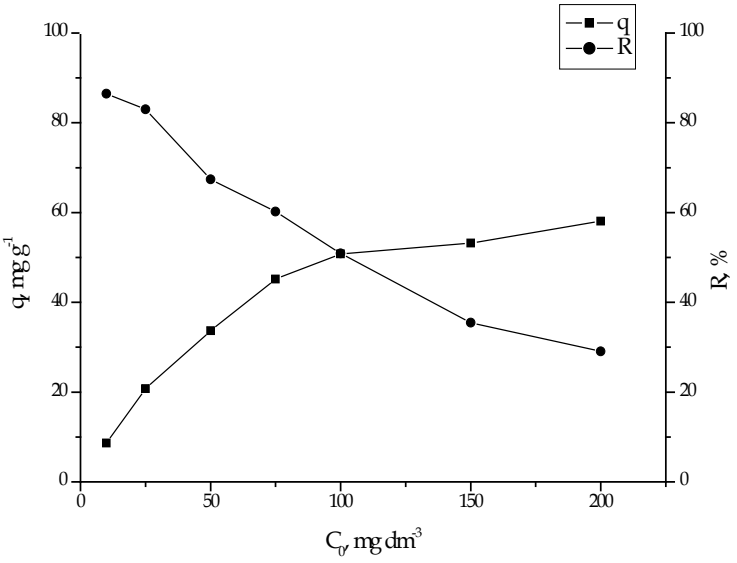

Fig. 3. Influence of the initial metal concentration on Zn(II) uptake and removal efficiency

With the increasing of the concentration of the metal ion from 10 to 75 mg dm^{-3} the metal uptake also increased from 8.65 to 45.15 mg g^{-1} and a plateau occurred. The removal of the metal ions varied from 86.5 to 29.05%. Different researchers have been examined the biosorption capacity of waste *Streptomyces rimosus* biomass chemically modified with NaOH for Zn(II) removal (MAMERI *et al.*, 1999), Pb(II) (SELATNIA *et al.*, 2004b), Cr(III) (SAHMOUNE & LOUHAB, 2010) with varying initial concentrations from 25 to 300 mg dm^{-3}. Due to different process parameters it is hard to compare the data but it is seen that with the increasing of the initial metal concentrations the metal uptake for gram biomass increase but the removal decrease.

Influence of stirring speed

The stirring speed also influenced the biosorption process (Fig. 4).

Agitation speed takes part in the contact between the metal ions and the biomass and influences the mass transfer in system sorbent-sorbat. Higher metal uptake of 33.69 mg g^{-1} and recovery of 67.38% were at 300 rpm. SELATNIA *et al.*, (2004b) explained the lower metal uptake at higher agitation speeds with the non-homogeneity of the sorbent-sorbat system as a result of vortex phenomena.

Influence of contact time

The time needed for equilibrium to be reached was analyzed with series of experiments. Fig. 5 shows that the biosorption of Zn(II) consists of two phases: a primary rapid one and a secondary slower phase. The Zn(II) uptake is rapid for the first 10 – 15 min of the biosorption process. When the initial concentrations were 25 mg dm^{-3} and 50 mg dm^{-3} equilibrium was reached for 40 min. After 60 min of contact time equilibrium was reached for all of the concentrations.

When the initial concentrations of metal ions are low there is abundance of free metal binding sites on the surface of the biosorbent and less metal ions in the solution to bind to them. The result is higher speed of the biosorption process. At higher metal concentrations the competition between metal ions for sorption sites decreased the biosorption speed. Similar results were reported by BAL *et al.* (2004). The biosorption of metal ions by *Streptomyces* species is a rapid process and equilibrium is reached from 20 to 180 min (MAMERI *et al.*, 1999; SELATNIA *et al.*, 2004b; KUJAN *et al.*, 2005; SAHMOUNE & LOUHAB, 2010).

Adsorpetion isotherms

For better understanding of the biosorption process and to describe the

affinity between the metal ions and the waste biomass Langmuir and Freundlich adsorption models were used. The Langmuir adsorption isotherm suggests monolayer adsorption with fixed number of adsorption sites, in which the active sites on the surface on the biosorbent reacts with one molecule of the sorbat and once the active sites have been taken they don't react further. The Freundlich isotherm model describes biosorption on heterogeneous surface. The obtained constants and regression coefficients (Table 1), obtained from the linear plots of equations 3 and 4, had shown that the biosorption of Zn(II) by waste *Streptomyces fradiae* biomass was better described by the Langmuir adsorption isotherm.

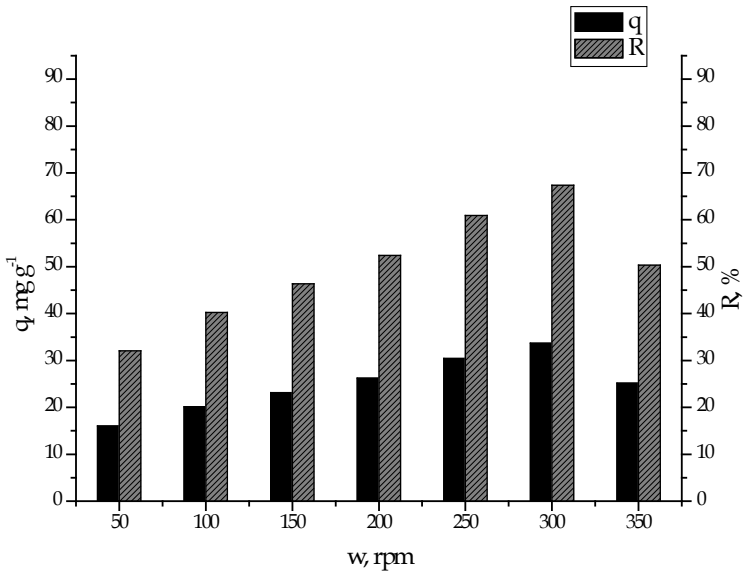

Fig. 4. Influence of stirring speed on Zn(II) uptake

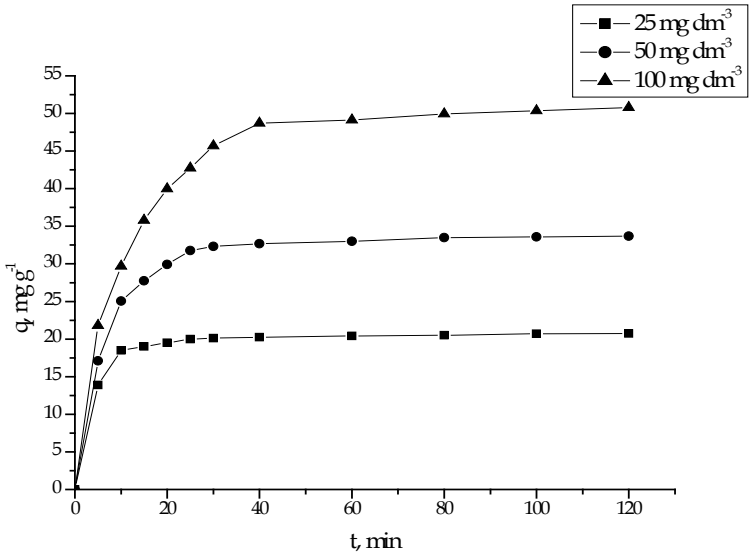

Fig. 5. Influence of contact time on Zn(II) biosorption

Table 1. Langmuir and Freundlich constants and correlation coefficients for Zn(II) biosorption by waste *Streptomyces fradiae* biomass

Langmuir model			Freundlich model		
q_{max}, mg g^{-1}	b, dm^3 mg^{-1}	R^2	K_F, mg g^{-1} (mg $dm^{-3})^{-1/n}$	n	R^2
61,09	0.097	0,999	9,91	2,56	0,965

LI *et al.* (2010) examined the biosorption capacity of living and dead *Streptomyces ciscaucasicus* CCNWHX 72-14 biomass for Zn(II) biosorption from aqueous solution and they also stated that the Langmuir model describes better the biosorpton process with maximum biosorption capacity of 42.75 mg g^{-1} for the living and 54 mg g^{-1} for the dead sorbents.

Kinetic modeling

The kinetic of the biosorption process was described by the pseudo-first order and pseudo-second order kinetic models of Lagergren and Ho. The Lagergren kinetic model (Fig. 8) is applicable for the first 20 – 30 min (rapid phase) of the biosorption process as the Ho model (Fig. 9) is suited for the whole range of contact time.

