

THE DEVELOPMENT OF PHYSIOTHERAPY IN LITHUANIA

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The article presents the data on the development of physiotherapy and physiotherapist training in Lithuania in accordance with the requirements of the European Network of Physiotherapy in Higher Education. The problems of the physiotherapist training in Lithuania and the possibility of their solution are discussed in the paper.

Key words: physiotherapy, physiotherapist training, higher education.

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Movement is a physiologic stimulator of human body, its growing, formation and a basis for existence of the animate nature. Motion and movement are perhaps the most important elements of the patient rehabilitation. The treatment of patients by means of motions was known since a long time ago. From time immemorial, people understood the significance of the value of movement for the healthy as well as the sick body. However, evidence-based motion treatment developed just in the period of the Renaissance (the 14th - 16th centuries), whereas kinesitherapy (from Greek *kinesis* – movement, *therapeia* – treatment), as a speciality formed just in the beginning of the 20th century.

The article reviews the evolution of physiotherapy in Lithuania, its place in the system of the patient rehabilitation, and the problems of training the specialist in the field.

In this country, a rehabilitation system for patients and the disabled is being developed. The main tasks of which is prevention of disability

and integration of the disabled into the community. The World Health Organization defines rehabilitation as a coordinated complex usage of medical, social, educational and professional measures aiming at maximal functional activity of the rehabilitee. The term *rehabilitation* is very often identified with the term *physical medicine*, and both the terms are very often used as synonyms. These terms have much in common, but they are not identical. *Physical medicine* is traditionally associated with treatment of disorders by means of motion and employing special equipment and physical agents, e.g. heat, cold, water, electricity, magnetic and quantum waves, etc. *Rehabilitation* is a wider notion, emphasizing restoration of the disturbed biosocial functions, correction or the patient's adaptation in the presence of the dysfunctions. However, it must be admitted that physiotherapy is perhaps the most important part of the rehabilitation system. By employing adequately chosen physical exercises, it is possible to purposefully act on all the functions of the body.

The importance of movement, breathing exercises, and massage in treatment of disorders was understood already long ago in Lithuania. Therapeutic exercises commenced to be applied in hospitals in the beginning of the 20th century, and workplaces for them were arranged. However, the outset of methodical applying therapeutic exercise is linked with a person of K. Dineika (1998-1950). The proposed by him psychophysical training is a method of exerting influence on the body by changing muscular tone, breathing control, active attention, will-power, adequate reactions to stimuli. The recommend topics of the psychophysical training are as follows {1}:

- Use your mind power. Balance between the ingested food and the consumed energy.
- Restore natural breathing. How to control respiration?
- How to master the relaxation technique? Healing properties of joy.
- Individual lifestyle.
- A minute of psychophysical exercise.
- Self-control as a sign of maturity.
- Is it possible to change one's temperament?
- Diaphragmatic breathing.
- Self-massage.

Therapeutic exercises are employed in steadily wider extent for prevention, treatment of disorders and rehabilitation of patients. Therefore a need of therapeutic exercise was established in the Lithuanian State Institute of Physical Education. In 1952, a park of physical therapy was opened in the health resort Druskininkai. In 1962, the professionals in physical therapy commenced to be trained. In 1995, two hundred and eighty one specialists were already prepared for work in physical therapy field.

In 1991, the law on social integration of the disabled in Lithuania was passed by the Parliament {2} which legitimized the creation of a multiprofile rehabilitation system {3}. During the period of 1992-2002, over 60 specialized rehabilitation divisions were opened in sanatoria, out-patient clinics and hospitals. An important role was played in the development of the rehabilitation system in Lithuania by a governmental programme of social integration of the disabled for a period of 2003-2012 {4}, in which it was indicated what is to be done during this decade and shown that the need for physiotherapists is steadily growing and qualification requirements for them augmented. Physiotherapists are obliged not only to have good understanding of treatment by motion but also to master the methods of applying physical means of therapy, psychological influence, and preventive measures. They act independently and collegially with other members of the rehabilitation team {5}. The established in 1995 the European Network of Physiotherapy in Higher Education has presented the following recommendations:

- A four-year university education.
- A clinical practice of no fewer than 1 000 hours.
- Work-based training.
- Continuous professional education.

In 1995, a four-year bachelor programme and a two-year master programme were included in the curriculum of the Lithuanian Academy of Physical Education. Up to 2003, the degree of bachelor were conferred on 237 students, and the degree of master on 82 students.

A great need of the specialists in the field has compelled the authorities concerned to look for means how to fill the gap. Therefore, in 1999, the assistants of physiotherapists commenced to be trained in six junior colleges (in Kaunas, Vilnius, Panevėžys, Šiauliai, Klaipėda, Utena) according to a three-year programme. However, such a training did not justify itself, as the education programme did not answer the up-to-date requirements. Therefore, from 2003, the junior colleges began to train the physiotherapists in accordance with a new four-year programme, whereas the earlier prepared physiotherapists commenced to pass levelling 30-50-credit courses, which enabled

them to obtain the full professional qualification of the physiotherapist.

In the presence of a considerable shortage of such professionals, schools of higher education with a medical profile joined in training them. In 2001, bachelor programmes started in the Medical Faculty of Vilnius University and in Kaunas University of Medicine; in 2005, a master programme was commenced in Kaunas University of Medicine. In 2006, the staff of the health care institutions in this country comprised 474 physiotherapists with university education and 299 physiotherapists with professional qualifications obtained in the junior colleges. In Lithuania, one physiotherapist is for about 4 400 of inhabitants, whereas this number in many other countries is several times lower. The calculation of the demand of physiotherapists in accordance with the European standards shows that the demand of such specialist in Lithuania should equal to approximate 4 700 individuals. The shortage of these specialists could be compensated by training them in Lithuania throughout a period of 15-20 years, provided that after graduation they would not go abroad.

A very important problem is qualification of physiotherapists. At present much effort is paid for

improving the physiotherapeutical programmes in the universities as well as in the other schools of higher education, postgraduate qualification perfection courses are continuously organized. Considerable input in the work is being made by the Lithuanian Scientific Society of Physiotherapists headed by Dr. Gražina Krutulytė, which is a member of the World Confederation for Physical Therapy (W.C.P.T.). Also a journal the *Kineziterapija* has begun to be issued. In 2003, a seminar-conference *The Assessment of Physiotherapeutical Educational Competence in Europe in realizing the Bologna Declaration* was held in Druskininkai, during which much attention was paid to training of physiotherapists, to the standards of their professional competence in whole Europe at the bachelor and master levels {6}. Highly qualified teachers and especially guides of practical skills instruction are still being missed. The Finnish experience shows that physiotherapists even after completion of the master studies are not be good teachers without the additional pedagogical preparedness. Therefore, Yvaskula University has included a compulsory one-year programmes for the teachers. Considerable expertise in the field, especially in training practical skills instructors, have Danes {6}.

Table 1. The number of phtyiotherapists in some European countries

Country (year)	Number of Inhabitants	Number of physiotherapists	Number of inhabitants per 1 physiotherapist
Denmark (2005)	5 336 394	9 408	567
Estonia (2005)	1 431 471	238	6 027
Finland (2005)	5 167 486	12 100	427
Germany (2005)	82 797 408	75 000	1 103
Latvia (2005)	2 404 926	260	9 249
Lithuania (2006)	3 392 550	773	4 389
Norway (2005)	4 481 162	9 500	471
Poland (2003)	38 632 453	10 000	3 863
Romania (2003)	22 430 457	860	26 082
Sweden (2005)	8 873 052	15 400	576
Turkey (2005)	68 893 918	3 500	19 684
United Kingdom (2005)	60 270 708	35 952	1 676

(European Region of the World Confederation for Physical Therapy)

In evaluation of the development of physiotherapy and training of the Lithuanian specialists in the field, it is possible to assert that physiotherapy takes a proper place in the created rehabilitation system. However, there are still many problems in its development, as follows:

- The organizers of the public health still insufficiently appreciate the possibilities of physiotherapy in the treatment of disorders and rehabilitation of patients.
- The number of physiotherapists is still clearly insufficient, and it is indispensable to increase their training in the schools of higher education.
- The number of physiotherapeutical workplaces in the health care institutions is insufficient. It is necessary to arrange them so that severe patients could obtain necessary rehabilitation means from the very first days of the illness or trauma and in all the stages of the disease or injury.
- Shortage of highly qualified teachers and especially of practical skills instructors. Therefore, it is necessary to intensify doctoral studies in this field.
- Lack of textbooks and practical guidelines in Lithuanian, together with insufficient material and technical base for specialist training.
- Still not formulated standards for physiotherapeutic work in concrete disorder cases.

The solution of the afore-mentioned problems, first of all, depends on the standpoints of the politicians, public health care organizers, managers of the health care institutions, and institutions taking part in the training of the physiotherapists.

REFERENCES

- Dineika K. (1984). Judėjimas, kvėpavimas, psichofizinė treniruotė (Movement, breathing, and psychophysical training). Vilnius, p. 158. (In Lithuanian).
- Lietuvos Respublikos invalidų socialinės integracijos įstatymas (The Law of Social Integration of the Disabled in the Republic of Lithuania. Parliamentary record). Vilnius, 1991 m. lapkričio 28 d. Nr. 1-2044. 1992. 10.01. No. 10. (In Lithuanian).
- Klimavičius, R. Reabilitacijos strategija (Rehabilitation strategy). Vilnius, 1995. (In Lithuanian).
- Nacionalinė žmonių su negalia socialinės integracijos 2003-2012 metų programa (2002). (National Programme of Social Integration of the Disabled for the Period of 2003-2012). Vyriausybės žinios N57, 2002 m. birželio 12 d. (In Lithuanian).
- Physiotherapy. ECTS-Course Guide. Social and Health Care 2001-2002.
- Guidelines for Clinical Teaching, School of Occupational Therapy and Physiotherapy in Aarhus. January 2003.

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EXCESSIVE PHYSICAL EXERCISE IN TOURISM AND RECREATION AND ITS METABOLIC EFFECTS

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An excessive physical exercise destructively influences on humans. This question has now a not overpriced meaning because there are more and more popular extreme kinds of tourism, recreation and sport, and far shifting limits of results attained in elite sport, and there are wider range of time and loads of professional work, which can lead even to work holism. If compare human body organization to not oversized device or building construction, one has to say that human body is in the same way subjected to stress, it means energy expenditure. A subjection to permanent stress without a full recovery can cause an abiding change of a metabolism regulation level. It means strain of this regulation. It is a shift within a genetically programmed range of homeostasis and a change of biological requirements of human body subordinative to maintenance a relative and very labile metabolic balance. However, it is not free. Each physical exercise is a download of an energetic credit from human body energetic substrates. If this credit is too high, it can cause a dysfunction of some functional spheres of a human being and can turn into an overtraining status. Usually, it manifests in suppression of the most energy-consuming function, it means reproductive function. It occurs in both genders. Then, this question is very complicated from the psychic sphere of human being, too.

Key words: extreme tourist and recreational activity, excessive exercise threat, work holism, gender

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INTRODUCTION

All situations associated with energy expenditure by humans are considered as catabolic conditions. For example: mental work, physical work, digestion, disease, emotion (both positive and negative). They have, of course, their anabolic counterparts as, responsively, sleep,

resting, absorption of nutritive elements, convalescence and relaxation. It gives as a result a labile balance of metabolic processes in humans. This phenomenon is known under the idea of homeostasis which determines a range of possible adaptation of organism to actual environmental conditions as ambient

temperature, level of nutrition and an intensity of physical effort, physical activity. It is also known that homeostasis is far more stable in women than in men (Charzewski 1996, Szczepanowska 2001). It means men are more trainable “adaptive, eco-sensitive“ than women (Wolański 1999). It is a result of a reproductive function of each human gender. Stable internal metabolic conditions of female organism guarantees a proper internal environment to create a new life. And also a range of homeostasis is narrower for older people (Szczepanowska 2001). It means their adaptation to environmental conditions is weaker and occurs through a worse organism’s tolerance (Szczepanowska 2001). The apogee of human homeostasis stability in each gender is round the age of forty. So, it is understandable why astronauts, cosmonauts and ticonauts are flying into the space at this age. The very disadvantageous influence of open space, without gravity, can cause less damage at this age than in other periods of human life. These damages are easy comparable on earth to the results of bed rest, from one side, or from the other - to an excessive physical load, associated sometimes with emotional stress, and they are very often not possible to compensate. Then, the recovery of organism to its previous function is sometimes not possible.

If compare human body organization to not oversized device or building construction, one has to say that human body is in the same way subjected to stress, it means energy expenditure. A subjection to permanent stress without a full recovery can cause an abiding change of a metabolism regulation level. It means strain of this regulation. It is a shift within a genetically programmed range of homeostasis and a change of biological requirements of human body subordinative to maintenance a relative and very labile metabolic balance. Very often it means a disease, sometimes a permanent one – to the end of life. This disease can also make life shorter. However, this shift “strain“ is not free. Each physical exercise is a download of an energetic credit from human body energetic substrates. If this credit is too high, it can cause a dysfunction of some functional spheres of a human being

and can turn into an overtraining status. Usually, it manifests in suppression of the most energy-consuming function, it means reproductive function (Hackney et al. 2003). It occurs both in women and men. Then, this question is very complicated from the psychic sphere of human being, too. Research indicates that endurance exercise training, as prevailing in the tourist and recreational training, has significant effects upon the reproductive endocrine system of humans. Until recently, this effect was thought to be limited primarily to females (Bullen et al. 1984, 1985). However, a growing body of evidence demonstrates that the male reproductive endocrine system is also affected. Specifically, the circulating hormonal levels of testosterone are found to be at low concentrations and, the hypothalamic-pituitary-testicular axis that regulates testosterone production is altered in endurance trained men. Potentially, the lowered testosterone levels of the endurance-trained male could disrupt some of their anabolic or androgenic dependent processes (Hackney 2001). Fatigue may modify the hormone responses to exercise. Overall fatigue from prolonged endurance activity may introduce a resetting in the pituitary-adrenocortical component of the endocrine system, expressed either by intensified or by suppressed endocrine functions (Virus et al. 2001). The findings of suppressed reproductive hormones in males and females may exist because they are overtrained or are developing the overtraining syndrome (Hackney 1996, Hackney et al. 2000, Hackney 2001). The overtraining syndrome is a pathological disorder, where there is consistent and persistent exercise performance incompetence in a qualified tourist participant that does not reverse itself after a few days of rest and recovery. It indicates a change of endocrine system secretion to suppression and extremely low circulating levels of testosterone in males, and estrogens and progesterone in females, and also gonadotropins: lutropin, follitropin (Hackney 2001). Thus, the hormonal changes between overtrained and chronic endurance trained males and females are similar. Overtraining and decrease of hormone levels causes an infringement of immune system (Hackney 2001, Miles et al. 1999). And excessive

extreme exercise is a reason of a decreased protein synthesis and muscle mass development, then bone demineralization – severe mineral loss from bones (Hackney 2001).