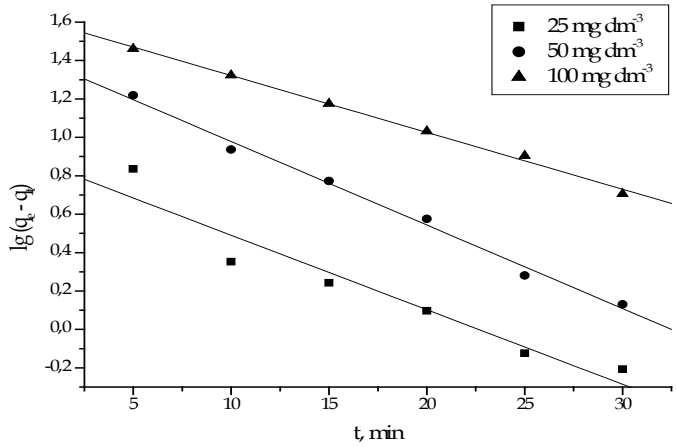

Fig. 8. Linear plot of Lagergren pseudo-first order kinetic model

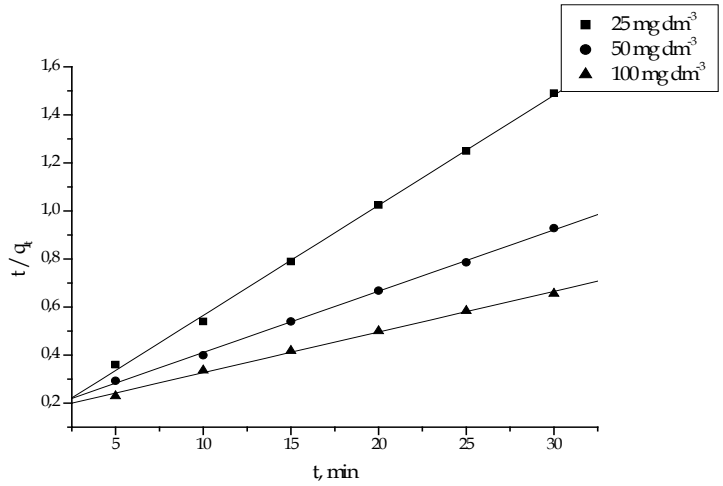

Fig. 9. Linear plot of Ho pseudo-second order kinetic model

Table 2. Pseudo-first and pseudo-second order kinetic parameters obtained for Zn(II) biosorption by waste *Streptomyces fradiae* biomass

Zn(II), mg dm^{-3}	$q_{(exp)}$, mg g^{-1}	Pseudo-first order			Pseudo-second order		
		k_1, min^{-1}	$q_{(model)}$, mg g^{-1}	R^2	k_2, g mg^{-1} min^{-1}	$q_{(model)}$, mg g^{-1}	R^2
25	20.75	$8.93.10^{-2}$	7.56	0.962	$1,91.10^{-2}$	21,97	0.999
50	33.68	$1.01.10^{-1}$	25.89	0.966	$4,17.10^{-3}$	39,20	0.999
100	50.77	$6.82.10^{-2}$	41.49	0.998	$1,82.10^{-3}$	59,98	0.998

The obtained constants, sorption capacities and correlation coefficients are shown in Table 2. As seen from the rable there is a good correlation between the experimental results and the kinetic data and the Ho kinetic model for pseudo-second order reaction fited better to the experimental results.

Conclusions

Based on the obtained results the following conclusions could be made:

Caustic treated waste *Streptomyces fradiae* biomass from tylosin production was found to be suitable and promising sorbent for Zn(II) removal from aqueous solutions with 61.09 mg g^{-1} maximum adsorption capacity, found by the Langmuir adsorption isotherm.

The kinetic data fitted well with the kinetic model for pseudo-second order reactions. The biosorption of the metal ion by the waste chemically treated sorbent is a rapid process.

References

ABBAS H.S., H.L. SWADI. 2013. Performance of adsorption/biosorption for removal of organic and inorganic pollutants. - *Journal of Chemical and Pharmaceutical Research*, 5(12):1168-1178.

ATKINSON B.W., F. BUX, H.C. KASAN. 1998. Considerations for application of biosorption technology to remediate metal-contaminated industrial effluents. - *Water SA*, 24(2):133.

BAL Y., K.E. BAL, A. LALLAM. 2004. Removal of Bi(III) and Zn(II) by nonliving *Streptomyces rimosus* biomass from nitric solutions. - *European Journal of Mineral Processing and Environmental Protection*, 3(1):42-48.

BARNARD A.J., H.A. FKASHKA. 1972. *Chelates in Analytical Chemistry*. Vol. IV. New York. Marcel Deckker Inc.

DHANKHAR R., A. HOODA. 2011. Fungal biosorption – an alternative to meet challenges of heavy metal pollution in aqueus solutions. - *Environmental Technology*, 32(5):467-491. DOI: 10.1080/09593330.2011.572922

ESPOSITO A, F. PAGNANELLI, A. LODI, C. SOLISIO, F. VEGLIÒ. 2001. Biosorption of heavy metals by *Sphaerotilus natans*: an equilibrium study at different pH and biomass concentrations. - *Hydrometallurgy*, 60(2):129-141. DOI: 10.1016/S0304-386X(00)00195-X

GADD G.M., C. WHITE, L. DEROME. 1988. Heavy metal and radionuclide uptake by fungi and yeasts. - In: Norri P.R. & Kelly D.P. (Eds): *Biohydrometallurgy*. Chippenham, Wiltshire. UK. Antony Rowe Ltd., pp. 43-59.

GOURDON R., BHENDE S, RUS E, SOFER SS. 1990. Comparison of cadmium biosorption by Gram-positive and Gram-negative bacteria from activated sludge. - *Biotechnology Letters*, 12(11): 839-842. DOI: 10.1007/BF01022606

HAMZA S.M., H.F. AHMED, A.M. EHAB, F.M. MOHAMMAD. 2010. Optimization of Cadmium, Zinc and Copper biosorption in an aqueous solution by *Saccharomyces cerevisiae*. - *Journal of American Science*, 6(12):597-604.

KIROVA G., Z. VELKOVA, V. GOCHEV. 2012. Copper (II) removal by heat

inactivated *Streptomyces fradiae* biomass: Surface chemistry characterization of the biosorbent. - *Journal of BioScience and Biotechnology*, SE/ONLINE: 77-82.

KUJAN P., A. PRELL, H. SAFAR, T. REZANKA, P. HOLLER. 2005. Removal of copper ions from dilute solutions by *Streptomyces noursei* mycelium. Comparison with yeast biomass. *Folia Microbiologica*, 50(4):309-313. DOI: 10.1007/BF02931411

LI H., Y LIN, W. GUAN, J. CHANG, L. XU, J. GUO, G. WEI. 2010. Biosorption of Zn (II) by live and dead cells of *Streptomyces ciscaucasicus* strain CCNWHX 72-14. - *Journal of Hazardous Materials*, 179(1-3): 151-159. DOI: 10.1016/j.jhazmat.2010.02.072

MACEK T., M. MACKKOVA. 2011. Potential of Biosorption Technology. - In: Kotrba P, M. Mackova, T. Macek (Eds): *Microbial Biosorption of Metals*. Germany. Springer-Verlag, p. 8.

MAMERI N., N. BOUDRIES, L. ADDOUR, D. BELHOCINE, H. LOUNICI, H. GRIB, A. PAUSS. 1999. Batch zinc biosorption by a bacterial nonliving *Streptomyces rimosus* biomass. - *Water Research*, 33(6):1347-1354. DOI:10.1016/S0043-1354(98)00349-2

MISHRA V., S. TADEPALLI. 2014. Biosorption of toxic heavy metals on sawdust. - *CLEAN Soil Air Water*, 42(9999):1-8. DOI:10.1002/clen.201300934

NAJA G., B. VOLESKY. 2011. The Mechanism of Metal Cation and Anion Biosorption. - In: Kotrba P., M. Mackova, T. Macek (Eds): *Microbial Biosorption of Metals*. Germany. Springer-Verlag, pp. 37-38.

ÖZDEMIR S., E. KILINC, A. POLI, B. NICOLAUS, K. GÜVEN. 2009. Biosorption of Cd, Cu, Ni, Mn and Zn from aqueous solutions by thermophilic bacteria, *Geobacillus toebii sub. sp. decanicus* and *Geobacillus thermoleovorans sub. sp. stromboliensis*: Equilibrium, kinetic and thermodynamic studies. - *Chemical Engineering Journal*, 152(1):195-206. DOI: 10.1016/j.cej.2009.04.041

SAHMOUNE M.S., K. LOUHAB. 2010. Kinetic analysis of trivalent chromium biosorption by dead *Streptomyces rimosus* biomass. - *Arabian Journal for Science and Engineering*, 35(2):70-80.

SELATNIA A., A. BOUKAZOULA, N. KECHID, M.Z. BAKHTI, CHERGUI A. 2004a. Biosorption of Fe^{3+} from aqueous solution by a bacterial dead *Streptomyces rimosus* biomass. - *Process Biochemistry*, 39(11):1643-1651. DOI:10.1016/S0032-9592(03)00305-4

SELATNIA A., A. BOUKAZOULA, N. KECHID, M.Z. BAKHTI, A. CHERGUI, Y. KERCHICH. 2004b. Biosorption of lead (II) from aqueous solution by a bacterial dead *Streptomyces rimosus* biomas. - *Biochemical Engineering Journal*, 19(2):127-135. DOI: 10.1016/j.bej.2003.12.007

SHUKLA S.R., R.S. PAI. 2005. Adsorption of Cu(II), Ni(II) and Zn(II) on dye loaded groundnut shells and sawdust. - *Separation and Purification Technology*, 43(1):1-8. DOI:10.1016/j.seppur.2004.09.003

TARANGINI K., G.R. SATPATH. 2009. Optimization of heavy metal biosorption using attenuated culturea of *Bacillus subtilis* and *Pseudomonas aeruginosa*. - *Journal of Environmental Research and Development*, 3(3):677-684.

United States Environmental Protection Agency (US EPA). 2009. National recommended water quality criteria. Washington, DC. US EPA, p. 2.

VIEIRA M.G.A., A.F. DE ALMEIDA NETO, M.G. CARLOS DA SILVA, C.C. NÓBREGA, A.A. MELO FILHO. 2012. Characterization and use of in natura and calcined rice husks for biosorption of heavy metals ions from aqueous effluents. - *Brazilian Journal of Chemical Engineering*, 29(03):619-633.

VOLESKY B. 2004. *Equilibrium biosorption performance. Sorption and biosorption.* Section 6. Montreal, Canada. BV, Sorbex, pp. 103-116.

WANG J.L., C. CHEN. 2009. Biosorbents for heavy metals removal and their future. - *Biotechnology Advances*, 27(2):95-226. DOI:10.1016/j.biotechadv.2008.11.002

WORLD HEALTH ORGANIZATION (WHO). 2008. *Guidelines for drinking-water quality,* Geneva.

ZHOU G.J., F.Q. PENG, L.J. ZHANG, G.G.YING. 2011. Biosorption of zinc and copper from aqueous solutions by two freshwater green microalgae *Chlorella pyrenoidosa* and *Scenedesmus obliquus*. - *Environmental science and pollution research internationa,* 19(7):2918-29. DOI:10.1007/s11356-012-0800-9

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Preliminary Data on the Plant and Vertebrate Animal Diversity in the Area of Dedovo Village (West Rhodopes Mts.)

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Abstract. Dedovo Village (Rodopi Municipality, Plovdiv District) is located at 25 km from Plovdiv City in the Western Rhodopes Mts., at an altitude of 1000 to 1060 meters. Its proximity to the city and relatively preserved natural environment make it a more attractive place during the last years for relaxation, especially in the summer. However, the increased tourist presence in the area leads to an increase of anthropogenic pressure on the natural ecosystems. Aim of this study is to assess the plant and vertebrate animal diversity in the area of Dedovo Village and to identify the potential threats and risks to its conservation. More than 70 plant species were described, including one rare species and 5 Balkan endemics and 30 species, listed in the Bulgarian Medicinal plants Act. From the vertebrate animals 39 species were described, including 15 mammals (3 species with conservation status), 15 birds (4 species with conservation status), 6 reptiles and 2 amphibians.

Key words: biodiversity, Dedovo Village, medicinal plants, conservation status, threats.

Introduction

Dedovo Village (Rodopi Municipality, Plovdiv District) is located at 25 km from Plovdiv city in the Western Rhodopes Mts., at an altitude of 1000 to 1060 meters. Nearest villages are Ravnishta Village – at 2.0 km and Boykovo Village - at 3.2 kilometers. Area of Dedovo Village covers 15.326 km² (RODOPI MUNICIPALITY, 2015). Resident population continuously decreased over the years – from 134 citizens in 01.01.2007 to 54 in 01.02.2011 (NSI, 2011).

Climate is typical for Western Rhodopes Mts., because of the high altitude the mountain climate prevails. It is mitigated by the warm Mediterranean air masses penetrating along the rivers. Average annual temperatures are between 5 and 10°C, and the average amount of precipitation varies from 750 to 1100 mm. In nearly 80% of the mountain, with the exception of southwestern and southern parts, the runoff is directed to the Maritsa River by its right tributaries – Chepinska Reka River, Stara Reka River, Pepelashka Reka River, Cherkezitsa River and other smaller rivers. In the high zone of the Western Rhodopes Mts., the large amount of rainfall, the prolonged detention of snow, the negligible evaporation, the big slope of the terrain and the prevailing watertight geological base are a prerequisite for the high value of the drain module (over 25 l/s km²). Runoff mode within the average

altitude belt areas has reduced to 10-15 l/s km² due to increased precipitation and strong evaporation (RODOPI MUNICIPALITY, 2015).

Soils are largely influenced by the nature of the climate, geological base and the peculiarities of the relief. Foot and main belt of the mountain slopes are occupied by Cambisols, the mountain ridges are covered with Gleyic chromic luvisols, and Mollic Fluvisols are distributed along the rivers (RODOPI MUNICIPALITY, 2015).

Proximity of Dedovo Village to Plovdiv City, the fresh mountain air and relatively preserved natural environment make the village an even more attractive place during the last years for relaxation, especially in the summer. Increased tourist presence in the area leads to an increase of anthropogenic pressure on the natural ecosystems. The aim of this study is to assess the plant and vertebrate animal diversity in the area of Dedovo Village and to identify the potential threats and risks to its conservation.

Materials and Methods

Plant and vertebrate animal diversity in the region were examined through numerous field studies in the period 2014-2015. Field work was made using the method of line transect, as 8 transects were built using GPS Garmin E-Trex Vista - to N, NE, E, SE, S, SW, W and NW directions, starting from the village periphery. Each one was at least 1 km long depending on the peculiarities of the relief. Observations were made up to 3 m to the left and right side of each transect. Plants species were determined according to DELIPAVLOV & CHESHMEDZHIEV (2003). For determination of the vertebrate fauna, the Identification guide of vertebrate animals in Bulgaria (PESHEV, 2001) was used. Conservation status of the identified species was presented according to the contemporary Bulgarian and European legislation – Red Data Book of the Republic of Bulgaria vol.1. (PEEV *et al.*, 2015), Red Data Book of the Republic of Bulgaria vol.2. (GOLEMANSKI *et al.*, 2015), BULGARIAN BIOLOGICAL DIVERSITY ACT (2002), BULGARIAN MEDICINAL PLANTS ACT (2000), and IUCN Red List of Threatened Species (IUCN, 2015). Potential problems and threats to biodiversity in the region (fire, waste disposal, plant picking, poaching, etc.) were examined through direct observations and interviews with tourists and local population.

Description of the conservation status categories according to the UICN criteria (IUCN, 2015):

EN - Endangered (a taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild).

VU - Vulnerable (a taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild).

NT - Near Threatened (a taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future).

LC - Least Concern (a taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category).

Fig. 1. Indicative map of study area.

Results and Discussion

Plant diversity

Dedovo Village falls into Rhodopes Mts. (middle) floristic region. We described about 70 plant species common for the region – 7 with conservation status [including one rare species – *Erodium hoefftianum*, and 5 Balkan endemics – *Silene fabarioides*, *Genista rumelica*, *Digitalis viridiflora*, *Fritillaria pontica*, *Rorippa lippizensis,* and two with conservation status LC in IUCN Red List - *Dactylorhiza cordigera* and *Rorippa lippizensis*] (Table 1) and 30 species, included in the Bulgarian Medicinal plants Act (Table 2).We found that in the region of Dedovo Village meet coniferous, deciduous and mixed forests of *Abies alba*, *Picea abies*, *Pinus sylvestris*, *Pinus nigra*, *Fagus sylvatica*, *Betula pendula*, *Populus tremula*, *Tilia* spp., and others (Table 3). Subforest and herb layer consist mainly of *Dryopteris filix-mas*, *Juniperus communis*, *Rubus caesius*, *Rubus idaeus*, *Rosa canina*, *Vaccinium vitis-idaea*, *Vaccinium myrtillus*, *Fragaria vesca* and others (Table 4). Some other species were also observed: *Dactylis glomerata*, *Campanula sparsa*, *Luzula sylvatica*, *Myosotis sylvatica*, *Lamium garganicum*, *Chaerophyllum aureum*, *Trifolium aureum*, *Holcus lanatus*, *Campanula rapunculus*, *Chamaenerion angustifolium*, *Poa annua*, *Quercus petraea*, *Sedum pallidum*, *Acer hyrcanum*, *Nepeta nuda*, *Lysimachia punctata*, *Lychnis coronaria*, *Trifolium purpureum*, *Galium tenuissimum*, *Lapsana communis*, *Carduus candicans*, *Prenanthes purpurea*, *Doronicum austriacum*, *Trifolium hybridum*.

Table 1. List of identified plant species with conservation status.

№	Scientific name	Common name	Family	Bulgarian Red Data Book, Vol. 1	Bulgarian Biological Diversity Act	IUCN Red List
1	*Erodium hoefftianum* C. A. Meyer	Hoefftianianst Storksbill	Geraniaceae	Rare species	-	-
2	*Silene fabarioides* Hausskn.	Campion	Caryophyllaceae	Balkan endemic	-	-
3	*Genista rumelica* Velen.	Rumelian Greenweed	Fabaceae	Balkan endemic	-	-
4	*Digitalis viridiflora* Lindley	Green Foxglove	Scrophulariaceae	Balkan endemic	-	-
5	*Fritillaria pontica* Wahlenb.	Pontic Fritillary	Liliaceae	Balkan endemic	+	-
6	*Rorippa lippizensis (Wulfen)* Reichenb.	-	Brassicaceae	Balkan endemic	-	LC
7	*Dactylorhiza cordigera (Fries)* Soó	Heart Shaped Lip Dactylorhiza	Orchidaceae	-	-	LC

Table 2. List of identified plant species included in the BULGARIAN MEDICINAL PLANTS ACT (2000).