Physical exercise under conditions of excessive physical load may cause many disadvantageous somatic and metabolic changes. These changes are multifactor. To enumerate a majority of them there are as follows: oxidative stress, risk of cardiovascular disease, cardiac injury, overtraining and decrease of hormone levels, then deterioration of metabolic regulation and integration of organism, infringement of immune system, deterioration of cell membranes, and even a syndrome of anorexia athletica. Today one can observe extreme antithetic forms to realize human dreams: from one side only conveniences, comfortable life and limited physical activity, and from the other - a desire to be the best in every respect, also from physical activity point of view. In any case it is connected with human psyche because motivation and consciousness are the most important determinant of performance – physical capacity. It is more important than oxygen supply, resources of energy substrates and efficiency of equalization of homeostasis disturbances “ efficiency of effective recovery. Therefore, today it is a great need, from one hand, to propagate a praise of being physically active. This problem is worked out by many persons involved with civilized diseases. And there is also, from the other hand, a great need to propagate a praise of resting, just simply of being lazy (M.N.M. 2001). Health gets benefits of sleeping eight to nine hours a night, taking naps and avoiding long work hours and extreme exercise. The benefits of moderate exercise are far more healthful than more intensive exercises. Extreme forms of tourist and recreational excessive activity are forms of extreme kind of sport, indeed. There are many changes of human body during this kind of qualified tourism. For example, an effect of high altitude exposure during a mountain climbing expedition is confirmed by weight loss and decrease of body mass components. Physical demand of mountain climbing to high altitudes significantly impacts the overall body composition reducing the

body’s primary components, i.e. fat and lean body mass (Shaw et al. 1995). Practicing exercise, even at the tourist and recreational level, is associated with increased energy expenditure, which typically changes body composition parameters (Lehmann et al. 1999).

Considering an influence of extreme loads on humans one has to notice that today limitations and threats of excessive physical exercises are known. This problem seems to be very interesting now when people are conscious in undertaken of risk forms of physical activity.

Despite the many known health benefits of exercise, there is a body of evidence suggesting that endurance exercise is associated with oxidative stress. The extreme endurance exercise results in the generation of lipid peroxidation with a concomitant increase in vitamin E disappearance (Mastaloudis et al. 2001). When endurance training is coupled with antioxidant vitamin supplementation it reduces blood creatine kinase increase under exercise stress (Rokitzki et al. 1994).

Although physical exercise is beneficial to health of people who exercise at high intensities throughout their lifetime it may have increased risk of cardiovascular disease (Sharman et al. 2004). Aerobic exercise, as it is mentioned above, increases oxidative stress and may contribute to atherogenesis by augmented oxidation of plasma lipoproteins. Obtained findings suggest that people with high aerobic power, due to extreme endurance exercise, have plasma with decreased antioxidant capacity and higher susceptibility to oxidation which may increase their cardiovascular risk (Sharman et al. 2004). The relationship between extreme exercise and coronary artery disease is not well understood, and the information available is contradictory. Conditions in which the partial pressure of environment oxygen varies constantly, it means during extreme mountain bike challenges for example, can induce myocardial cell injury (Ortega et al. 2006). In male amateur mountain bikers, this kind of strenuous exercise may induce sub-clinical myocardial injury (Ortega et al. 2006). The basis

role of etiology in this disease may play cardiac troponin I. Strenuous endurance exercise can change levels of cardiac troponin I (Neumayr et al. 2001). It causes health hazards of extreme exercise but hypotheses explaining the exercise-induced cardiac injuries are not confirmed yet (Neumayr et al. 2001).

It is well-known that persons with a drug addiction experience feelings of anhedonia during "normal" daily activities. It has been proposed that these symptoms of anhedonia are the result of direct pharmacological influences of drugs on the dopamine system. Anhedonic symptoms in skydivers who regularly expose themselves to thrilling extreme kind of tourist activity (and then experience intense hedonic feelings) are tested to confirm the assumption that non pharmacological processes are also involved in anhedonia. The main findings of the study is that subjects who engage in the high-risk activity of sky-diving have experienced more anhedonic symptoms than subjects who do not engage in such an extreme kind of activity and then, prefer a low-risk activity like rowing. This finding supports the notion that skydiving has similarities with addictive behaviors and that frequent exposure to "natural high" experiences is related to anhedonia. This suggests that the negative emotional state as observed in drug users may not be exclusively the results of exogenous psychopharmacological effects, but might also result from psychological mechanisms that are partly responsible for these anhedonic feelings (Franken et al. 2006).

Exercise gives benefits to human body but too much exercise causes disadvantages, known as a syndrome of *anorexia-athletica* (Current Health 2004). It is characteristic for many qualified tourists. The benefits of exercise are clear. Exercise helps control weight, tone muscles, strengthen bones, and improve cardiovascular health. It can reduce stress and give a mental lift, too. But there is such a thing as exercising too much. Some exercise addict young people, often teenage girls exercise compulsively. This can be dangerous. How one can tell if exercise program is getting extreme? Here are some warning signs:

being preoccupied with weight and exercise, exercising even when somebody is ill, withdrawing from family, social, or school activities in order to exercise instead, getting upset whenever accompanying person cannot exercise, worrying that somebody will gain weight if he do not exercise, using herbs, diet aids, or other chemicals to "improve" himself physically, being dissatisfied with physical achievements of other people. This situation describes an important need to get medical and psychological help (Current Health 2004).

Experiments on animals and clinical studies in athletes have shown also a negative impact of extreme exercises on the physicochemical characteristics of biomembranes. The resultant decrease in the activity of different isoforms of the multienzymatic system of hepatic cytochrome P450 may underline firstly, the formation of a vicious circle of increases in the microviscosity of biomembranes and membrane-dependent processes and, secondly, the lowered resistance of athletes environmental factors, which should be borne in mind during the professional activity of high-class athletes (Tverdokhlib & Nikonorov 2002). Then, throughout the deterioration of cell membranes and a microscopic damage to muscle fibers, a full deterioration of metabolic regulation and integration of organism succeeds (Tverdokhlib & Nikonorov 2002).

It is a wide range of biochemical and biomechanical methods to investigate metabolic and mechanic effect of a hard exercise in humans. To choose only a few of them one can enumerate: a study of formation of the EMN index (Electrophoretic Mobility of Cell Nuclei in epithelial tissue - ratio of cells with mobile nuclei to cells with non-mobile nuclei); then an indication of sexual hormones, especially testosterone, in the group of trained and sedentary control subjects, and a measurement of grip force differences of power in finger muscle flexors (PFMF) between right and left hand in physically active men (PAM) - in consecutive categories of their vocationally active age - and in sedentary men (SM).

Aim of work

The aim of work is to introduce three examples of our own studies carried out in regard to metabolic changes as a result of a great volume of exercise, it means a product of multiplication between intensity and time of exercise during practicing tourism and recreation, and also as a result of a hard physical work during the vocational period of life.

The first example

The EMN index is a percentage ratio of buccal epithelium cells with nuclei vibrating (moving) in an electrical field to cells with non-vibrating (moving) nuclei. This phenomenon is related to metabolic processes occurring in the area of the cell nucleus (Markiewicz & Cholewa 1979) and also to cellular physicochemical properties (Shakhbazov & Colupaeva 1991, Shckorbatov et al. 1995a,b,c, Shckorbatov et al. 1998, Shckorbatov 1999). Increased metabolic processes accelerate the activity of a cell nucleus and change its structure. Then, the resultant charge is changed. The electro-negatively

charged nucleus vibrates in compliance with the change of the imposed variable magnetic field to the electrodes, moving towards the anode (Shakhbazov et al. 1986). The lowering of pH of plasma through an increase of acidity during exercise captures anions and changes the permeability of cellular membranes in the direction of a decrease of homeostatic imbalance inside and outside the cellular milieu. The Electrophoretic Mobility of Cell Nuclei (EMN) index reflects physiological changes in the body associated with environmental factors potentially harmful to the health of the individual (Czapla & Cieřlik 2000). Electrophoretic activity within cell nuclei is assessed by intracellular microelectrophoresis (Shakhbazov et al. 1986). The EMN index is used then as an indicator of biological age (Czapla 2000, Shckorbatov & Shakhbazov 1992) and physiological conditions of the body (Czapla 1999, Czapla & Cieřlik 2000, Shakhbazov et al. 1996, Shakhbazov et al. 1997). An average, the EMN index rises progressively during development, reaching maximal values at 17-18 years of age and then declines gradually with advancing age (Figure 1).

The EMN phenomenon is related to the biochemical composition and physiology of

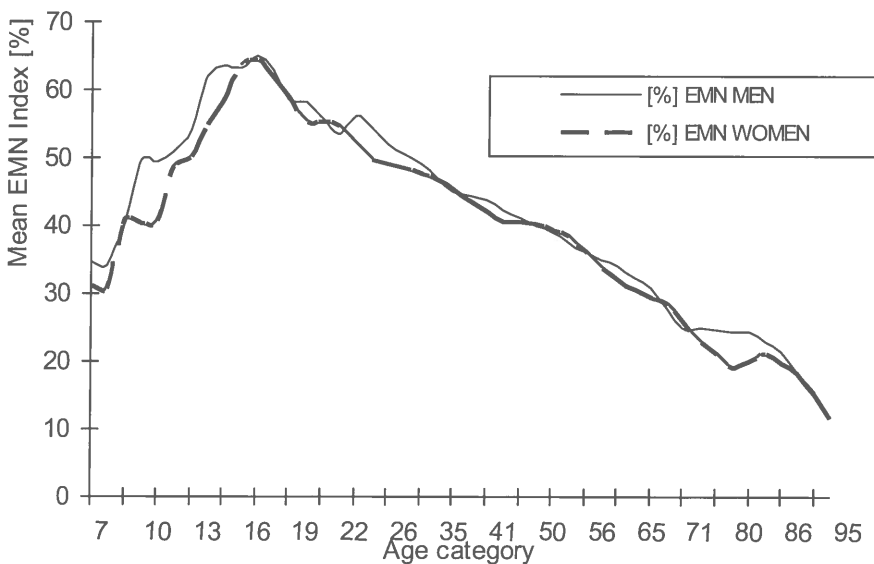


Fig. 1. Average values of the EMN index in human being ontogenesis formation. Rising line- progressive phase (Cieřlik et al. 1994), dropping line- stable and involutionary phase (Czapla 1999, Czapla 2000).

cellular structures and to properties of physical and chemical nature, or to electrokinetic and electrostatic properties of nuclei and other cellular structures changing with age (Czapla 1999). The EMN index describes the physiological state of the body not only at resting status but also under intensive exercise conditions.

The physiological condition of the body changes in genetic limits defined by homeostatic mechanisms specific for individual structures and functions. One of these mechanisms is acid-base balance of blood, cerebrospinal fluid and extracellular liquids. Regular tourist and recreational training may shift the level and direction of this balance: on one hand, more effectively eliminating acid products of metabolism and energy conversion, and on the other hand, buffering blood volume extension (Szczepanowska 2001). It is an adaptation to the demands of rigorous training due to a more efficient metabolism which under extreme conditions of exercise in trained individuals as compares to untrained ones permits an achievement of a high level of performance, and also can show metabolic differences between maximal and supermaximal exercises.

The purpose of this study is to evaluate the relationship between changes in the physiochemical characteristics of buccal epithelial cells measured by the EMN index and physiological parameters of the blood acid-base balance (pH, BE and LA) during maximal and supermaximal exercises.

Two groups of females practicing rowing as a form of spending their leisure time have been subjected to the study. One group (N=33) has been younger, at the average age 15 y.o. and the second was older (N=10) at age 22 y.o. As expected, practicing experience is greater in the older group as compares to the younger one. Two types of exercise tests on Concept II (Morrisville, USA) rowing ergometer have been administered to all females:

1. Supermaximal – accruing extreme exercise intensity in the shortest period

of time during 2000 m. Under these conditions, intensity has reached super-maximal level above maximal oxygen uptake (VO_{2max}).

2. Maximal - accruing exercise intensity up to VO_{2max} . Exercise intensity has been increased every 3 minutes by 30W up to VO_{2max} .

Arterial blood from the finger tip has been drawn out 3 minutes before and 3 minutes after the exercise in order to measure acid-base balance parameters (pH and BE) and lactic acid concentration (LA). Buccal epithelial cells have been collected before and just after the exercise bout by disposable, sterile spatulas. It was a non-invasive, bloodless and painless procedure. The nuclei have been placed in 0.9% NaCl solution and have been observed under the microscope, magnified 200 times, on a special plate in an alternating electric field of 20-30V and 0.1mA intensity and 1"2Hz electric field frequency alterations.

Changes in the EMN index, pH, BE and LA concentration before and after the exercise bouts have been calculated statistically, also with correlation analysis. The following parameters: pH, BE and LA have changed significantly ($p<0.05$) from pre- (resting) to post-exercise status, while the EMN index has changed only in younger group of females under super-maximal conditions. Correlations between the EMN index and pH, BE and LA are stronger after super-maximal exercise, and also stronger for younger group ($p<0.01$). Correlations between the EMN index and these acid-base balance physiological parameters reflect the homeostatic disturbance associated with intensive exercise conditions. The decline in the EMN index appears to be dependent on the post-exercise changes of an organism's acidity.