№	Scientific name	Common name	Family
1	*Fagus sylvatica* L.	European Beech	Fagaceae
2	*Cardamine bulbifera* (L.) Crantz. (*Dentaria bulbifera* L.)	Coralwort	Brassicaceae
3	*Euphorbia amygdaloides* L.	Wood Spurge	Euphorbiaceae
4	*Fragaria vesca* L.	Strawberry	Rosaceae
5	*Tussilago farfara* L.	Coltsfoot	Asteraceae
6	*Dryopteris filix-mas* (L.) Schott	Wood Fern	Aspidiaceae
7	*Vaccinium myrtillus* L.	Bilberry	Ericaceae
8	*Geranium sanguineum* L.	Bloody Cranesbill	Geraniaceae
9	*Prunella vulgaris* L.	Self-heal	Lamiaceae
10	*Pinus sylvestris* L.	Scots Pine	Pinaceae
11	*Carpinus betulus* L.	European Hornbeam	Betulaceae
12	*Abies alba* Miller	Silver Fir	Pinaceae
13	*Rubus caesius* L.	European dewberry	Rosaceae

14	*Veronica officinalis* L.	Heath Speedwell	Scrophulariaceae
15	*Urtica dioica* L.	Stinging Nettle	Urticaceae
16	*Geum urbanum* L.	Common Avens	Rosaceae
17	*Hypericum cerastoides* (Spach) N. K. B. Robson	St. John's wort	Hypericaceae
18	*Hypericum perforatum* L.	Perforate St John's wort	Hypericaceae
19	*Geranium macrorrhizum* L.	Cranesbill	Geraniaceae
20	*Polypodium vulgare* L.	Polypody	Polypodiaceae
21	*Chamaecytisus albus* (Jacq.) Rothm.	White Broom	Fabaceae
22	*Digitalis lanata* Ehrh.	Woolly Foxglove	Scrophulariaceae
23	*Achillea millefolium* L.	Common Yarrow	Asteraceae
24	*Clinopodium vulgare* L.	Wild Basil	Lamiaceae
25	*Viola tricolor* L.	Wild Pansy	Violaceae
26	*Betula pendula* Roth	Silver Birch	Betulaceae
27	*Crataegus monogyna* Jacq.	Common Hawthorn	Rosaceae
28	*Matricaria trichophylla* (Boiss.) Boiss.	-	Asteraceae
29	*Lathyrus pratensis* L.	Tom Thumb	Fabaceae
30	*Trifolium pratense* L.	Red Clover	Fabaceae

Table 3. Identified plant species in deciduous, coniferous and mixed forests.

№	Scientific name	Common name	Family
1	*Abies alba* Mill.	Silver Fir	Pinaceae
2	*Picea abies (L.)* H. Karsten	Norway Spruce	Pinaceae
3	*Pinus sylvestris* L.	ScotsPine	Pinaceae
4	*Pinus nigra* L.	Austrian Pine	Pinaceae
5	*Fagus sylvatica* L.	CommonBeech	Fagaceae
6	*Quercus petraea* (Mattuschka) Liebl.	Sessile oak	Fagaceae
7	*Betula pendula* Roth.	Silver Birch	Betulaceae
8	*Carpinus betulus* L.	European Hornbeam	Betulaceae
9	*Populus tremula* L.	Aspen	Salicaceae
10	*Tilia tomentosa* Moench	Silver Linden	Tiliaceae
11	*Tilia cordata* Miller	Small-leaved Linden	Tiliaceae
12	*Tilia platyphyllos* Scop.	Large-leaved Linden	Tiliaceae
13	*Acer hyrcanum* Fisher & C. A. Meyer	Balkan Maple	Aceraceae

Table 4. Identified plant species in subforest and herb layer.

№	Scientific name	Common name	Family
1	*Juniperus communis* L.	Common Juniper	Cupressaceae
2	*Rubus caesius*L.	European Dewberry	Rosaceae
3	*Rubus idaeus* L.	Raspberry	Rosaceae
4	*Fragaria vesca* L.	Wild strawberry	Rosaceae
5	*Rosa canina* L.	Dog-rose	Rosaceae
6	*Crataegus monogyna* Jacq.	Common hawthorn	Rosaceae
7	*Vaccinium vitis-idaea* L.	Mountain Cranberry	Ericaceae
8	*Vaccinium myrtillus* L.	Bilberry	Ericaceae
9	*Dryopteris filix-mas* (L.) Schott	Wood Fern	Aspidiaceae
10	*Polypodium vulgare* L.	Polypody	Polypodiaceae

Vertebrate animal diversity

More than 50 vertebrate species were found, including 15 mammals (3 species with conservation status) (Table 5) and 15 bird species (4 species with conservation status) (Table 6). Only two amphibians were registered - *Salamandra salamandra* and *Pelophylax ridibundus*; reptiles were presented by *Elaphe longissima*, *Vipera berus*, *Lacerta viridis*, *Lacerta trilineata*, *Testudo hermanni* and *Emys orbicularis*.

Table 5. List of identified mammals in the region of Dedovo Village.

№	Scientific name	Common name	Family	Bulgarian Red Data Book, Vol.2	IUCN Red List
1	*Lepus europaeus* Pallas	European hare	Leporidae	-	LC
2	*Sus scrofa* L.	Wild boar	Suidae	-	LC
3	*Capreolus capreolus* L.	European roe deer	Cervidae	-	LC
4	*Cervus elaphus* L.	Red deer	Cervidae	-	LC
5	*Dama dama* L.	Fallow deer	Cervidae	-	LC
6	*Rupicapra rupicapra* L.	Wild goat	Bovidae	EN	LC
7	*Ursus arctos*L.	Brown bear	Ursidae	EN	LC
8	*Vulpes vulpes* L.	Red fox	Canidae	-	LC
9	*Canis lupus* L.	Gray wolf	Canidae	VU	LC
10	*Canis aureus* L.	Golden jackal	Canidae	-	LC
11	*Sciurus vulgaris* L.	Red squirrel	Sciuridae	-	LC
12	*Martes foina* (Erxl., 1777)	Beech marten	Mustelidae	-	LC
13	*Mustela putorius* L.	European polecat	Mustelidae	-	LC
14	*Meles meles*L.	European badger	Mustelidae	-	LC
15	*Erinaceus roumanicus* Barrett-Hamilton, *1900*	Southern white-breasted hedgehog	Erinaceidae	-	LC

Table 6. List of identified birds in the region of Dedovo Village.

№	Scientific name	Common name	Family	Bulgarian Red Data Book, Vol.2	IUCN Red List
1	*Tetrao urogallus* L.	Western capercaillie	Phasianidae	EN	LC
2	*Phasianus colchicus mongolicus* von Brandt	Common Pheasant	Phasianidae	-	LC
3	*Perdix perdix* L.	Grey partridge	Phasianidae	-	LC
4	*Coturnix coturnix*L.	Common quail	Phasianidae	-	LC
5	*Columba palumbus* L.	Common wood pigeon	Columbidae	-	LC
6	*Streptopelia turtur* L.	European turtle dove	Columbidae	-	VU
7	*Streptopeliadecaocto* Friv., 1838	Eurasian collared dove	Columbidae	-	LC
8	*Scolopax rusticola* L.	Eurasian woodcock	Scolopacidae	EN	LC
9	*Aquila pomarina* Brehm	Lesser spotted eagle	Accipitrida	VU	LC
10	*Cuculus canorus* L.	Common cuckoo	Cuculidae	-	LC
11	*Dendrocopos major*L.	Great spotted woodpecker	Picidae	-	LC
12	*Dryocopus martius* L.	Black woodpecker	Picidae	VU	LC
13	*Falco sp.*	Falcons	Falconidae	-	-
14	*Strix aluco*(Linnaeus, 1758)	Tawny owl	Strigidae	-	LC
15	*Asio otus* L.	Long-eared owl	Strigidae	-	LC

Threats to plant and vertebrate animal diversity in the region of Dedovo Village

There are signs that tourist are picking up many of the identified wild berries (*Rubus caesius, Rubus idaeus*, *Rosa canina*, *Vaccinium vitis-idaea*, *Vaccinium myrtillus*, *Fragaria vesca*) and herbs with medicinal use (*Tussilago farfara, Dryopteris filix-mas, Geranium sanguineum, Veronica officinalis, Urtica dioica, Hypericum cerastoides, Hypericum perforatum, Geranium macrorrhizum*, etc.). In some cases they were taken out with the roots which is especially damaging to the populations.

Poaching and illegal fishing also were registered, they are the threats which directly affect the biodiversity but the perpetrators in most cases remained unpunished. Poachers mostly kill the following species: *Cervus elaphus, Capreolus capreolus, Sus scrofa, Rupicapra rupicapra* and *Ursus arctos*. According to the data, provided by tourists, there are isolated cases of illegal fishing in Pepelashka River. Object of this fishing is mainly *Salmo trutta fario*.

Another big problem is the wastes disposal from tourists, mainly of packaging and food scraps.

Conclusion

Data obtained assumed that the studied area is characterized by preserved natural environment with high biodiversity and therefore offers many opportunities for tourism and recreation. To deal with the problems, arising from the threats of anthropogenic origin, it is recommended some assistance to municipalities of Dedovo Village and of the neighboring settlements, in order to solve these problems.

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References

BIOLOGICAL DIVERSITY ACT. 2002. Promulgated. - *State Gazette* No. 77/9.08.2002 (In Bulgarian).

DELIPAVLOV D., I. CHESHMEDZHIEV (Eds.). 2003. *Key to the plants in Bulgaria*. Academic Publishing House of Agricultural University, Plovdiv (In Bulgarian).

GOLEMANSKI V., P. STOEV, D. DOBREV, P. BERON, M. ZHIVKOV, A. POPOV, V. POPOV, V. BESHKOV, CH., DELTSHEV, T. MICHEV, N. SPASSOV (Eds.). 2015. *Red Data Book of the Republic of Bulgaria, Volume 2 – Animals,* Digital edition. Bulgarian Academy of Sciences & Ministry of Environment and Waters. Available at: [e-ecodb.bas.bg]. Last accessed on 20.11.2015.

IUCN 2015. *IUCN Red List of Threatened Species.* Version 2015-4. Available at: [iucnredlist.org]. Last accessed on 20.11.2015.

MEDICINAL PLANTS ACT. 2000. Promulgated. - *State Gazette*, No. 29/7.04.2000 (In Bulgarian).

NSI. 2011. National statistical institute. Population in districts and urban areas up to 01.02.2011. Available at: [www.nsi.bg]. Last accessed on 20.11.2015.

PEEV D., V. VLADIMIROV, A. PETROVA, M. ANCHEV, D. TEMNICKOVA, C. DENCHEV, A. GANEVA, CH. GUSSEV (Eds.). 2015. *Red Data Book of the Republic of Bulgaria, Volume 1 – Plants and Fungi,* Digital edition. Bulgarian Academy of Sciences & Ministry of Environment and Waters. Available at: [e-ecodb.bas.bg/rdb/en/vol1/]. Last accessed on 20.11.2015.

PESHEV T., D. NANKINOV, D. PESHEV. 2003. I*dentification Guide of vertebrate animals in Bulgaria*. Publishing House "Bulvest 2000", Sofia, 414 p. (In Bulgarian).

RODOPI MUNICIPALITY. 2015. *Rodopes Municipality.* Available at: [www.rodopi-bg.org]. Last accessed on 20.11.2015. (In Bulgarian).

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Short note

Preliminary Data of the Shell Morphometry of Populations of Zebrina detrita (Mollusca: Gastropoda: Pulmonata) from Bulgaria

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Abstract. Six populations of *Zebrina detrita* Müller, 1774 (Mollusca: Gastropoda: Pulmonata) occuring in different habitats, regions and altitude were studied by shell morphology. The width and height of the shell and its aperture were measured, and also the last whorl height. Their proportions were calculated. Some differences in the shell size were registered in populations situated at different altitude.

Keywords: terrestrial, gastropod, shell size, shell morphology, *Zebrina detrita*, Bulgaria.

Introduction

The data of the shell size variations of the European terrestrial snails is relatively scares. Few studies on the subject are done by WELTER-SCHULTES (2000, 2001), HAUSDORF (2003), NEKOLA *et al.* (2013), GIOKAS *et al.* (2014). Currently, there are no studies concerning the shell size of *Zebrina detrita* Müller, 1774 and its variations at different habitats and altitudes but many forms and subspecies were described (WELTER-SCHULTES, 2012). For example in Bulgaria, *Z. d. inflata* is known to be a high-mountain subspecies, typical for alpine areas of Pirin (mainly below Vihren peak) and Alibotush Mts. (DEDOV, 2008).

The aim of the current short communication is to present preliminary information on the variation of the shell characteristics in populations at different habitats and regions in various altitudes in Bulgaria.

Material and Methods

We measured a total of 168 empty shells of *Zebrina detrita*, collected from six localities in south Bulgaria between 2000 and 2013:

- Locality №1 - Upper Thracian Lowland, 100-150 m a.s.l., grasslands near an agricultural area at the village of Podslon, 36 shells;
- Locality №2 - Upper Thracian Lowland, 100-150 m a.s.l., grasslands near an agricultural area at the east part of Stara Zagora City, 15 shells;
- Locality №3 - Sarnena Sredna Gora Mts., 200-300 m a.s.l., grass and bush area east of Starozagorski Mineralni bani Resort, 43 shells;
- Locality №4 – Stara Planina Mts., 1441 m a.s.l., Hadzhi Dimitar Peak, 14 shells;
- Locality №5 - Sarnena Sredna Gora Mts., 240 m a.s.l., north of Stara Zagora City, bush terrains, 29 shells;
- Locality №6 - Sarnena Sredna Gora Mts., 240 m a.s.l., north of Stara Zagora

City, moderately wet bush area with *Clematis* sp., 31 shells;

The following main shell morphometric parameters (DAMJANOV & LIKHAREV, 1975) were measured, using caliper (with 0.1 mm accuracy): H – shell height, D – shell width, AH – aperture height, AW – aperture width, LH – body whorl height, as well as the following indices: D/H, AH/H, AH/AW, LH/H.

The results were statistically processed using descriptive statistics - mean, minimum value, maximum value, standard deviation, standard error and variation (FOWLER *et al.*, 1998).

For the statistical processing of the data we used the software package "PAST v.3.06" (HAMMER *et al.*, 2001). Also cluster analysis was performed to evaluate the similarity in the means of the conchiometric parameters between the studies populations, with group average link and Bray-Curtis index, calculated with the computer software "BioDiversityPro" (MCALEECE *et al.*, 1997).

Results and Discussion

The data about the measured conchiometric parameters of the studied populations of *Zebrina detrita* is given in Table 1.

The values of the height of the shell of the studied populations are within the limits of variation for the species, as referred to by WELTER-SCHULTES (2012), who reports shell height of this species of 12-30 mm and width of 8-12 mm.

The smallest shell height (H) have the individuals from the population at Hadzhi Dimitar Peak (Population №4). The average height is 18.4 mm (min-max: 16.8-20.0 mm). The studied populations from the Upper Thracian Valley have generally shorter shells (average 23 mm, min-max: 18.7-27.1 mm), than those in the adjacent slopes of the Sarnena Sredna Gora Mts. (on average 24-25 mm, min- max: 20.7-28.7 mm), but higher than those of specimens from the ridge of Stara Planina Mts.

We recorded differences in the values of the height of the shell in populations located in one geographical area, but in different habitats. In the Upper Thracian Valley, the individuals from the population at Podslon Village, near arable land (Population №1) have slightly higher shells (10.3 mm) than the ones in the vicinity of Stara Zagora City, near the irrigation canal in herbaceous and shrub vegetation (Population №2) – 9.7 mm (Table 1).

At Sarnena Sredna Gora Mts., the individuals from the two populations inhabiting open grassland with shrubs have on average higher shells (approx. 25 mm) than the population located in damp and shady habitat with shrubs (mean of approx. 24 mm).

From altitude point of view, the shortest shells are from the individuals from the highest, studied population Hadzhi Dimitar Peak (Population №4), located at 1441 m a.s.l. The studied populations from the Upper Thracian Valley (100-150 m a.s.l.) have shells with medium height and the highest shells, which we recorded were at the populations on the slopes of Sarnena Stedna Gora Mts. - 200-300 m a.s.l. (Table 1).

The values of the width of the shell (D) of the studied populations are also within the limits of variation for the species, as referred to by WELTER-SCHULTES (2012), except for the recorded minimum values from Population №4 at Hadzhi Dimitar Peak (7.7 mm).

The smallest width of the shell are again among the population at Hadzhi Dimitar peak (average 8.4 mm, min-max: 7.7-8.9 mm). The studied populations from the Upper Thracian Valley have generally narrower shells (average 10 mm, min-max: 9.0-11.2 mm), than those in the adjacent slopes of Sarnena Sredna Gora Mts. (average 11 mm, min-max: 10.0-12.3 mm), but wider than those of the specimens from the ridge of Stara Planina Mts. The shells of the individuals from the population at Podslon Village (Population №1) are slightly wider than the shells of the individuals around Stara Zagora City - Population №2 (Table 1).

Lowest height (AH) and width (AW) of the aperture (opening of the shell) have the shells from the population at Hadzhi Dimitar Peak. The proportions of the

various parts of the shell are species specific for many types of gastropods and these results are expected. The average value of the height of the opening of the shell in this population is 8.1 mm (min-max: 7.5-8.8 mm) and width of 6.0 mm (min-max: 5.3-6.6 mm).

The body whorl height (LH) again was recorded at the population at Stara Planina Mts. (average 12.4 mm, min-max: 11.7-13.7 mm). The highest value was registered at Sarnena Stedna Gora Mts. populations in forest habitat and in the Upper Thracian Valley, with slightly lower values of about 1-2 mm.