In conclusion, the EMN index reflects acid-base alterations and may be useful in evaluating systematic reactions to stress an expression of energy expenditure and thus production of metabolic intermediates (e.g. pH, BE, LA).

It is clear that super-maximal exercise of a deep acidity produces the greatest changes in the physicochemical features of buccal epithelial cells. No significant changes in the EMN index for the older group may reflect an effective metabolic mechanism to compensate stress during intensive exercise in these females. It has meant that the older group could show deeper acid reaction after the exercise.

The second example

The determination of hormone levels by radioimmunoassay is a commonly known method to recognize hormone changes during different conditions of humans. This method has been used just in the following work together with the infusion of gonadotropin-releasing hormone (GnRH) to induce testicular testosterone production via subsequent elevations of lutropin. Testosterone production rate has been statistically analyzed with adjustments for confounding factors and compared between groups.

This study can show an influence of recreational training of long-distance running on a level of sexual hormones, especially testosterone. These hormones besides an obvious reproductive function are responsible for a proper regulation and also integration of circulating system.

Research indicates that nevertheless, in a recreation long-distance running of 100 km per week, endurance-trained men have lower basal testosterone concentrations than age-matched sedentary control men. Therefore, in this study the peripheral component in the hypothalamic-pituitary-testicular (H-P-T) axis in endurance-trained men is examined to determine if basal testicular production of testosterone is suppressed. The study design has been retrospective, with a case-control approach. All examined men have been 40 y.o.

Recreational long-distance runners as trained men (N=5) and sedentary control men (N=6) have been infused with gonadotropin-releasing

hormone (GnRH) to induce testicular testosterone production via subsequent lutropin elevations. Testosterone production rate has been statistically analyzed with adjustments for confounding factors and compared between groups.

The basal testosterone concentrations have differed significantly between the trained and sedentary control men groups [pooled mean values; 13.9 (3.0) nmol·l⁻¹ vs. 23.4 (3.2) nmol·l⁻¹, p<0.05]. The testosterone production rate has been significantly lower (~20-30%; p<0.05) in the trained men as compared with the sedentary control men following GnRH infusion.

It is concluded that the exogenous stimulated testicular production rate of endurance-trained men is suppressed. This finding may account, in part, for the lower circulating basal testosterone concentrations found in these men. The present evidence supports the hypothesis that endurance exercise training induces a degree of peripheral adaptation (i.e., testicle) in the H-P-T axis. One can assume that this adaptation in the axis could be both a permanent or transient phenomenon. It seems to be dependent on the period of time as a practicing experience. Organism sacrifices a sexual-reproductive function to survive, it means to preserve life. Too heavy exercise then can disturb the most energy-consuming function of human body. Literature data have shown this phenomenon firstly in females, and then researches had observed the similar behavior of males' body. It is characteristic also for overtraining, work holism, and exercise addiction (Hackney et al. 2003).

The third example

From the mechanical point of view there are some types of handgrip. They are mainly associated with a vocational work. A finger-palm grip multipoint, called also power grip, is used in power type of work (Fiutko 1989, Dunnet et al. 1995). The increase in electrical activity of the finger flexor muscles with an increase in the grip force is observed to be most significant under static as well as dynamic loading conditions

(Gurram et al. 1995). Finger motion is a balance of flexor muscles and intrinsic extensor muscles and provides incredible versatility of finger and hands (von Schroeder, Botte 1997).

In this example it is necessary to analyze the influence of a high physical exercise load during a majority of life spans. The measurements of power in finger muscle flexors (PFMF) can then describe a development of decrease of muscle mass. In this work it is shown within the period over 30 years (between 21-54 y.o.) in PAM and SM.

The aim of this work is to analyze differences in a breakdown of PFMF between right and left hand and to compare them between PAM (during a vocational period of life in consecutive categories of their vocationally active age) and SM.

The group of PAM consisted of 38 subjects and group of SM of 42 subjects. The range of age for both groups is between 21-54 y. Body height of physically active is 178.5 cm (SD=4.97 cm) and for sedentary ones – 173.9 cm (SD=6.21 cm).

A PFMF value of right and left hand has been determined by the JAMAR hydraulic hand dynamometer Sammons Preston INC. To obtain additional quantities the following measurements have been carried out: width of elbow epiphysis, width of distal forearm epiphysis, upper extremity length, and forearm length. All principles of measurement methods have been preserved (Drozdowski 1998). All subjects are right-handed. Examined subjects show also asymmetry in morphological features of upper extremities (right and left). Massiveness of skeleton in upper extremity has been greater in PAM (width of elbow epiphysis and width of distal right forearm epiphysis between both groups: $p < 0.0001$; width of distal left forearm epiphysis between both groups: $p < 0.05$). Length of upper extremity has been comparable in both examined groups (ns difference for both extremities). These results can be explained by a high workload in PAM during many years of their vocational activity. However, in the whole age range PFMF mean value of right hand is higher in SM (a ns difference), and PFMF

mean value of left hand is higher in PAM ($p < 0.05$). Furthermore, taking under the consideration the dynamics of this feature in both hands it is clear that a significant quick rate of PFMF increase ($p < 0.01$) appears in PAM between 31-35 y.o. The highest development of PFMF in SM is between 26-30 y.o. The PFMF increase in SM is then milder than in PAM. In PAM, in turn, there is a decrease between 36-40 y.o. of both hands ($p > 0.05$). In this group after 50 y.o. PFMF of left hand is higher than right hand ($p < 0.05$). In the case of SM PFMF of both hands achieves the highest value between 46-50 y.o. At the age 36-45 y.o. a value of PFMF in PAM is equal to the value of PFMF in SM. In PAM since 46 y.o. is a regression of PFMF in both hands as compares to SM. Concluding, a decrease in PFMF observed in PAM can be caused and explained by a higher physical exploitation of this work organ in this vocational group as compare to SM (Quaine et al. 2003).

DISCUSSION

Even if submit a hypothesis that there are not differences between genders in relationships to the development of maximum force (Hackney, Gilliam 1984) and also find that women are more resistant to the fatigue (Ziembra 1998) in endurance exercise it is worth to mention that females are stronger gender. It is connected also with the psychic sphere of organism's function. The excessive exercise any how plays a destructive role in body structure, function and psychics from the point of understanding a supercompensation phenomenon, too. The whole proceeds mainly by impossibility to realize the entire, complex recovery. Each exercise is a stress for organism – throughout energy expenditure – the recovery means reconstruction of this lack of energy and achievement of a metabolic balance – homeostasis. Homeostasis means health. Noncompliance of a normal, healthful lifestyle, incomprehension of principles of this way of life causes an excessive exploitation of organism's biological structures. If this process lasts many years it means a degradation of body, its function and psychics. During an explosive development of technology it is necessary to

understand limitations of humans. There are exact limits of human biological possibilities and remarkable adaptations enabling withstand extreme conditions. However, some scientists have discovered a genetic mutation in muscle cells that can cause extreme exercise intolerance (Kallen 2000). It creates a new future situation for a great differentiation of humans in regard to their physical possibilities.

CONCLUSION

A need to explore what happens to human body in inhabitable environment should be accompanied by a common sense allowing preserve health and life.

REFERENCES

- Bullen B.A., Skrinar G.S., Beitins I.Z., Carr D.B., Reppert S.M., Dotson C.O., Fencel M. de M., Gervino E.V., McArthur J.M. 1984. Endurance training effects on plasma hormonal responsiveness and sex hormone excretion. *J. Appl. Physiol.*, 56(6):1453-1463.
- Bullen B.A., Skrinar G.S., Beitins I.Z., Von Mering G., Turnbull B.A., McArthur J.W. 1985. Induction of menstrual cycle disorders by strenuous exercise in untrained women. *N. Engl. J. Med.*, 312:1349-1353.
- Charzewski J. 1996. Odmienne odpowiedź płci na stresy środowiskowe. In: Skierska E. (ed.). *Sport Kobiet. Polskie Stowarzyszenie Sportu Kobiet*, Warszawa 7-16. (In Polish).
- Cieślak J., Kaczmarek M., Kaliszewska-Drozdowska M. D. 1994. Wiek fizjologiczny. In: *Dziecko Poznańskie '90*. Poznań. (In Polish).
- Czapla Z. 1999. Fazowość rozwoju biologicznego człowieka oceniania wybranymi metodami fizykochemicznymi, maszynopis pracy doktorskiej, Uniwersytet Adama Mickiewicza, Poznań. (In Polish).
- Czapla Z. 2000. The phaseness of human biological development assessed with the use of selected physicochemical methods. *Variability and Evolution*, Vol. 8, 135-141.
- Czapla Z., Cieślak J. 2000. The EMN index as measure of the biological condition of the human organism, *Medical Review. Scripta Periodica*, III(3):24-38.
- Current Health 2004. 30(7):2-2.
- Drozdowski, Z. 1975. Doniesienie z badań asymetrii siły mięśni zginaczy palców ręki. Materiały konferencyjne „Morfofunkcjonalna asymetria człowieka”. AWF Poznań, 68. (In Polish).
- Drozdowski, Z. 1998. Antropometria w wychowaniu fizycznym. AWF Poznań, 24. (In Polish).
- Dunnet W.J., Housden P.L., Birch R. 1995. Flexor to extensor tendon transfers in the hand. *J. Hand Surgery*, 20(1):26-28.
- Fiutko, R. 1989. Ocena siły mięśni zginaczy ręki u pracowników Huty Katowice na tle uwarunkowań społecznych i zdrowotnych. AM Warszawa. (In Polish).
- Franken I.H., Zijlstra C., Muris P. 2006. Are nonpharmacological induced rewards related to anhedonia? A study among skydivers. *Progress In Neuro-Psychopharmacology & Biological Psychiatry*, 30(2):297-300.
- Gurram R., Rakheja S., Gouw G.J., Ma S. 1995. Influence of power tool-related parameters on The response of finger flexor muscles. *Int Arch Occup Environ Health*, 66(6):393-398.
- (Hackney A.C., Gilliam T.B. 1984. Assessment of maximum isometric, isotonic and isokinetic leg extensor strength in young adult females. *National Strength & Conditioning Association Journal*, 6(4):28-31.

- Hackney A.C. 1996. The male reproductive system and endurance exercise. *Medicine & Science in Sports & Exercise*, 28(2):180-189.
- Hackney A.C., Dobrigde J., Wilson L.S. 2000. The overtraining syndrome in athletes: hypothesis as to development and steps to treatment. *Medicina Sportive Polonica*, 4(1):E15-E27.
- Hackney A.C. 2001. Endurance Exercise Training and Reproductive Endocrine Dysfunction in Men: Alterations in the Hypothalamic-Pituitary-Testicular Axis, *Current Pharmaceutical Design*, 7:261-273.
- Hackney A.C., Szczepanowska E., Viru A.M. 2003. Basal testicular testosterone production in endurance trained men is suppressed. *European Journal of Applied Physiology*, 89:198-201.
- Kallen B. 2000. Muscle mutation. *Shape*, 19(8):58-67.
- Lehmann M., Foster C., Gastmann U., Keizer H., Steinacker J. 1999. Overload, performance incompetence and regeneration in sport. *Kluwer-Plenum, London*, pp1-52:268-189.
- Markiewicz K., Cholewa M. 1979. Dynamika zmian gospodarki wodno-elektrolitowej i równowagi kwasowo-zasadowej w czasie wysiłku fizycznego i restytucji, *Acta Physiol. Pol.*, 30(5-6), Suppl. 19:91-100. (In Polish).
- Mastaloudis A., Leonard S.W., Traber M.G. 2001. Oxidative stress in athletes during extreme endurance exercise, *Free Radical Biology&Medicine*, 31(7):911-922.
- Miles M.P., Naukam R.J., Hackney A.C., Clarkson P.M. 1999. Blood leukocyte and glutamine fluctuations after eccentric exercise, *International Journal of Sports Medicine*, 20(5):322-327.
- M.N.M., 2001, It's time to Get Lazy. *Natural Health*, 31(7):22-25.
- Neumayr G., Gaenger H., Pfister R., Sturm W., Schwaracher S.P., Eibl G., Mitterbauer G., Hoertnagl H. 2001. Plasma Levels of Cardiac Troponin I After Prolonged Strenuous Endurance Exercise, *American Journal of Cardiology*, 87(3):369-371.
- Ortega F.B., Ruiz J.R., Gutierrez A., Castillo M.J. 2006. Extreme mountain bike challenges may induce sub-clinical myocardial damage, *J Sports Med Phys Fitness*, 46(3):489-493.
- Quaine F., Vigouroux L., Martin L. 2003. Finger flexors fatigue in trained rock climbers and untrained sedentary subjects. *Int J Sports Med*, 24(6):424-427.
- Rokitzi L., Logemann E., Sagredos A.N., Murphy M., Wetzel-Roth W., Keul J. 1994. Lipid peroxidation and antioxidative vitamins under extreme endurance stress, *Acta Physiologica Scandinavica*, 151(2):149-158.
- Shakhbazov V.G., Colupaeva T.V., Nabokov A.L. 1986. Novyj metod opredelenija biologiceskogo vozrosta celoveka, *Laboratornoe Delo*, 7:404-407.
- Shakhbazov V.G., Grigoreva H.H., Colupaeva T.V. 1996. Novyj cito-biofizycieskij pokazatel biologiceskovo vazrosta i fizjologiceskovo sotajaniya organizma, *Fizjologija celoveka*, 22:71-75.
- Shakhbazov V.G., Shckorbatov Y.G., Colupaeva T.V. 1997. On connection between the electrokinetic properties of cell nuclei and human biological age, *Mech. Ageing Dev.*, 99(3):193-197.
- Shakhbazov V.G., Colupaeva T.V. 1991. Determination of the state of human organism by assessment of the electrokinetic properties of cell nuclei. Abstracts of the Conference Problems of Informatics, Moscow, 86-87
- Sharman J.E., Geraghty D.P., Shing C.M., Fraser D.I., Coombes J.S. 2004. Endurance exercise,