In our opinion the conditions in some habitats and altitudes are unfavorable for this species, which leads to the small sizes of their shells. However, the proportions between the measured parts of the shell have strong overlapping values and have no relation to the habitat, the altitude or the geographical area. These ratios are probably species-specific, and although portions of the shell are different, their proportions are maintained.

The conducted cluster analysis shows that all six populations of *Zebrina detrita* are very similar based on their morphology (Fig. 1). The population from Hadzhi Dimitar Peak (Population №4) is most distinguishable among all in separate cluster at about 85% similarity. From the rest of the population two cluster are formed at about 95% similarity. They are grouped on geographic and altitude principle. The first cluster is formed by population №1 and №2 (96% similarity) from the surrounding of Stara Zagora City, located at similar altitude. The second cluster contains populations № 3, 5 and 6 (97% similarity), all from Sarnena Sredna Gora Mts., also located at similar altitudes. This confirms our conclusion that the registered differences in the measured conchiometric parameters and ratios is due to the habitat and altitude.

Overall, the dimensions of the conchiometric parameters vary more than the proportions between them. This indicates that although the size of the shell of each species varies to some extent, the ratios between the different parts remains steady and that's why each species has a species-specific exterior (appearance). From all conchipmetric parameters the most variable is the height of the shell reaching index of variation of about 3.1 units in Sarnena Sredna Gora (Population №6). And the least variable height remains in the population at Hadzhi Dimitar Peak - about 0.9 units. The second most variable parameter is the height of the last turn (0.4 to 1.05 units). All other conchiometric parameters vary less and none exceed 0.5 units. The variation of the proportion of the shell is generally with index with values of about zero, but most varying is the ratio between the height and width of the aperture.

Conclusions

In habitats, geographic regions and altitude, considered unfavorable for the species, the shells usually have smaller size. The smallest shells in this study were recorded at Hadzhi Dimitar Peak in Stara Planina Mts., which minimal values of shell width exceeds the known values for the species. Although the conchiometric parameters vary from population to population, their ratios maintain relatively unchanged and that's why they can be considered species-specific.

References

DAMJANOV S., I. LIKHAREV 1975. Gastropoda terrestria. - In: *Fauna of Bulgaria.* Volume 4. Publishing House of the Bulgarian Academy of Sciences, Sofia. 425 p. (In Bulgarian)

DEDOV I. 2008. Terrestrial gastropods (Mollusca, Gastropoda) of the Bulgarian part of the Alibotush Mts. – *Malacologica Bohemoslovaca*, 7: 17-20.

FOWLER J., L. COHEN, P. JARVIS. 1998. Practical statistics for field biology. Chichester: John Wiley & Sons.

GIOKAS S., B. PALL-GERGELY, O. METTOURIS. 2014. Nonrandom variation of morphological traits across environmental gradients in a land snail. - *Evolutionary Ecology*, 28(2): 323-340. DOI: 10.1007/s10682-013-9676-5.

Table 1. Descriptive statistics of the conchiometric parameters of the shell of *Zebrina detrita* in the studied populations.

Population №	H	D	AH	AW	LH	D/H	AH/H	AH/AW	LH/H
	Mean								
1	23,131	10,319	10,144	7,731	15,244	0,447	0,439	1,313	0,660
2	22,615	9,738	9,743	7,282	14,755	0,432	0,431	1,339	0,653
3	25,303	11,206	11,094	8,454	16,505	0,443	0,439	1,313	0,653
4	18,364	8,357	8,100	5,957	12,436	0,455	0,441	1,362	0,677
5	23,707	11,052	11,198	8,424	16,321	0,467	0,473	1,330	0,689
6	25,210	11,058	11,097	8,129	16,697	0,440	0,441	1,366	0,663
	Minimum values								
1	21,000	9,600	8,800	7,000	13,600	0,410	0,400	1,170	0,620
2	18,710	9,010	8,770	6,220	12,850	0,403	0,405	1,278	0,614
3	22,290	9,950	9,680	7,350	14,590	0,418	0,410	1,161	0,621
4	16,800	7,700	7,500	5,300	11,700	0,430	0,421	1,206	0,634
5	20,700	10,000	10,000	7,400	14,600	0,431	0,443	1,178	0,639
6	21,500	10,000	9,000	7,000	14,600	0,348	0,383	1,235	0,564
	Maximum values								
1	27,100	11,200	11,100	8,500	16,700	0,470	0,480	1,470	0,690
2	24,740	10,420	10,800	7,900	16,200	0,503	0,469	1,415	0,687
3	25,310	10,900	11,460	8,230	16,440	0,431	0,453	1,392	0,650
4	20,000	8,900	8,800	6,600	13,700	0,478	0,478	1,473	0,699
5	26,000	12,300	12,400	9,300	18,200	0,507	0,505	1,438	0,735
6	28,700	12,000	12,500	9,000	18,400	0,512	0,488	1,528	0,707
	Standard Deviation								
1	1,205	0,403	0,531	0,339	0,699	0,018	0,017	0,059	0,017
2	1,521	0,436	0,603	0,493	1,017	0,025	0,019	0,046	0,025
3	1,472	0,522	0,658	0,450	0,874	0,015	0,017	0,053	0,020
4	0,930	0,396	0,376	0,341	0,636	0,015	0,015	0,066	0,021
5	1,397	0,656	0,679	0,447	0,908	0,019	0,016	0,064	0,019
6	1,760	0,604	0,857	0,544	0,942	0,030	0,025	0,071	0,027
	Standard Error								
1	0,201	0,067	0,089	0,056	0,117	0,003	0,003	0,010	0,003
2	0,393	0,112	0,156	0,127	0,263	0,006	0,005	0,012	0,006
3	0,224	0,080	0,100	0,069	0,133	0,002	0,003	0,008	0,003
4	0,248	0,106	0,101	0,091	0,170	0,004	0,004	0,018	0,006
5	0,259	0,122	0,126	0,083	0,169	0,004	0,003	0,012	0,004
6	0,316	0,109	0,154	0,098	0,169	0,005	0,004	0,013	0,005
	Variance								
1	1,4490	0,1671	0,2778	0,1129	0,4911	0,0003	0,0003	0,0035	0,0003
2	2,3215	0,1863	0,3691	0,2443	1,0525	0,0006	0,0003	0,0021	0,0006
3	2,1692	0,2734	0,4361	0,2057	0,7478	0,0002	0,0003	0,0028	0,0003
4	0,8640	0,1565	0,1415	0,1165	0,4040	0,0002	0,0002	0,0043	0,0004
5	1,9507	0,4304	0,4654	0,1998	0,8246	0,0004	0,0002	0,0041	0,0004
6	3,0976	0,3652	0,7343	0,2961	0,8870	0,0009	0,0006	0,0050	0,0007

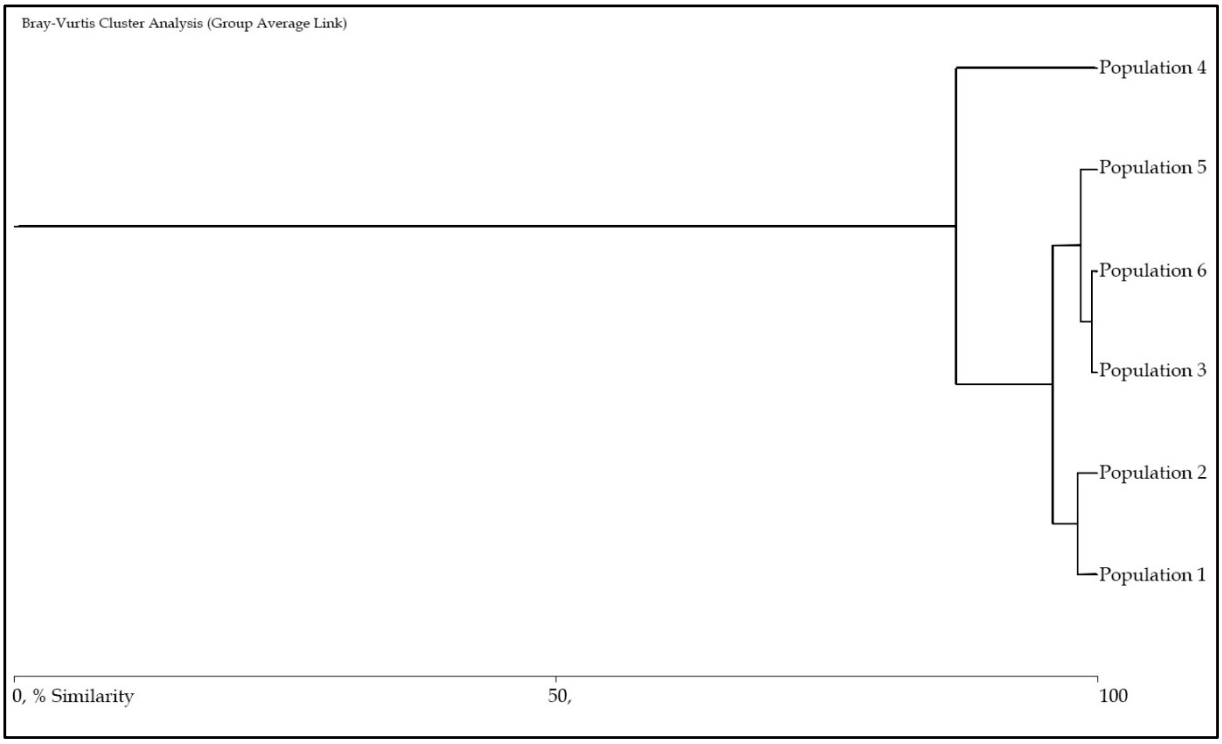

Fig. 1. Cluster analysis of the means of all measured conchiometric parameters and ratios of the six studied populations (Bray-Curtis index, group average link).