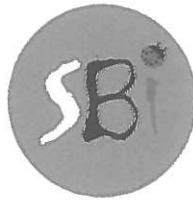
- plasma oxidation and cardiovascular risk, *Acta Cardiologica*, 59(6):636-642.
- Shaw E., Feith S., Coyne J.T., Bales B., Pozos R., Hackney A.C. 1995. Effects of high altitude exposure in the sub-Arctic on weight loss and anthropometric measures of body composition, *Israel Journal of Sports Medicine*, 2:173-178.
- Shckorbatov Y.G., Shakhbazov V.G. 1992. Bioelektricheskiye svoystva kletocnykh jader, *Uspiechy Sowlrjemjennoj Biologii*, 112:499-511. (in Russian).
- Shckorbatov Y.G., Colupaeva T.V., Shakhbazov V.G., Pustovoj P. A. 1995a. O swjazi elektriceskich swoystwa jader kletok celoveka c nekatorymi fizjologiceskimi parametrami, *Fizjologija celoveka*, 21(2):93-97. (In Russian).
- Shckorbatov Y.G., Shakhbazov V.G., Bogoslavsky A.M., Rudenko A.O. 1995b. On age-related changes of cell membrane permeability in human buccal epithelium cells. *Mech. Ageing Dev.*, 83:87-90.
- Shckorbatov Y.G., Shakhbazov V.G., Colupaeva T.V., Rudenko A.O. 1995c. Changements des proprietes electrocinetiques des noyaux et de la permeabilite des membranes des cellules buccales humaines avec l'age du donneur, *L'Eurobiologiste* 28(N 218):25-253-28-256.
- Shckorbatov Y.G., Grigoryeva N.N., Shakhbazov V.G., Grabina V.A., Bogoslavsky A.M. 1998. Microwave irradiation influences on the state of human cell nuclei, *Bioelectromagnetics* 19(7):414-419.
- Shckorbatov Y.G. 1999. He-Ne Laser light induced changes in the state of chromatin in human cells, *Naturwissenschaften* 86:452-453.
- Szczepanowska E., 2001, Odpowiedzi hormonów glukostatycznych i płciowych na wysiłek fizyczny organizmu człowieka, *Monografie* 345, AWF Poznań. (In Polish; abstract in English).
- Tverdokhlib V.P., Nikonorov A.A. 2002. Biokhimicheskie aspekty reaktsii organizma na ekstremalnuuu fizicheskuiu nagruzku, *Higienu i Sanitariia*, 5:49-51. (In Russian).
- Viru A.M., Hackney A.C., Valja E., Karelson K., Janson T., Viru M. 2001. Influence of prolonged continuous exercise on hormone responses to subsequent exercise in humans, *European Journal of Applied Physiology*, 85(6).
- von Schroeder H.P., Botte M.J. 1997. Functional anatomy of the extensor tendons of the digits. *Hand Clin.*, 13(1):51-62.
- Wolański N. 1999. Możliwości organizmu ludzkiego a środowisko. *Medicina Sportiva*, 3(3):161-175. (In Polish; abstract in English).
- Ziemba A.W. 1998. Biochemiczne i fizjologiczne przejawy dymorfizmu płciowego. In: *Kobieta, sport, zdrowie (part 2)* Gajewski A. (ed.) *Polskie Stowarzyszenie Sportu Kobiet i AWF Warszawa*. (In Polish).

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THE CARDIOPROTECTIVE EFFECT OF THE SINGLE EXERCISE SESSION – HOW LONG DOES IT LAST?

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Skorupska S., Kryzstofiak H., Światowiec A., Mamcarz A. 2008., The cardioprotective effect of the single exercise session – how long does it last? *Acta Biol. Univ. Daugavp.*, 8(1): 17 - 23.

Background: The warm – up phenomenon refers to improved exercise tolerance in the second of two successive exercise treadmill tests. Short episodes of ischemia caused by exercise make the myocardium more resistant to longer ischemia. Molecular mechanisms underlying the warm - up phenomenon remain unclear. The aim of this study was the assessment of this phenomenon's duration. **Material and methods:** Twenty - three men, aged 46 – 75 years (mean 61.35), with coronary heart disease participated in this study. Patients performed two successive exercise treadmill tests, using the Bruce protocol. After first test they were randomly divided into four groups. In the group 1 were patients who underwent second test one hour after finishing the first one. In the group 2 were patients who performed second test after two-hour rest. The group 3 was consisted of patients who rested four hours before consecutive test and in the group 4 were patients who performed next test 24 hours later. **Results:** We noticed statistically significant ($p < 0.05$) decrease of maximal systolic blood pressure in group 1 ($\bar{A} = - 15$), in groups 2 and 4 we observed similar results but they weren't statistically significant. Maximal rate pressure product in groups 1 ($\bar{A} = - 15.16$), 2 ($\bar{A} = - 13,00$) and 4 ($\bar{A} = - 7.33$) was lower in the second test but this decrease wasn't significant. **Conclusions:** Parameters improvement was observed two hours after exercise. The protective effect of physical activity seems to return 24 hours after finishing exercise.

Key words: coronary heart disease, physical activity, warm up.

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INTRODUCTION

For many years cardiologists thought that the best treatment for patients with coronary heart disease (CHD) is prolonged rest. However, during past 3 decades this thinking changed significantly and physical activity became not

only form of prevention but also the most important treatment for patients with coronary heart disease, after myocardial infarction, angioplasty, coronary by-pass surgery, stable heart failure and heart transplantation (Shepard & Balady 1999). Regular physical activity has indirect and direct effects on cardiovascular

system contributing to improvement of life quality and decrease occurrence of cardiac problems. Indirect effects of exercise are: reduction in cardiovascular risk factors and change in the life style. Physical activity reduces excessive body mass, influences body composition, prevent diabetes (improves sensitivity to insulin and increases glucose uptake), improves lipid profile (reduces LDL-cholesterol fractions and total cholesterol levels, increases HDL-cholesterol level) (Fletcher et al. 2001, Scrutinio et al. 2005, Shepard & Balady 1999). Direct benefits of regular exercise training are: lower rest heart rate, reduction of systolic and diastolic blood pressure at rest, increased stroke volume, better myocardial contractility. Improves ischemic threshold by decrease oxygen requirement and uptake (Fletcher et al. 2001, Scrutinio et al. 2005, Shepard & Balady 1999). On the other hand physical activity is one the factors that trigger myocardial ischemia. However, these short episodes of ischemia make the myocardium more resistant to the next longer ischemia. Heberden (Heberden 1785) first saw that angina symptoms are weaker or even disappear on continuing exercise and Gallavardin (Gallavardin 1925) claimed that patients improve ischemic threshold when they exercise a few minutes after an episode of exercise angina. These phenomenons were called *warm – up phenomenon or walking through angina* and its beneficial effect on myocardium was proved (Bilińska 1999, Luppi et al. 1998). This effect refers to increased exercise tolerance of myocardium in the second of two successive exercise tests (Okazaki et al. 1993, Stewart et al. 1995, Tomai et al. 1996, Tomai & Perino et al. 1999, Williams et al. 1985). It is estimated that 20 – 80% of patients present this phenomenon (Marber et al. 1994, Tomai et al. 1996). Mechanisms underlying the warm – up phenomenon still remain unclear and controversial. Incidence of this phenomenon has been explained by an increase in blood flow to the ischemic area through vasodilatation of the diseased artery, enhanced recruitment of collateral vessels (Williams et al. 1985) or attenuated oxygen consumption (Okazaki et al. 1993). Molecular mechanisms underlying the warm - up phenomenon remain unclear.

The aim of this study was the assessment of warm – up phenomenon's duration on the basis of changes of hemodynamic and electrocardiographic parameters during two consecutive treadmill exercise tests performed after 1 hour, 2 hours, 4 hours or 24 hours rest among the patients with stable coronary heart disease.

MATERIAL AND METHODS

Twenty three men, aged 46 – 75 years (mean 61.35), with coronary heart disease participated in this study. Patients didn't stop medications which they take continuously. The inclusion criteria were: stable coronary heart disease, positive previous exercise test (1 mm ST-segment depression at least in two leads, 80 ms after J point), oral consent for participation in this study. Exclusion criteria were: unstable coronary heart disease, acute heart infarction, low exercise capacity (< 4 MET in previous exercise test), implanted peacemaker, patients with rest ECG difficult to interpretation (e.g. left bundle - branch block).

Patients performed two successive exercise treadmill tests, using the Bruce protocol. After first test they were randomly divided into four groups. In the group 1 were patients who underwent second test one hour after finishing the first one. In the group 2 were patients who performed second test after two - hour rest. The group 3 was consisted of patients who rested four hours before consecutive test and in the group 4 were patients who performed next test 24 hours later. In rest and during tests 12-leads ECG and heart rate were continuously monitored. Blood pressure was measured before exercise and every 2 minutes during exercise and recovery. In recovery patients were in the sitting position. Criteria for terminating tests were: significant ST-segment depression, increasing chest pain, fatigue, arrhythmia, attaining 85% of maximal age - related heart rate, excessive increase or drop of systolic blood pressure, claudication or patients request. Before tests patients were instructed to promptly inform about appearing symptoms

(anginal pain, dyspnea, dizziness). Myocardial ischemia was diagnosed when horizontal or downsloping ST – segment depression of 1 mm at 80 ms from J point was observed in at least two leads.

The following parameters were measured:

1. baseline heart rate, blood pressure and rate pressure product;
2. time, in seconds, to the onset of 1mm ST – segment depression;
3. maximal heart rate, blood pressure and rate pressure product;
4. maximal achieved workload, in MET's;
5. fatigue, in Borg scale;
6. exercise duration, in seconds;

Received results were analyzed using SPSS 13.0 program. Data are expressed as mean values and

standard deviation. p values < 0.05 were considered significant.

RESULTS

The main clinical features of the 4 groups of patients are listed in table I. Twenty-two patients completed the study protocol. One patient in group 2 didn't undergo second test because atrial fibrillation appeared during the first test and patient was excluded from the study. Results presented in table II compare changes in hemodynamic parameters during both tests in all groups and other exercise test parameters are summarized in table III.

The first exercise test was interrupted because of severe myocardial ischemia in two patients from groups 1 (33%) and 2 (33%), three from group 3 (60%) and one from group 4 (16%). The second test was terminated because of severe fatigue in 34% of studied patients.

Baseline hemodynamic parameters improved during the second test in group 1 and 2. Maximal values of this parameters also enhanced but only

Table 1. Patient characteristics

	GROUP 1	GROUP 2	GROUP 3	GROUP 4
n	6	6	5	6
AGE	67,2 ± 3,2	63 ± 5,4	55,6 ± 8,6	58,7 ± 9,4
CHD	2	5	3	4
MI:	4	1	2	2
CABG	2	1	1	1
PTCA	1	-	-	1
Medications:				
β-blockers	5	5	3	3
ACE-i	2	3	3	3
Ca-antagonists	-	-	1	1
Nitrates	2	-	-	3
No medications	1	1	1	-
DIABETES	1	1	-	-
HYPERTENSION	1	4	-	2

Table 2. Changes in hemodynamic parameters.

Parameters	Group 1	Group 2	Group 3	Group 4
baseline SBP:				
test 1	125 ± 14,83	126,67 ± 26,20	109 ± 8,94	126,67 ± 10,33
test 2	123 ± 18,34	110,83 ± 58,69	117 ± 4,47	123,33 ± 7,53
p	ns	ns	ns	ns
maximal SBP:				
test 1	173,33 ± 28,58	152,5 ± 28,93	148 ± 24,65	174,17 ± 16,86
test 2	158,33 ± 29,44	143,33 ± 77,11	157 ± 37,35	165,83 ± 11,14
p	0,023	ns	ns	ns
Baseline DBP				
test 1	79,17 ± 8,01	80 ± 10,95	74 ± 8,94	80,83 ± 4,91
test 2	75,83 ± 10,20	69,17 ± 34,41	74 ± 8,94	80 ± 7,07
p	ns	ns	ns	ns
Maximal DBP				
test 1	78,33 ± 11,69	81,67 ± 14,72	73 ± 8,37	83,33 ± 5,16
test 2	77,5 ± 8,80	65,83 ± 34,12	76 ± 5,48	80,83 ± 8,01
p	ns	ns	ns	ns
baseline HR				
test 1	81 ± 12,88	80,5 ± 8,73	74,8 ± 20,27	73,67 ± 12,60
test 2	77,5 ± 16,04	66,83 ± 35,94	72,4 ± 19,98	75 ± 8,22
p	ns	ns	ns	ns
maximal HR				
test 1	129 ± 9,67	133 ± 11,64	125,8 ± 20,12	120,33 ± 19,86
test 2	131,33 ± 8,59	109,5 ± 54,55	126,6 ± 19,96	122,17 ± 15,61
p	ns	ns	ns	ns
baseline RPP				
test 1	102,5 ± 26,14	102,67 ± 27,96	81,8 ± 26,53	93,33 ± 18,45
test 2	96,66 ± 30,51	89,83 ± 53,67	84,8 ± 25,19	92,83 ± 13,89
p	ns	ns	ns	ns
maximal RPP				
test 1	224,16 ± 43,58	203,17 ± 42,04	189,8 ± 63,98	210,33 ± 44,50
test 2	209 ± 46,68	190,17 ± 107,74	204,4 ± 83,79	203 ± 31,54
p	ns	ns	ns	ns

Values presented as mean ± standard deviation, $p < 0,05$. SBP-systolic blood pressure, DBP – diastolic blood pressure, HR – heart rate, RPP – rate pressure product.

in group 1 systolic blood pressure change was statistically significant ($173,3 \pm 28,58$ vs $158,33 \pm 29,44$, $p = 0,023$). Maximal heart rate in group 1 was higher in the second test ($129,9 \pm 9,67$ vs $131,33 \pm 8,59$). In group 4 baseline ($73,67 \pm 12,60$ vs $75 \pm 8,22$) and maximal ($120,33 \pm 19,86$ vs $122,17 \pm 15,61$) heart rate was lower in the first test. In group 3 only baseline HR was slightly lower in the second test compared to the first ($74,8 \pm 20,27$ vs $72,4 \pm 19,98$). In groups 1, 2 and 4 signs of ischemia appeared earlier in the second test

compared to the first, but in group 3 ST segment depression appeared later in second test ($347,4 \pm 200,51$ vs $350 \pm 244,44$). Exhaustion measured with Borge's scale was similar during both tests in all groups except group 2 in which the second was assessed as lighter ($13,67 \pm 0,82$ vs $11,5 \pm 5,75$). In all groups second exercise test lasted longer.

Table 3. Exercise treadmill test parameters.

Parameters	Group 1	Group 2	Group 3	Group 4
time to ST depression				
test 1	295,83 ± 104,33	256,83 ± 221,59	347,4 ± 200,51	360 ± 138,92
test 2	233,17 ± 228,80	245,33 ± 205,27	350 ± 244,44	332,33 ± 96
p	ns	ns	ns	ns
MET's				
test 1	6,93 ± 2,33	8,8 ± 1,45	9,22 ± 1,02	8,12 ± 2,75
test 2	7,95 ± 2,29	9,5 ± 0,89	9,84 ± 2,33	8,58 ± 2,47
p	ns	ns	ns	ns
Borg's scale				
test 1	13,5 ± 0,55	13,67 ± 0,82	13,8 ± 1,30	14,33 ± 1,21
test 2	13,33 ± 0,52	11,5 ± 5,75	14,4 ± 1,14	14,5 ± 1,22
p	ns	ns	ns	ns
test duration				
test 1	324,67 ± 132,47	432,6 ± 94,85	456 ± 52,53	386,83 ± 122,93
test 2	386 ± 136,94	476,6 ± 52,69	492,8 ± 137,87	393,17 ± 99,67
p	ns	ns	ns	ns

Values presented as mean ± standard deviation, $p < 0,05$. Time to ST depression in seconds (s), Borg's faitgue scale (6-20), test duration in seconds (s).

DISCUSSION

The main findings were that the warm – up phenomenon was observable in three of four groups of patients participated in this study, being manifested as lower, both baseline and maximal, systolic blood pressure, heart rate, rate pressure product, longer time to onset of ischemia and less significant ST segment changes during the second test. However, its intensity was different in those groups. The best noticeable warm – up effects were observable two hours after the first test and the weaker among patients who underwent second test 24 hours after finishing the first one (group 4). In patients in group 3 we didn't noticed improvement in studied parameters. In many studies warm – up phenomenon was observed after very short resting periods. Rinaldi et al. (Rinaldi et al. 1999) showed that it occurs only 30 minutes after the first exercise. Exercise time, time to angina, time to 1mm ST depression, workload and RPP were significantly improved in the second test, but maximum ST segment depression was unchanged. Similar results received Maybaum et al. (Maybaum et al. 1996). While Stewart (Stewart et al. 1995), Lupi et al. (Luppi et al. 1998), Williams et al. (Williams et al. 1985) in their studies patients underwent second test 10 minutes after

the first one. Equally short rests were used in studies of Okazaki (Okazaki et al. 1993), Tuomainen (Tuomainen et al. 2002) and Jaffe and Quinn (Jaffe & Quinn 1980). In that studies warm up effects were demonstrated to 15 minutes after exercise. Tomai (Tomai et al 1996) claims that cardioprotective effects of exercise can be seen maximal to 2 hours. Studies of Rinaldi (Rinaldi et al. 1999) and ours investigated if this protection can be regarded after 4 hours rest and we received similar results. Rinaldi and we didn't noticed changes in observed parameters. The late phase of this phenomenon is the most controversial problem. Similar outcomes, as we received, had Dana et al. (Dana et al. 2000) who revealed that exercise induces early and late phase of myocardial protection in patients with CHD. These observations are confirmed by Lambiase et al. (Lambiase et al. 2003) who observed 40% increase in time to 0.1 mV ST segment depression and 60% decrease in ventricular ectopic frequency, compared to initial exercise test. Tomai et al. (Tomai & Perino et al. 1999) in his study confirmed the occurrence of the early phase of preconditioning but not delayed, however, he didn't deny it exists but if it occurs it must be weaker. If warm up – phenomenon has late phase can we say that it is a clinical counterpart of ischemic preconditioning.

These two phenomena share several common features. To induce protection both need a short episode of ischemia which is followed by reperfusion (ischemic preconditioning) or rest (warm-up phenomenon). During the protection phase myocardium is more resistant to ischemic damage, measured by a less ST segment depression or smaller infarct size (warm-up phenomenon and preconditioning, respectively) (Edwards et al. 2005, Maybaum et al. 1996). Protective effects can be seen up to 2 hours after initiating ischemia and then they disappear (Edwards et al. 2005, Marber et al. 1994, Tomai et al. 1996). On the other hand, however, molecular mechanisms underlying both phenomena are different. K_{ATP} channels play the main part in ischemic preconditioning and their role in warm-up phenomenon wasn't proved (Edwards et al. 2005, Kelion et al. 2002, Tomai & Danesi et al. 1999).

Warm-up phenomenon shows why physical activity is so much important for patients with coronary heart disease not only as a treatment but also as a form of prevention. Regular physical activity decreases disease progression and improves patients' life (Myers 2003), so we can say that physical activity is an insurance policy for better and healthier life (Domenech 2006).

CONCLUSIONS

In our studies we show that cardioprotective effects of the exercise can maintain 2 hours after physical activity and 24 hours later they seem to reappear.

REFERENCES

Bilińska M.; Hartowanie przez niedokrwienie w sercu człowieka; *Kardiologia Polska* 1999; 51; suppl. 1: 73–76.

Dana A., Carroll R., Yellon D. M., Walker J. M.; Exercise induced ischemia triggers the early and delayed myocardial adaptation: no role

for adenosine; *Circulation* 2000; 102; suppl. 2: 26.

Domenech R. J.; Preconditioning a new concept about the benefit of exercise; *Circulation* 2006; 113: e1–e3.

Edwards R. J., Redwood S. R., Lambiase P. D., Marber M. S.; The effect of an angiotensin-converting enzyme inhibitor and a K_{ATP}^+ channel opener on warm-up angina; *European Heart Journal* 2005; 26: 598–606.

Fletcher G. F., Balady G. J., Amsterdam E. A. et al.; Exercise standards for testing and training. A statement for healthcare professionals from the American Heart Association; *Circulation* 2001; 104: 1694–1740.

Gallavardin L., *Les anghes de poitrine*, Paris: Masson & Cie 1925:119.

Heberden W., A letter to Dr Heberden concerning the angina pectoris and an account of the dissection of one who had been troubled with that disorder. *Medical Transactions published by the College of Physicians*, London 1785; 1-11.

Jaffe M. D., Quinn N. K.; Warm-up phenomenon in angina pectoris; *The Lancet* 1980; 1: 934–936

Kelion A. D., Webb T. P., Grandjean M. A. et al.; Does a selective adenosine A₁ receptor agonist protect against exercise-induced ischemia in patients with coronary artery disease; *Heart* 2002; 78 (2): 115–120.

Lambiase P. D., Edwards R. J., Cusack M. R. et al.; Exercise-induced ischemia initiates the second window of protection in humans independent of collateral recruitment; *Journal of the American College of Cardiology* 2003; 41 (7): 1174–1182.

- Luppi A., Lanza G. A., Lucente M. et al.; The warm-up phenomenon occurs in patients with chronic stable angina but not in patients with syndrome X; *The American Journal of Cardiology*; 1998; 81:123-127.
- Marber M. S., Joy M. D. Yellon D. M.; Is warm up in angina ischaemic preconditioning?; *British Heart Journal* 1994; 72: 213 – 215.
- Maybaum S., Ilan M., Mogilevsky J., Tzivoni D.; Improvement in ischaemic parameters during repeated exercise testing: a possible model for myocardial preconditioning; *The American Journal of Cardiology* 1996; 78: 1087 – 1091.
- Myers J.; Exercise and cardiovascular health; *Circulation* 2003; 107: 2-5.
- Okazaki Y., Kodama K., Sato H. et al.; Attenuation of increased regional myocardial oxygen consumption during exercise as a major cause of warm – up phenomenon; *Journal of the American College of Cardiology* 1993; 21: 1597 – 15604.
- Rinaldi C. A., Masani N. D., Linka A. Z., Hall R. J.; Effect of repetitive episodes of exercise induced myocardial ischaemia on left ventricular function in patients with chronic stable angina: evidence for cumulative stunning or ischaemic preconditioning?; *Heart* 1999; 81: 404 – 411.
- Scrutinio D., Bellotto F., Lagioia R., Passantino A.; Physical activity for coronary heart disease: cardioprotective mechanisms and effects on prognosis. *Monaldi archives for chest disease* 2005; 64: 77 – 87.
- Shepard R. J., Balady G. J.; Exercise as cardiovascular therapy; *Circulation* 1999; 99: 963 – 972.
- Stewart R. A. H., Simmonds M. B., Williams M. J. A.; Time course of warm - up in stable angina; *The American Journal of Cardiology* 1995; 76: 70 – 73.
- Tomai F., Crea F., Perino M. et al.; Mechanisms of the warm – up phenomenon; *European Heart Journal* 1996; 17: 1022 – 1027.
- Tomai F., Danesi A., Ghini A. S. et al.; Effects of K_{ATP} channel blockade by glibenclamide on the warm – up phenomenon; *European Heart Journal* 1999; 20: 196 – 202.
- Tomai F., Perino M., Ghini A. S. et al.; Exercise – induced myocardial ischemia triggers the early phase of preconditioning but not late phase; *The American Journal of Cardiology* 1999; 83 (4): 586 – 588.
- Tuomainen P., Vanninen E., Halonen P., Peuhkurinen K.; Characterization of the warm – up phenomenon in patients with coronary artery disease; *American Heart Journal* 2002; 144: 870 – 876.
- Williams D. O., Bass T. A, Gewirtz H., Most A. S.; Adaptation to the stress of tachycardia in patients with coronary artery disease: insight into the mechanism of the warm-up phenomenon; *Circulation* 1985; 71: 687 – 692.

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THE IMPACT OF SYSTEMIC CRYOTHERAPY ON HEMODYNAMIC PARAMETERS IN HYPERTENSIVE AND NORMOTENSIVE PATIENTS

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Koczorowska M., Wujek-Krajewska E., Kuch M., Dłużniewski M. 2008. The impact of systemic cryotherapy on hemodynamic parameters in hypertensive and normotensive patients. *Acta Biol. Univ. Daugavp.*, 8(1): 25 - 28.

Systemic cryotherapy is one of newer methods of therapy and rehabilitation. Significant group of patients exposed to systemic cryotherapy are patients with coronary heart disease and hypertension. That's why it's important to evaluate the influence of cryogenic temperatures on circulatory system. The aim of our study was evaluation of the impact of systemic cryotherapy on some hemodynamic parameters (blood pressure, heart rate). Methods: 65 patients (44 female and 21 male, average age of 51) categorized into two groups - hypertensive and with correct blood pressure, underwent 10 systemic cryotherapy sessions and 30-40 minutes of aerobic training after it. Blood pressure and heart rate measurements were made before and just after cryotherapy procedure and also after aerobic training in first, fifth and tenth day of session. Results: We noticed statistically significant ($p < 0.05$) increase of systolic blood pressure after cryotherapy in both groups ($\Delta = 14.7$) and decrease of heart rate after cryotherapy ($\Delta = 4$; $p < 0.05$) and training ($\Delta = 5.85$; $p < 0.05$) in group with normal blood pressure. There was no statistically significant influence on diastolic blood pressure. Conclusions: We noticed that 10 sessions of systemic cryotherapy increases systolic blood pressure and may significantly overload circulatory system.

Key words: systemic cryotherapy, cryochamber, cryokinesis, hypertension.

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INTRODUCTION

Currently we can observe significant increase in the number of chronic patients and the disabled and also costs of treatment. That's why so important is reduction in expenses of cure and retain quality of service. Physiotherapy is a branch of medicine that could be the partial

solution to this problem. There are evidences shows that in case of physiotherapy we can observe low cost/efficiency factor. When the society is growing old, large-scale implementation of the physiotherapy could bring medical and social-economic benefits. Z. Zagrobelny 1996; A. Jagier 2005; P. Dylewicz, et al. 2001).

Using heat and cold is very popular in rehabilitation. The conception of cryotherapy, which is understood as an impulsive supporter treatment, is known since 70' last century (K. Spodaryk 2003) Significant group of patients exposed to systemic cryotherapy are patients with coronary heart disease and hypertension. That's why it's important to evaluate the influence of cryogenic temperatures on circulatory system. (Biologiczne efekty oddziaływania zimna 2003) In Poland there is over 30% of adult population with blood pressure over 140/90 mmHg. So high frequency of hypertension accompanies very low efficiency of treatment – only 12%. (T. Zdrojewski, et al. 2001)

Systemic cryotherapy is one of methods of cryotreatment. It consists in use very low temperatures (-100°C ÷ -160°C) on human body for activation specific thermoregulatory reactions. Low temperature may be obtained by use of air flow cooled with liquid nitrogen; this could be applied either locally, over chosen part of the body, or generally, over the whole body, in cryochamber. Short-lasting (2-3 minutes) exposures patients to very low temperatures activating only physical thermoregulation, and that's why it seems to be safe and well tolerated.