HAMMER Ø., D. HARPER, P. RYAN. 2001. PAST: Paleontological Statistics Software Package for Education and Data Analysis. - *Palaeontologia Electronica,* 4(1): 9. Avaiable at: [http://folk.uio.no/ohammer/past/].

HAUSDORF B. 2003. Latitudinal and altitudinal body size variation among north-west European land snail species. - *Global Ecology and Biogeography,* 12(5): 389-394. DOI: 10.1046/j.1466-822X.2003.00050.x.

MCALEECE N., P. LAMBSHEAD, G. PATERSON, J. GAGE. 1997. *BioDiversity Professional,* London (UK), Oban (Scotland). The Natural History Museum, The Scottish Association for Marine Sciences. Software, Available at: [http://www.sams.ac.uk/research/software].

NEKOLA J., G. BARKER, R. CAMERON, B. POKRYSZKO. 2013. Latitudinal variation of body size in land snail populations and communities. - In: Smith F., K. Lyons (Eds.) *Animal body size: linking pattern and process across space, time, and taxonomic group*. The University of Chicago Press, Chicago.

WELTER-SCHULTES F. 2000. The pattern of geographical and altitudinal variation in the land snail *Albinaria idaea* from Crete (Gastropoda: Clausiliidae). - *Biological Journal of the Linnean Society,* 71(2): 237-250. DOI: 10.1111/j.1095-8312.2000.tb01256.x.

WELTER-SCHULTES F. 2001. Spatial variations in *Albinaria terebra* land snail morphology in Crete (Pulmonata: Clausiliidae): constraints for older and younger colonizations? - *Paleobiology,* 27(2): 348-368. DOI: 10.1666/0094-8373(2001)027<0348:SVIATL>2.0.CO;2.

WELTER-SCHULTES F., 2012. *European non-marine molluscs, a guide for species identification.* – Planet Poster Editions, Göttingen.

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Short note

New Information on the Malacofauna of the Catchment Area of Rusenski Lom River (North Bulgaria)

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Abstract. After this short note adding 8 species to the faunal list of the area, a total of 130 mollusk species are known from the catchment area of Rusenski Lom River both aquatic and terrestrial.

Key words: faunal list, Mollusca, Northern Bulgaria.

A total of 122 freshwater and terrestrial molluscs were known from the catchment area of Rusenski Lom River (KOLEV *et al.*, 2015; GEORGIEV & GLÖER, 2015). Revision of the materials collected by I. Kolev (and deposited in the collection of D. Georgiev, see KOLEV *et al.*, 2015), during the period 2012-2014 revealed 8 newly recorded species for this area which rises the species number known there to 130:

Pisidium pseudosphaerium Schlesch, 1947: 04.06.2014; deposits of a small stream flowing from village of Golyamo Gradishte at its inflow in Kalakoch River near village of Krepcha,N43°27'55.49E26°06'38.86,203 m;

Pisidium subtruncatum Malm, 1855: 05.03 and 09.07.2014, Cherni Lom River at village of Katselovo, N43°30'57.79 E26°04'39.77, 123 m; 04.06.2014, Kalakoch River, at Krepchenski Rock Monastery, N43°28'02.15 E26°06'59.78, 189 m;

Pisidium nitidum Jenyns, 1832: 08.08.2012, water source at village of Pisanets, N43°40'01.74 E26°10'23.42, 101 m;

Bathyomphalus contortus (Linnaeus, 1758): 10.12.2014, deposits of Cherni Lom River, at village of Katselovo, N43°31'25.57 E26°02'22.25, 115 m;

Discus perspectivus (Megerle von Mühlfeld, 1816): 10.12.2014, deposits of Cherni Lom River, at village of Katselovo, N43°31'25.57 E26°02'22.25, 115 m;

Vitrea contracta (Westerlund, 1871): 10.12.2014, deposits of Svrachi Dol near village of Katselovo, N43°31'25.57 E26°02'22.25, 115 m;

Oxychilus investigatus Riedel, 1993: 04.06.2014; near Kalakoch River near village of Krepcha, N42°26'58.38E26°06'39.80,244 m;

Lehmannia nyctelia (Bourguignat, 1861): 12.05.2014, in a shaft in the valley of Kalakoch River,N43°27'23.43E26°06'33.52,233 m.

References

GEORGIEV D., P. GLÖER. 2015. New taxa of subterranean freshwater snails from Bulgaria (Gastropoda, Hydrobiidae). - *Ecologica Montenegrina*, 3: 19-24.

KOLEV I., D. GEORGIEV, I. DEDOV 2015. Malacofauna of the catchment area of Rusenski Lom River (North Bulgaria). - *ZooNotes*, 76: 1-12.

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Short note

New Information on the Snail Fauna of "Sinite Kamani" Nature Park (Stara Planina Mountains, Bulgaria)

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Abstract. The malacofauna in the Bulgarian nature parks situated in Stara Planina Mts. is poorly known. So far only one research in the area of Nature Park "Sinite kamani" was carried out in 2008. A total of 23 species of terrestrial snails were discovered and some data on their habitats were presented, but no freshwater snails were found. The author has suggested that many other species could be found in case of future studies. In the present paper we present some new terrestrial and aquatic species discovered on the territory of the park.

Key words: protected area, Bulgaria, malacofauna.

The study was carried out in the period 20.10.2013 - 27.04.2014. Snails were hand-collected or collected by using a sieve from 24 different places in the park (Table 1). Species were determined mainly by DAMJANOV & LIKHAREV (1975), WELTER-SCHULTES (2012) and a reference shell collection by GEORGIEV (2013).

In the current study 23 new species of snails were found: 3 freshwater and 20 terrestrial species of snails (Table 2). Till now there are 46 gastropod species known in the area. The present study confirmed the existence of 11 species of terrestrial snails. During the short period of the on-field research made in 2014, the following species were not found - *V. pulchella; A. biplicata; B.urbanskii; Z. nitidus; V. neglecta; O. urbanskii; L. (Limacus) flavus; L. nyctelia; D. reticulatum; L. girva* and *H. figulina.*

It's impressive that most of the species (12 of them) were discovered in coppice forests, pure and mixed forest of *Ulmus sp.* with *J. regia, Cornus sp.* and *H. lupulus* located at 500 m height, outside the river valleys. Furthermore such an altitude it should be noted that refers also to grass terrain, open grass terrain among limestone and *Tilia sp.* and *Fraxinus sp.* forest with, wherein the number of the observed mollusks increase up to 18 species.

Six of the species were forund in the mixed deciduous forests of *F. sylvatica maesiacus* and *Quercus sp.* in the hilly and foothill regions and 3 of the species in the coastal forests, open grasslands and rocks.

Table. 1. Places of collection in the NP "Sinite Kamani" used for the present study.

№	Date	Coordinates	Alt.	Habitat
1	20.10.2013	N42 43 53.1 E26 17 54.9	806 m	*Carpinus betulus* and *Acer sp.* forest
2	20.10.2013	N42 43 50.6 E26 18 03.1	845 m	open bush, grass and rocky terrains
3	20.10.2013	N42 43 42.8 E26 18 08.8	837 m	spring near planted coniferous trees
4	21.10.2013	N42 43 03.8 E26 15 39.8	399 m	*Tilia sp.* and *Fraxinus sp.* forest
5	21.10.2013	N42 42 36.6 E26 16 14.4	426 m	open grass terrain among limestone rocks
6	21.10.2013	N42 42 06.0 E26 15 56.3	309 m	*Ulmus sp.* forest with *Juglans regia*, *Cornus sp.*, *Humulus lupulus*
7	21.10.2013	N42 44 43.0 E26 22 04.0	1040 m	bush area near a watersource
8	21.10.2013	N42 43 01.8 E26 22 00.7	944 m	*Fagus sylvatica* forest near a watersource, watersource
9	21.10.2013	N42 43 03.6 E26 22 31.4	922 m	*Populus sp.* trees near a building
10	21.10.2013	N42 43 03.7 E26 22 35.5	919 m	small artificial pond
11	21.10.2013	N42 43 38.3 E26 18 07.2	810 m	bush area
12	22.10.2013	N42 42 31.4 E26 17 25.9	521 m	*Quercus sp.* forest near a watersource
13	29.11.2013	N42 42 54.8 E26 15 49.3	420 m	rocks occupied by bush as *Carpinus orientalis*, *Fraxinus sp.*, *Quercus sp.*
14	29.11.2013	N42 42 41.8 E26 15 39.7	300 m	river bank forest dominated by *Alnus glutinosa*, *Rubus sp.*, *Hedera helix*
15	29.11.2013	N42 42 50.4 E26 15 48.0	308 m	spring near Asenovska River
16	29.11.2013	N42 42 50.4 E26 15 48.0	308 m	around a spring near Asenovska River
17	29.11.2013	N42 42 53.3 E26 15 44.3	311 m	grass terrain
18	19.3.2014	N42 44 15.1 E26 24 34.4	539 m	*Fagus sylvatica* and *Quercus sp.* forest
19	19.3.2014	N42 43 09.6 E26 21 34.2	987 m	*Fagus sylvatica* forest
20	19.3.2014	N42 43 06.8 E26 21 22.2	909 m	*Fagus sylvatica* forest
21	19.3.2014	N42 43 08.0 E26 21 26.1	932 m	steep limestone rocks in *Fagus sylvatica* forest
22	26.4.2014	N42 44 03.4 E26 21 37.4	1030 m	*Fagus sylvatica* forest
23	26.4.2014	N42 44 16.5 E26 18 07.2	894 m	open bush, grass and rocky terrains, limestone
24	27.4.2014	N42 42 17.1 E26 17 25.9	592 m	*Carpinus betulus* and *Quercus sp.* forest,