Cryotherapy is used as procedure that supports basic treatment. It turned out to have been widely used in the treatment of disease of motor system, neurologic disorders and also in biological renovation for tired and overworked muscles. Therapeutic effects of cryogenic temperatures are characterized by decrease of pain and swellings, improvement of skeletal muscle strength, decrease of hypertonus and increase of muscle joint mobility. Cryotherapy exerts positive influence on human psyche. Regular usage of systemic cryotherapy allows diminishing doses of non-steroidal anti-inflammatory medicines and making kinesitherapy painless and more effective. (Biologiczne efekty oddziaływania zimna 2003; R. Suszko 2003; E. Birkner E 2003; K. Książopolska-Pietrzak 1997; E. Wojtecka-Łukasik 2002; B. Dariusz 1998)

Cardiovascular system is one of body systems that its functional changes, especially microcirculation changes under the influence of low temperatures, induce changes in other organs. During the exposition on low temperatures vasoconstriction in the skin and hypodermis with slowing blood flow and decreasing temperatures of this structures are

Table 1. The differences of middle values of blood pressure and heart rate before and after cryotherapy

Parameters Day of session	SBP		DBP		HR	
	Hypertensive patients	Normotensive patients	Hypertensive patients	Normotensive patients	Hypertensive patients	Normotensive patients
1th day	14,8	6,0	1,9	-0,3	-3,7	3,2
5th day	16,6	13,8	2,8	5,8	-3,5	0,4
10th day	13,4	23,0	3,0	0,5	-4,8	-3,0

observed. In several minutes since end of procedure we can observe intensified blood flow and even multiple dilation of blood vessels that causes slowly warming up integuments. This effect is observed for several minutes and causes changes of blood volume distribution in systemic circulation and potentially can cause function disturbances of many organs. Therefore cryotherapy is procedure that has very strong effect on human body. As a result of exposure on cryogenic temperatures it comes to micro- and macro circulation reactions. Microcirculation reaction determines therapeutic action of cryotherapy and macro circulation reaction determines safety of procedure.

In spite of relative safe of cryotherapy there are some disease in which it's contraindicated, for example: cold intolerance, claustrophobia, dysaesthesia, significant anemia, hypothyreosis, locally perfusion disturbances, etc. (Biologiczne efekty oddziaływania zimna 2003; R. Suszko 2003).

The aim of our study was evaluation of the impact of systemic cryotherapy and cryokinesis in normotensive and hypertensive patients on some hemodynamic parameters (blood pressure, heart rate).

METHODS

65 patients (44 female and 21 male, average age of 51) categorized into two groups – hypertensive (>140/90 mmHg) and with correct blood pressure. They underwent 10 systemic cryotherapy sessions. Each therapeutic session consisted of 3-minute treatment in cryochamber (1 minute in -65°C and after that 2 minutes in -125°C) followed by 30-40 minutes of aerobic training after it. Blood pressure and heart rate measurements were made before and just after cryotherapy procedure and also after aerobic training in first, fifth and tenth day of session.

RESULTS

We noticed statistically significant ($p < 0.05$) increase of systolic blood pressure after

cryotherapy in both groups (" $=14.7$) and decrease of heart rate after cryotherapy (" $=4$; $p < 0.05$) and training (" $=5.85$; $p < 0.05$) in group with normal blood pressure. There was no statistically significant influence on diastolic blood pressure (Figs 1-6; Table 1).

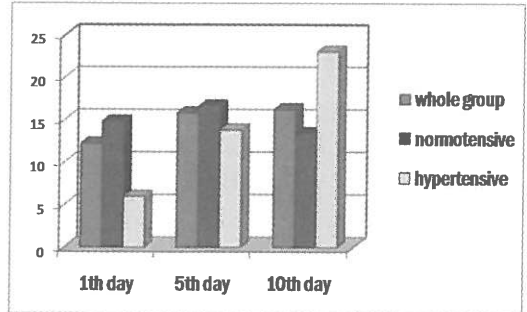


Fig. 1. Differences of the middle values of systolic pressure after cryotherapy during following procedure days in whole group of patients, in patients normotensive and hypertensive.

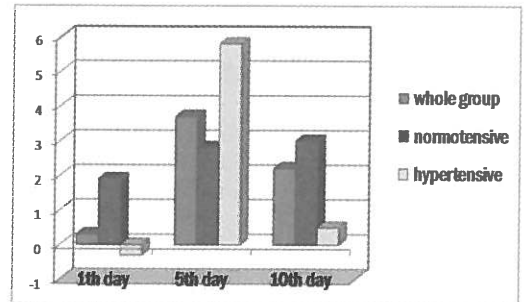


Fig. 2. Differences of the middle values of diastolic pressure after cryotherapy during following procedure days in whole group of patients, in patients normotensive and hypertensive.

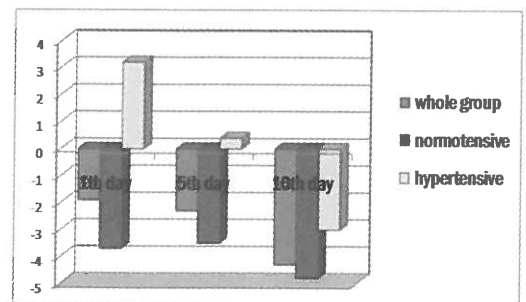


Fig. 3. Differences of the middle values of heart rate after cryotherapy during following procedure days in whole group of patients, in patients normotensive and hypertensive.

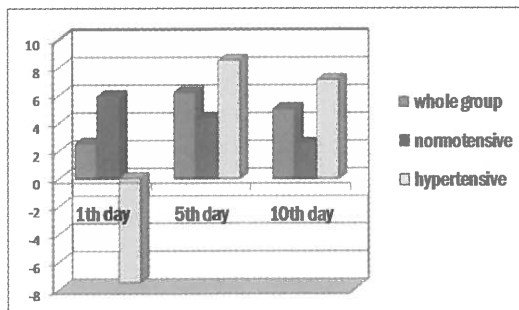


Fig. 4. Differences of the middle values of systolic pressure after cryokinesis during following procedure days in whole group of patients, in patients normotensive and hypertensive.

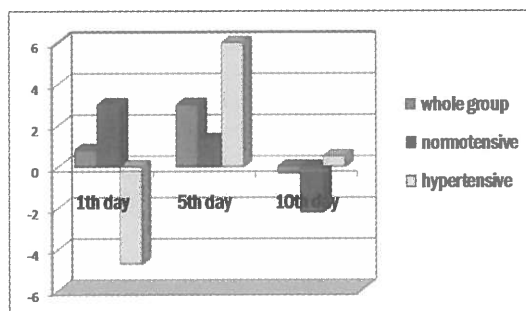
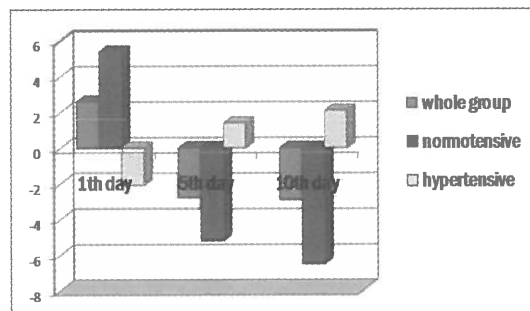


Fig. 5. Differences of the middle values of diastolic pressure after cryokinesis during following procedure days in whole group of patients, in patients normotensive and hypertensive.



Graph 6. Differences of the middle values of heart rate after cryokinesis during following procedure days in whole group of patients, in patients normotensive and hypertensive.

CONCLUSIONS

We noticed that 10 sessions of systemic cryotherapy increases systolic blood pressure and may significantly overload circulatory

system. In case of hypertensive patients it's necessary to pay attention to initial value of blood pressure and circulatory system respond to the procedure. It may contribute to increase patient's safety.

REFERENCES

- Zagrobелny Z.: Lecznicze zastosowanie zimna. *Acta Bio-Optica et Informatica Medica* 1996; 2: 83-88.
- Jagier A.: Układ krążenia a wysiłek fizyczny. *Rozdział w: Rehabilitacja kardiologiczna – stosowanie ćwiczeń fizycznych.* Pod red. Bromboszcza J., Dylewicz P., ELIPSA – JAIM s.c. 2005; 11-39.
- Dylewicz P., Przywarska I.: Perspektywy rehabilitacji kardiologicznej w XXI wieku 2001; 5: 9-12.
- Spodaryk K.: Biologiczne oddziaływania miejscowo stosowanego zimna. *Rehabilitacja Medyczna* 2003; 7(2): 48-55.
- Biologiczne efekty oddziaływania zimna. *Rozdział w: Zastosowanie zimna w medycynie – kriochirurgia i krioterapia.* Pod red. Sieronia A., Cieślara G. ?i-medica Press 2003; 43-113.
- Zdrojewski T., Bandosz P.: Znaczenie aktywności ruchowej oraz zalecenia ćwiczeń fizycznych chorym z nadciśnieniem tętniczym. *Rehabilitacja Medyczna* 2001; 5: 21-24.
- Suszko R.: Krioterapii ogólnoustrojowa. *Rehabilitacja Medyczna* 2003; 7 (2): 63-71.
- Birkner E., Sieroń A., Beck B. et al.: Zastosowanie temperatur kriogenicznych w medycynie. *Wiadomości Lekarskie*, 2003; 56 (1-2): 53-56.
- Księżopolska-Pietrzak K.: Rola niskich temperatur w leczeniu narządu ruchu. *Nowa Medycyna*, 1997; 4 (20): 38-40.
- Wójtecka-Łukasik E., Księżopolska-Orłowska K., Burakowski T. i wsp.: Wpływ krioterapii na przebieg odczynu zapalnego. *Badania doświadczalne.* *Reumatologia* 2002; 40 (1): 28-35.
- Dariusz B., Zimmer K., Skrzek A., Zagrobелny Z.: Kriokomora Kriogeniczna – możliwości zastosowania w rehabilitacji. *Balneologia Polska* 1998; 40 (3-4): 44-48.

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CORRECTION OF FAULTY POSTURES IN PUPILS FROM SZCZECIN PRELIMINARY SCHOOLS

Danuta Umiastowska, Ewa Szczepanowska

Umiastowska D., Szczepanowska E. 2008. Correction of Faulty Postures in Pupils from Szczecin Preliminary Schools. *Acta Biol. Univ. Daugavp.*, 8(1): 29 - 34.

One of the conditions of human normal development and health is a right body posture. A teacher's task is to prevent health problems, compliance and prompting of children to use corrective recommendations. Gymnastics for pupils from I-III classes of preliminary school is carried out as obligatory exercises beyond regular lessons in time not smaller than two hours per week. In older classes a school director can arrange these exercises as optional ones. Corrective gymnastics exercises should be carried out by qualified teachers. In presented work an attempt to find answers to following questions is undertaken: What is an arrangement of exercises of corrective gymnastics? What is a base of schools to carry out these exercises? What qualifications should possess teachers carrying out exercises? A study has been realized in 56 preliminary schools: public (46 institutions) and non public (10 institutions). In this study the following methods have been used: an analysis of documents, interviews with directors of these institutions and teachers carrying out corrective gymnastics, and also an observation. Among public institutions exercises have been carried out in 88.11% of schools, and a difference between them has been statistically essential (at the level of significance $\alpha = 0.01$) in the reference to non public school realizing these exercises in 50.00% of schools. At public schools exercises have been carried out the most often in specially prepared rooms for corrective gymnastics (55.00%), and at non public schools in a gym (80.00%). The difference between these institutions is statistically significant at the level of significance $\alpha = 0.01$. Correction of faulty postures in children from I-III classes is realized in the majority of public institutions (85.11%), and in every second non public institution (50.00%). The base to realize exercise of corrective gymnastics in Szczecin preliminary schools is adequate. Public schools possess a better subsidiary. Teachers carrying out corrective exercises with children represent a required special education (postgraduate study, specialization or special course).

Key words: faulty posture, corrective gymnastics, public, non public preliminary schools, devices for corrective gymnastics

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INTRODUCTION

One of the conditions of human normal development and health is a right body posture. It is then the immensely important task to take

care of body posture during commenced education. Pupils spend many hours per day at school and therefore it has a great influence on formation of children's health. Teacher can quicker and easier perceive not big deviations

from a norm – if he can know how to find them. Whereas, in a child with a defect ascertained by physician he can easier and more effective control it's leveling. A teacher's task is to prevent health problems, compliance and prompting of children to use corrective recommendations.

In accordance to obligatory ministerial instructions participants of corrective gymnastics at schools can be children with:

- defects of body posture in the area of spinal column, chest or lower extremities,
- lower physical efficiency connected with disorders or disharmony of somatic development (e.g. obesity, underweight),
- delay of developmental age and motoric development,
- some chronic disorders of health status.

In the case of ascertained defects of body posture or other disorders of health status a physician specialist gives a recommendation to corrective gymnastics. Whereas, in the case of lowering a level of physical efficiency this recommendation a teacher of physical education can give. The base of referral is a result of physical efficiency tests.

Gymnastics for pupils from I-III classes of preliminary school is carried out as obligatory exercises beyond regular lessons in time not smaller than two hours per week. In older classes a school director can arrange these exercises as optional ones. Exercises should last 45 min. and it is recommended since 9 y.o. to carry out them separately for girls. A participation of pupil in gymnastics does not absolve him from obligatory physical exercises unless there are medical contraindications involving all or some exercises included in the exercise program.

Corrective gymnastics exercises should be carried out by qualified teachers. These qualifications have been possible to obtain during study of physical education with specialization of corrective gymnastics or during special courses arranged by teachers' improvement centres. Currently the enhancing of a level of qualification is possible through postgraduate study managed

by universities with physical education direction. Postgraduate study lasts three semesters and comprises of topics connected with biomedical background of realizing corrective gymnastics, methodology of exercises and practical exercises at a gym and in the swimming pool.

The aim of corrective gymnastics realized within a school system of physical education is:

- correction of current disorders of body statics and resulting, if it is possible, into a normal status,
- making impermissible a formation of body posture defects when there are conditions conducting their generation,
- leading-in physical efficiency of a child to a status recognized as a norm.

Among rooms adequate for corrective gymnastic exercises one could mention: special halls for corrective gymnastics, gym halls, school swimming pools and adapted rooms (e.g. spacious corridors).

Rooms for exercises should be adequate to determined requirements:

- per one pupil 4.5 m² of exercise surface,
- a floor of a smooth, safe, clean surface,
- air temperature not lower than +18 °C,
- exercise room with sanitary conditions according to obligatory norms, e.g.: changing room with racks, showers or washbasins.

Inside the room should be the following basic gymnastic devices: gymnastic benches, mattresses, wall-bars, and a posturographic paned mirror with protected lock and dimensions at least 60 x 140 cm (Kutzner-Kozińska, 1988).

Besides rooms in a school building it is possible to carry out corrective gymnastic exercises in the open area (sports field, kindergarten garden, meadow, forest). „Green hall” gives first of all a healthful aspect of physical exercises at the open air. There could be different following devices: multifunctional gymnastics sets for beetling, interleaving, beam exercises, waste tires to improve jumpiness because they are springy and elastic, ropes, levers, steeple paths, tunnels, tree

trunks. This exercise place should be adequate to a level of child's stage development, a child's efficiency level and it should influence positively on shaping a normal body posture, courage and resourcefulness (Strzyżewski, 1992).

Swimming-pool and water environment in regard to draught force and relief of spine has a significant influence on correction of body faulty postures. Thanks specifics of this environment one could apply different respiratory exercises, toughen organism, relieve particular parts of body, and use elongation exercises. It is possible to enhance an attraction of these exercises by using different devices, like rubber toys, planks, floats, fins, „macaronis” or lifebelts. Carrying exercise in water, at the outdoor or indoor swimming pool, it is categorically due to obey obligatory principles, safety principles, and basic principles of personal hygiene.

Using devices in corrective gymnastics allows:

- making exercise attractive,
- enhancing motivation to exercise,
- changing of exercise intensity,
- securing relief of pupil or opposite – increasing of load,
- forcing of proper performing an exercise in fixed position,
- limiting of movement range – especially when too large movement is undesirable or harmful,
- protecting against movement transmission to next parts of body,
- facilitating of submission and maintenance of correct position,
- making easier control and self-control at stretching particular muscle groups.

Special corrective gymnastics devices are:

- a rehabilitation-corrective bench with support under knees,
- a corrective-therapeutic bench,
- a wall-bar with folding bars,
- a wall-bar with a chest bag,
- a gymnastic-corrective bench with handhold and a chest bag,
- a rubber rug resembling “hedgehog”,
- foam mattresses.

Basic devices applied during corrective gymnastic exercises are:

- small blankets,
- gym sticks,
- training balls of different sizes (e.g. rubber, volley, ping-pong),
- small bags with sand or peas of different weight,
- medicine balls,
- rubber rings,
- hula hoop,
- rollers,
- expanders,
- handle bars, wrist and ankle Velcro barbells
- sashes,
- flags,
- physio-balls,
- fit-balls of different sizes,
- physio-roll („double ball”),
- rolls with points,
- jumping balls (balls with a handle to jump).

Making exercises more attractive is possible also throughout using unconventional devices. Their performing stimulates creative imagination of a child and shows how wonderful one could “play with exercise”.

To the most often used belong:

- newspapers,
- plastic bottles with sand of different weight (0.5–2.0 kg),
- cardboard boxes,
- cans,
- tubes,
- sponges,
- elastic,
- pieces of fabric,
- buttons,
- ribbons,
- crayons,
- exercise books,
- books,
- mascots,
- rulers (Umiastowska, Makris, 1999).

Carrying out open air exercises teacher can use, like devices:

- sticks,
- pebbles,
- cones,
- chestnuts, acorns,

- leaves,
- small feathers.

Aim of work

In presented work an attempt to find answers to following questions is undertaken: What is an arrangement of exercises of corrective gymnastics? What is a base of schools to carry out these exercises? What qualifications should possess teachers carrying out exercises?

Subjects and methods

A study has been realized in 56 preliminary schools: public (46 institutions) and non public (10 institutions).

In this study the following methods have been used: an analysis of documents, interviews with directors of these institutions and teachers carrying out corrective gymnastics, and also an observation.

RESULTS

Results of statistical analysis are introduced at the table 1 and at graphs 1–5.

The highest number of pupils from I–III classes in public institutions realizing corrective gymnastics is found at preliminary schools ¹ 10 (237), ¹ 2 (218), ¹ 47 (205) and ¹ 16 (137). Among non public schools, in turn, the most numerous

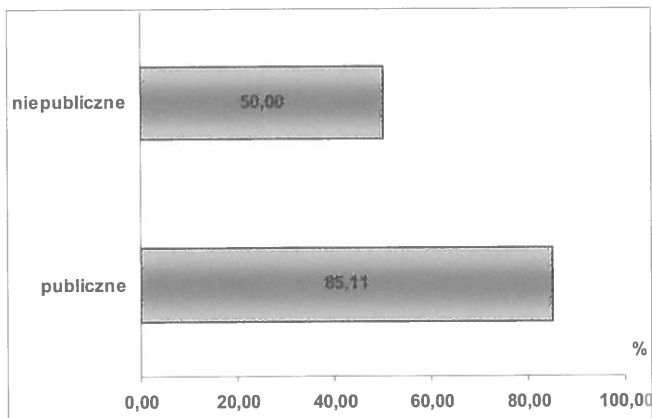


Fig. 1. A percentage of schools with exercises of corrective gymnastics

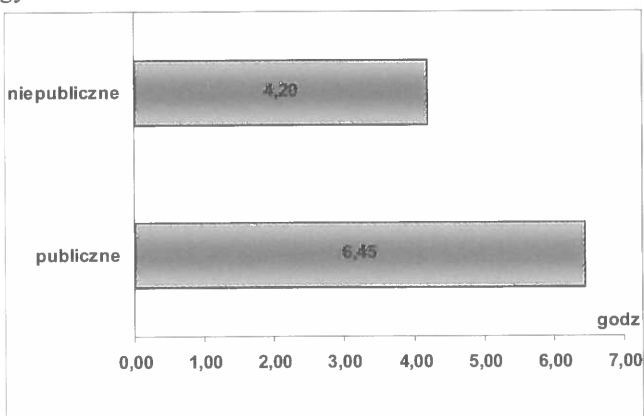


Fig. 2. Mean number of hours for corrective gymnastics in examined schools (niepubliczne – non public; publiczne – public)

group are pupils from a school TAK (Cultural Animation Society) – 100 persons.

Among public institutions exercises have been carried out in 88.11% of schools, and a difference between them has been statistically essential (at the level of significance $\alpha = 0.01$) in the reference

Table 1. Profile of schools involved in this research

SCHOOLS	Number of pupils	Number of teachers	Number of hours per week
PUBLIC 40 institutions	2351	61	258
NON PUBLIC 5 institutions	255	6	21

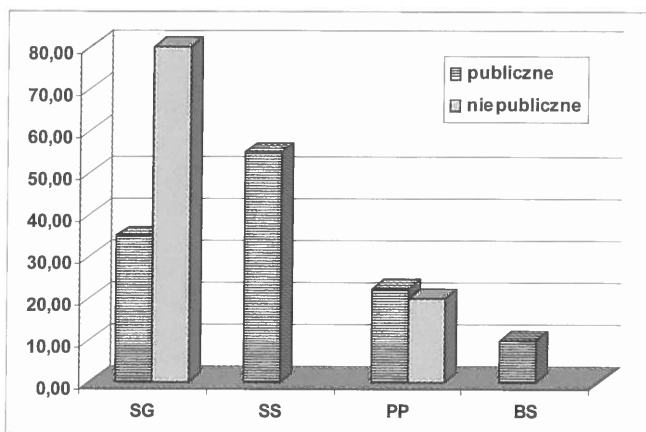


Fig. 3. The place of realization of corrective gymnastics exercises in examined schools (SG – gym, SS – special room for exercises, PP – accommodated room, BS school's swimming pool); (publiczne – public; niepubliczne – non public)

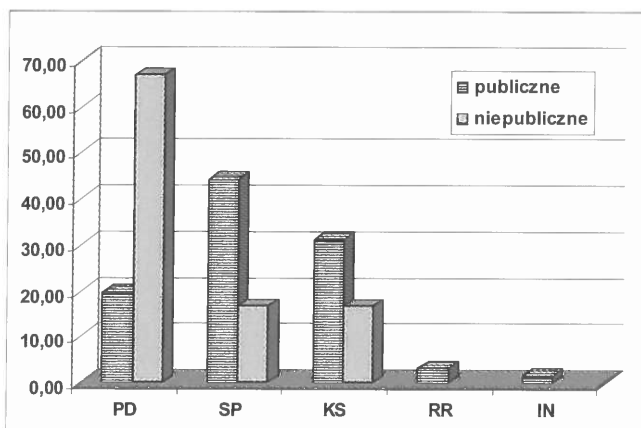


Fig. 4. Teachers' qualifications for carrying out exercises of corrective gymnastics (SPD – postgraduate studies, SS – specialization of corrective gymnastics during study, KS – specialist course, RR – finished direction of study in physical rehabilitation, IN – others); (publiczne – public; niepubliczne – non public)

to non public school realizing these exercises in 50.00% of schools.

Corrective gymnastic exercises have been arranged more often at public schools than in non public ones. The most often they have been arranged using a pool of hours to disposition of a given institution's director.

At public schools exercises have been carried out the most often in specially prepared rooms for corrective gymnastics (55.00%), and at non public schools in a gym (80.00%). The difference between these institutions is statistically significant at the level of significance $\bar{i} = 0.01$. In every fifth school exercises are carried out in adapted rooms – there are the most often lesson rooms lined with linoleum and equipped with basic gymnastic sports equipment. In this type of room there are not a mirror and wall-bars. A statistical difference between public and non public schools has not been noticed (a level of significance $\bar{i} = 0.43$). The probable reason of this state is a fact that non public schools from Szczecin City have not their own sport objects and very often use hired rooms. Only at four schools pupils with faulty postures participate in exercise carried out in water (10.00% of institutions).

At all schools corrective gymnastic exercises are carried out by a good prepared pedagogical staff. At non public schools the greater number of persons is postgraduated (66.67%) than at other public schools (19.67%) – a statistically significant difference at a level of significance $\bar{i} = 0.002$. However, a specialization of corrective gymnastics during study has been fulfilled by 44.26% of teachers from

public schools, and 16.67% teachers from non public institutions (a statistically significant difference at a level of significance $\bar{i} = 0.05$). Special courses arranged by centres of teachers' improvement have been fulfilled by 31.15% of teachers from public institutions, and 16.67% of teachers from non public institutions (a statistically significant difference at a level of significance $\bar{i} = 0.1$).

REASSUMING AND CONCLUSIONS

Among children at younger school age in a whole population the most often repeating faulty postures are defects in the area of spinal column and flat feet. The background to form these deformations in a smaller percent genetic and disease determinants are, and definitely more often there is a lack of a proper posture care. Sedentary life mode, a little physical activity, forms to spend leisure time in front of TV or computer monitor are the most often reason conducting to develop of defective child's silhouettes. In a majority of preliminary schools physical exercises at the level of integrated teaching (I–III classes) are not carried out by teachers of physical education. Hence, a regular observation of children in regard to their proper silhouette is limited. In recent years corrective exercises have not obligatory character. It means, they can not be realized at each school. The effect of this kind of decisions is unfortunately a use of hours to director's disposition for other forms of exercises, e.g. foreign languages, informatics etc. In preliminary schools of Szczecin City there is rather a good base to carry out corrective exercises with children. There are special rooms to exercise in over half of institutions equipped with mirrors and adequate equipment to corrective gymnastics. In 1999–2000 there have been only 34.50% these kinds of rooms in Szczecin City (Burak, 2000).

The most difficult element in carried out corrective exercises is teaching regularity and continuation of self-reliant work at home, since exercise at school are not sufficient. At many schools there open exercises for parents. At this kind of exercises parents have a possibility to recognize skills of their children and to acquire knowledge how to work with a child at home. Information transferred by teachers concerns not only exercises but also questions connected with:

- organization of place to learn and play,
- forms of physical activity preferred at determined faulty postures,
- adequate dress and footwear,
- ways of nutrition preventing obesity.

Analysis of results allows formulating the following observations:

1. Correction of faulty postures in children from I–III classes is realized in the majority of public institutions (85.11%), and in every second non public institution (50.00%).
2. The base to realize exercise of corrective gymnastics in Szczecin preliminary schools is adequate. Public schools possess a better subsidiary.
3. Teachers carrying out corrective exercises with children represent a required special education (postgraduate study, specialization or special course).

REFERENCES

- Burak M. 2000. Baza do prowadzenia zajęć w szczecińskich szkołach podstawowych. Uniwersytet Szczeciński, Instytut Kultury Fizycznej, postgraduate work, manuscript. (In Polish).
- Kutzner-Kozińska M., Właźnik K., 1995. Gimnastyka korekcyjna dla dzieci 6-10-letnich. WSiP, Warszawa. (In Polish).
- Strzyżewski S. 1992. Wychowanie fizyczne poza salą gimnastyczną. WSiP, Warszawa. (In Polish).
- Umiałowska D., Makris M. 1999. Dydaktyka wychowania fizycznego. Wydawnictwo Naukowe Uniwersytetu Szczecińskiego, Szczecin. (In Polish).

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THE DATA ON THE OBSERVATIONS OF THE EUROPEAN POND TURTLE (*EMYS ORBICULARIS* L.) AT THE NORTHERN EDGE OF ITS AREA IN LATVIA

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Pupins M., Pupina A. 2008. The data on the observations of the European pond turtle (*Emys orbicularis* L.) at the northern edge of its area in Latvia. *Acta Biol. Univ. Daugavp.*, 8(1): 35 - 46.

The European pond turtle *Emys orbicularis* L. is extremely rare species in Latvia, meeting on the northern border of its area. The given publication for the first time represents the full list of observations of *Emys orbicularis* in Latvia, registered by the authors during carried out research since 1985 until September 2007. In total have been registered 81 cases of observation of *Emys orbicularis* in Latvia.

Key words: Testudines; Emydidae, *Emys orbicularis*, distribution, Latvia

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INTRODUCTION

The European pond turtle *Emys orbicularis* L. is extremely rare species in Latvia, meeting on the northern border of its area. Now there are different opinions concerning the status of the given species in Latvia. The European pond turtle *Emys orbicularis* is officially put into the list of especially protected Latvian animals, specified in the document of the Cabinet of ministry of Latvia "Conditions on the list of especially protected species and limitedly used especially protected species" (Ministru kabinets 2000). Thus, in the Red Book of Latvia published in 2003 (Berzins 2003) *Emys orbicularis* is specified as already died out Latvian species, accordingly brought into 0 category. In the same book, it is underlined that reproduction of *Emys orbicularis* in Latvia is not ascertained within the decades.