Table 2. Gastropod species found in Nature Park "Sinite kamani" - locations, environmental data and conservation status (based on DEDOV, 1998 and IRIKOV & ERÖSS, 2008). *Legend:* lit. – species reported by GEORGIEV (2008); W - global significance; E - European significance; N - national significance; TRL – relict from the Tertiary Period; BC - Bern Convention; HD – the Habitats Directive; Rare – rare species; me - mesophiles ; me-hg – me - hygrophiles; xph – xerophiles.

№	Species	Locality №	Ecological groups and Conservation Status
	Freshwater species		
	Family Hydrobiidae		
1	*Belgrandiella* cf. *angelovi* Pintér 1968	3, 8, 15	
	Family Limnaedae		
2	*Radix auricularia* (Linnaeus, 1758)	10	
3	*Radix labiata* (Rossmässler, 1835)	15	
	Terrestrial species		
	Family Pomatiasidae		
4	*Pomatias rivularis* (Eichwald, 1829)	6, 13, 16	TRL
5	*Pomatias elegans* (O. F. Müller, 1774)	lit., 6	TRL
	Family Orculidae		
6	*Sphyradium doliolum* (Bruguière, 1792)	6, 18	
	Family Valloniidae		
7	*Vallonia pulchella* (O. F. Müller, 1774)	lit.	
8	*Acanthinula aculeata* (O. F. Müller, 1774)	6, 19	
	Family Cochlicopidae		
9	*Cochlicopa lubricella* (Porro, 1838)	2	me
	Family Enidae		

10	*Merdigera obscura* (O. F. Müller, 1774)	6	me
11	*Ena montana* (Draparnaud, 1801)	lit.	me-hg
12	*Zebrina detrita* (O. F. Müller, 1774)	lit., 5, 6, 7, 13	xph,E
13	*Pseudochondrula seductilis* (Rossmässler, 1846)	lit., 5	me
14	*Mastus rossmaessleri* (L. Pfeiffer, 1846)	23	me
15	*Eubrephulus bicallosus* (L. Pfeiffer, 1847)	lit., 18	me-xph, Rare, N
	Family Clausiliidae		
16	*Cochlodina laminata* (Montagu, 1803)	18	me
17	*Macedonica marginata* (Rossmässler, 1835)	22	me-xph, E
18	*Laciniaria plicata* (Draparnaud, 1801)	6	me,E
19	*Alinda biplicata* = Balea biplicata (Montagu, 1803)	lit.	me
20	*Bulgarica urbanskii* Nordsieck, 1973	lit.	xph,W
21	*Bulgarica* cf *varnensis* (L. Pfeiffer, 1848)	6	me,E
22	Baleinae indet.	21	
23	*Vitrina pellucida* (O. F. Müller, 1774)	2	me-hg
	Family Gastrodontidae		
24	*Zonitoides nitidus* (O. F. Müller, 1774)	lit.	
	Family Zonitidae		
25	*Vitrea neglecta* Damjanov et L. Pintér 1969	lit.	me,E
26	*Aegopinella minor* (Stabile, 1864)	1, 6, 20	me-xph
27	*Oxychilus glaber* (Rossmässler, 1838)	6, 14	me-hg,
28	*Oxychilus urbanskii* Riedel, 1963	lit.	me, N
29	*Oxychilus* cf *urbanskii* Riedel, 1963	18	
30	*Oxychilus investigatus* Riedel, 1993	22	me,N
31	*Daudebardia rufa* (Draparnaud, 1805)	1	me-hg
	Family Arionidae		
32	*Arion silvaticus* Lohmander, 1937	19, 24	me
	Family Limacidae		
33	*Limax maximus* complex Linnaeus, 1758	lit., 8	me
34	*Limax* (*Limacus*) *flavus* Linnaeus, 1758	lit.	me ,N
35	*Lehmannia nyctelia* (Bourguignat, 1861)	lit.	me
	Family Agriolimacidae		
36	*Deroceras turcicum* (Simroth, 1894)	1, 6, 14, 18	me
37	*Deroceras reticulatum* (O. F. Müller, 1774)	lit.	me
	Family Lindholmiolmiolinae		
38	*Lindholmiola girva* (Frivaldsky, 1835)	lit.	xph, E
	Family Hygromiidae		
39	*Xerolenta obvia* (Menke, 1828)	lit., 5, 17	xph, E
40	*Perforatella incarnata* = *Monachoides incarnatus* (O. F. Müller, 1774)	lit., 18	me
41	*Monacha cartusiana* complex (O. F. Müller, 1774)	lit., 4	me- xph
42	*Monacha carascaloides* (Bourguignat, 1855)	17	me- xph
	Family Helicidae		
43	*Cattania balcanica* (Kobelt, 1876)	20	
44	*Helix lucorum* Linnaeus, 1758	lit., 11, 12, 14, 16	xph-me, E
45	*Helix pomatia* Linnaeus, 1758	lit., 7, 9	Corine, IUCN, BC, HD,E
46	*Helix figulina* Rossmässler, 1839	lit.	me, N
47	*Cepaea vindobonensis* (Férussac, 1821)	lit., 6	xph

Totally 13 snail species were identified in habitats placed near water basins and coastal forest areas. 11 species were found in the rest of the park - more specifically in the deciduous forests of the hilly and high regions.

The main features of the malacofauna in the park are determined by the typical mesophilic and mesophilic-xerophilic representatives - a total of 35 species of terrestrial snails. 11 xerophilic and calciphilic species were discovered in the

grassland habitats, open forests and rocks which are typical for the park.

The most widely spread terrestrial snail species are the *Z. detrita*, *D. turcicum* and *H. lucorum*, which were discovered in four habitat types and among the aquatic snails these are - *B. cf. angelovi*, *P. rivularis* and *A. minor* which were registered in three habitats.

With regard to its conservation value, the malacofauna in the Natural Park "Sinite kamuni" has a significant diversity. Between the 46 species of freshwater and terrestrial snails discovered in the park, 17 have important conservation significance. Seven species have importance at national level. These are *P. rivularis*, *P. elegans*, *O. Investigates, O. urbanski*, *L. flavus*, *H. figulina* and *E. bicallosus*. The last species is pretty rare for our fauna and *O. urbanski*, *L. flavus* and *H. figulina* are tertiary relics. Nine of the species like *Z. detrita*, *M. marginata*, *L. plicata*, *Bulgarica cf varnensis*, *V. neglecta*, *H. lucorum*, *L. girva*, *H. pomatia* and *X. obvia* have importance at European level and two of them - *B. urbanski* and *V. neglecta* (Bulgarian endemic species) have importance for the world natural heritage.

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References

DAMYANOV S., I. LIKHAREV. 1975. *Terrestrial snails (Gastropoda terrestria),* Fauna Bulgarica 5, Marin Drinov Publ., Sofia, 425 p. (In Bulgarian).

DEDOV I. 1998. Annotated check-list of the Bulgarian terrestrial snails (Mollusca, Gastropoda). - *Linzer Biologische Beiträge,* 30(2): 745-765.

GEORGIEV D. 2008. The terrestrial snails of NP "Sinite Kamani"- habitat distribution and conservation importance. - In: Velcheva I., A. Tsekov (Eds.). *Anniversary Scientific Conference of Ecology, Proceedings,* 1 November 2008, Plovdiv, pp. 136-146. (In Bulgarian).

GEORGIEV D. 2013. Contribution to the Knowledge on the Gastropod Fauna of the Natural Park "Balgarka" (Stara Planina Mts., Bulgaria). - *Ecologia Balkanica*, 5(2): 103-105.

IRIKOV A., Z. ERÖSS. 2008. An updated and annotated checklist of Bulgarian terrestrial gastropods (Mollusca: Gastropoda). - *Folia Malacologica,* 16(4): 199-207.

WELTER-SCHULTES F.W. 2012. *European non-marine mollusks, a guide for species identification.* Planet Poster Editions, Göttingen, 674 p.

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