There also are opinions that *Emys orbicularis*, observable in Latvia, could be brought by human for terrarium maintenance and then set free where adapted, but cannot be reproducing in Latvian climate (Silins and Lamsters 1934). There were noted many cases of *Emys orbicularis* capture in Latvia since 1820 until 1932, including a find of juvenile animal (Silins and Lamsters, 1934.). There also are publications about some cases of observation of this species in Latvia during the last years (Pupina and Pupins 1996, Pupins 2005, Meeske at all 2006, etc). Considering relatively large number of finds of *Emys orbicularis* in Latvia, existence of native population of *Emys orbicularis* in Latvia seems to be real. At the same time, available data about condition of *Emys orbicularis* population in Latvia is insufficient, now it is not authentically known about any constant population of *Emys orbicularis* in Latvia.

Undoubtedly, this species, in connection with its rarity in Latvia demands further research on its distribution. The given publication for the first time represents the full list of finds of *Emys orbicularis* in Latvia, registered by the authors during carried out research since 1985 until September 2007.

MATERIALS AND METHODS

Research has begun in 1985 and will continue in the future. This publication reflects data about distribution of *Emys orbicularis* in Latvia, received by the authors until September 2007. The research took place all over the Latvian territory. If the messages on finds of *Emys orbicularis* were received, the given territories were surveyed additionally.

In connection with extremely low number of *Emys orbicularis* in Latvia the given research on distribution of *Emys orbicularis* L. was carried out by interrogation of Latvian inhabitants. There have been interrogated the following target groups of inhabitants: Zoo visitors; professionals, whose activity is connected with the nature (foresters, the inspector of wildlife management, hunters, etc.); inhabitants of areas where *Emys orbicularis* were seen earlier; readers of specialized editions about the nature, etc. The general number of interrogated people is more than 30000, taking into consideration TV and radio audience. The head method of interrogation since 1985 was oral interview. Also, radio and TV were used. From 2005 in addition to interviews and independently was carried out questioning by specially published questionnaires-booklets "Search for *Emys orbicularis* in Latvia" (Lidaka et al. 2005). For increase of validity of received data, the questionnaires included questions and recommendations for inhabitants about observation of *Emys orbicularis* in the nature and photos of characteristic attributes of *Emys orbicularis*: appearance, traces on sand; also photos of two exotic species of turtles most often imported into Latvia.

In case of receiving positive result at questioning, also was carried an additional oral interview about details of observation with the respondent. This interview included three consecutive stages.

1. stage. Question about observation of *Emys orbicularis* by the respondent in Latvian nature.

2. stage. In case of the positive answer to this question, there took place the check of its validity by presenting several color photos of *Emys orbicularis* L. and photos of imported by pet-shops to Latvia exotic turtles *Trachemys scripta elegans* and *Agrionemys horsfieldi* for an identification.

3. stage. In case of acknowledgement of reliability, took place the developed interview for acknowledgement of validity and receiving additional information:

3.1. Time data: In which year the observation took place; during what time (the season, if possible month and date), during what time of day, how long did the observation proceed, did the observation repeat or not, etc.

3.2. Geographical data: In what area of Latvia *Emys orbicularis* was observed; name of the nearest reservoir; name of nearest settlement, other local names of the nearest geographical objects, the nearest roads, etc.

3.3. External view data: The approximate size of a turtle; color of carapace, plastron, neck, head and extremities; presence of damages on the armor

3.4. Ecological data: In which biotope was the turtle observed; preview of the biotope characteristic (character and quantity of vegetation, use of the given place by the human, boundary biotopes); the approximate characteristic of the nearest reservoirs (size, flowing ability, depth, vegetation, character and structure of coast, use by the human, etc.)

3.5. Ethological data: observable behavior of a turtle, its dynamics

At the consent of the respondent, his/her contact information was also specified (not specified in the given article).

Also, expertise of the specified places and biotopes of observation during expeditions to the places specified by respondents were carried out.

RESULTS

In this publication for the first time presented the full list of the data received by the authors about distribution of *Emys orbicularis* to Latvia during the research since 1982 until September 2007. There is specified range of data for each message. Reg. Number. Individual message registration number.

Plausibility. Specifies the plausibility of observation exactly species *Emys orbicularis*. There specified the following levels of plausibility. 4. - checked by authors or photo; 3. - observed by professional biologist; 2. - observed by respondent himself; 1. - observed not by respondent, but by other people. In cases 2-3 for increase of plausibility, in addition the respondent was shown a set of photos of turtles and offered to choose an animal observed by himself. Observation registered only in case of a correct choice. In connection with that, in practice, all observation, except of group 1, are authentic in a high degree.

Observation year. Specifies the year of *Emys orbicularis* observation. In case the respondent could not specify the year precisely, registered the average date of the time interval specified.

Location. Specifies the place of observation, in some cases the biotope of find of *Emys orbicularis*.

Size class. Because observers did not measure the sizes of observable *Emys orbicularis* in most cases, respondents were offered to compare the sizes of observed turtles to standards of length.

Based on such comparisons were specified 4 classes of the length of carapace of observed turtles: 1. - smaller than 5 cm; 2. - 5-10 cm; 3. - 10-15 cm; 4. - more than 15 cm. In case the observable

animal was measured, the length of carapace is specified in cm.

Sex. Specified, if has been authentically determined during research.

Number of animals. Specify the quantity of simultaneously observed animals.

Observations frequency. Specify quantity of observations of turtles in the place according to the respondent words.

Observation time or season. Specify the season of *Emys orbicularis* observation. For some cases specified the exact date, if it is known.

Comments. Specify some data about concrete case of observation.

The list of observations of *Emys orbicularis* L. in Latvia, registered during 1982 till September, 2007

Reg. Number: 0001

Plausibility: 4 (checked by authors, photo). Observation year: 1984. Location: Daugavpils city, Sportu street, near to small Sunupe river, near ponds system. Size class: 4 (19.8 cm). Sex: female. Number of animals: 1. Observations frequency: 1. Observation time or season: late summer. Comments: found on the ground under bushes near ponds. Laying 12 eggs.

Reg. Number: 0002

Plausibility: 2. Observation year: 1978. Location: Daugavpils city, Stropu lake coast. Size class: 3. Sex: unknown. Number of animals: 2. Observations frequency: 1. Observation time or season: late summer. Comments: found on the potaeous field, under ground deep 10 cm by land potaeous works.

Reg. Number: 0003

Plausibility: 2. Observation year: 1982. Location: Sigulda district, Adazi, Jugu marsh, Lielais Jugezers lake. Size class: 2. Sex: unknown. Number of animals: 3. Observations frequency:

2. Observation time or season: spring. Comments: found in the water, in the pond.

Reg. Number: 0004

Plausibility: 4 (checked by authors). Observation year: 1995. Location: Daugavpils district, Skrudaliena region, Silene Nature park, Ricu lake, Priedaine base. Size class: 4 (16.5 cm). Sex: female. Number of animals: 1. Observations frequency: 1. Observation time or season: 20.07.1995. Comments: found in the water deep 1,5 m, by the diver.

Reg. Number: 0005

Plausibility: 2. Observation year: 1997. Location: Kraslava city, Perstena lake. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 3. Observation time or season: summer. Comments: found on the coast of the pond, in the water.

Reg. Number: 0006

Plausibility: 2. Observation year: 1982. Location: Daugavpils district, marsh near Beljani lake, near to Belorussia borders. Size class: 3. Sex: unknown. Number of animals: 2. Observations frequency: 3. Observation time or season: summer. Comments: found in marsh by hunters.

Reg. Number: 0007

Plausibility: 2. Observation year: 1989. Location: Daugavpils district, Visky city. Size class: 1. Sex: unknown. Number of animals: 3. Observations frequency: 1. Observation time or season: autumn. Comments: caught by the local man in the peat ponds.

Reg. Number: 0008

Plausibility: 2. Observation year: 1996. Location: Ventspils, Mauruciems, near to Zemsaka river. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: found in the marsh forest on the land.

Reg. Number: 0009

Plausibility: 2. Observation year: 1985. Location: Ventspils, near Mauru marsh, near to sea. Size class: 3. Sex: unknown. Number of animals: 1.

Observations frequency: 2. Observation time or season: summer. Comments: found in the marsh.

Reg. Number: 0010

Plausibility: 1. Observation year: 1996. Location: Ventspils, near to Mauruciems city, Mauru marsh near to railway. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 2. Observation time or season: summer. Comments: found in the marsh near railway.

Reg. Number: 0011

Plausibility: 2. Observation year: 1996. Location: Liepaja district, Skrunda Liepaja road, Vitoli village turn left, Graudusi village. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: found in the marsh forest.

Reg. Number: 0012

Plausibility: 1. Observation year: 1938. Location: Dobele district, near to Apgulde city, Apgulde lake. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: found on the road near to Apgulde road.

Reg. Number: 0013

Plausibility: 4 (photo). Observation year: 1997. Location: Dobele district, near to Apgulde city, fish pond. Size class: 1 (4.4 cm). Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: 27.07.1997. Comments: found on the coast of meliorative channel.

Reg. Number: 0014

Plausibility: 1. Observation year: 2004. Location: Riga city, Kisezers lake. Size class: unknown. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: found on the coast.

Reg. Number: 0015

Plausibility: 4 (checked by authors, Fig.1., Fig.2.). Observation year: 2003. Location: Madona district, Jumurda region, Vestieni Inesi road, near Laci village, Vecais kapukalns. Size class: 4 (19.6 cm). Sex: female. Number of animals: 1.

Observations frequency: 1. Observation time or season: 21.07.2003. Comments: found on the road near fish pond. Laying 7 eggs in 2 days.

Reg. Number: 0016

Plausibility: 2. Observation year: 1983. Location: Daugavpils district, Skrudaliena area, Silene nature park, 2 km near to Ricu lake, in the forest. Size class: 3. Sex: unknown. Number of animals: 1 (died, carapax only). Observations frequency: 1. Observation time or season: autumn. Comments: found near to Nyctereus proctionides hole.

Reg. Number: 0017

Plausibility: 2. Observation year: 1968. Location: Daugavpils district, Malinova region, Janciska village, pond near to former school. Size class: 3. Sex: unknown. Number of animals: 3. Observations frequency: 1. Observation time or season: November. Comments: observed by children under ice, water deep 20-30 cm, animals were active.

Reg. Number: 0018

Plausibility: 4 (checked by authors, Fig.3, Fig.4.). Observation year: 2004. Location: Daugavpils city, Jauna Forstate region, near to school #16. Size class: 4 (17.7 cm). Sex: B&. Colour: carapax black. Number of animals: 1. Observations frequency: 1. Observation time or season: 24.06.2005. Comments: found on the land.

Reg. Number: 0019

Plausibility: 2. Observation year: 2005. Location: Daugavpils city, Mezciems region. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: found on the road in the forest.

Reg. Number: 0020

Plausibility: 2. Observation year: 1964. Location: Daugavpils district, Viski region, Visku lake, near to Macula. Size class: 4. Sex: unknown. Number of animals: 1. Observations frequency: 3. Observation time or season: summer. Comments: hunt by local people in water on the beach, on the coast, for the hitting by legs, sticks.

Reg. Number: 0021

Plausibility: 2. Observation year: 1996. Location: Daugavpils district, Viski region, Korolevscina village. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 3. Observation time or season: summer. Comments: observed in a little home pond in a time of some days.

Reg. Number: 0022

Plausibility: 2. Observation year: 1997. Location: Daugavpils city, Veca Forstate region, near Suna ezers lake. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: on the road near to railway.

Reg. Number: 0023

Plausibility: 1. Observation year: 1983. Location: Talsi district, Slitere region, Ruksupurs marsh. Size class: unknown. Sex: unknown. Number of animals: 1. Observations frequency: e"3. Observation time or season: unknown. Comments: in the marsh.

Reg. Number: 0024

Plausibility: 3. Observation year: 1985. Location: Talsi district, Slitere region, Petera lake. Size class: unknown. Sex: unknown. Number of animals: unknown. Observations frequency: no. Observation time or season: summer. Comments: observed many fishes bubbles.

Reg. Number: 0025

Plausibility: 3. Observation year: 1988. Location: Talsi district, Stende city, near to former Mineral fertilizers store, near to railway. Size class: 4. Sex: female. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: on the ground.

Reg. Number: 0026

Plausibility: 3. Observation year: 1989. Location: Talsi district, Pitragi region, near Pitraga river, on the road. Size class: 4 (17 cm). Sex: female. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: on the road near to Pitraga river.

Reg. Number: 0027

Plausibility: 3. Observation year: 2003. Location: Talsi district, Melnsils region, Baltic sea coast. Size class: unknown. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: 07.2003. Comments: traces on the beach from the Baltic sea to the forest.

Reg. Number: 0028

Plausibility: 4. (photo). Observation year: 1972. Location: Jelgava city, Mezciems, near Vircava river. Size class: 4 (17 cm). Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: 06.06.1972. Comments: on the old sawdust store. Laid 12 eggs.

Reg. Number: 0029

Plausibility: 4. (checked by authors, photo). Observation year: 2005. Location: Kraslava district, Dagda region, near Dzeguze river. Size class: 4 (17.3 cm). Sex: female. Number of animals: 1. Observations frequency: 1. Observation time or season: 06.06.1972. Comments: on the road near Dzeguze river.

Reg. Number: 0030

Plausibility: 4. (photo). Observation year: 1998. Location: Talsi district, Kolka region, Pitraga village, sea coast beach near to Pitraga river. Size class: 4 (18 cm). Sex: female. Number of animals: 1. Observations frequency: 1. Observation time or season: 28.07.1998. Comments: found on the sea beach.

Reg. Number: 0031

Plausibility: 3. Observation year: 1980. Location: Dobeles district, Ukri city, pond near to local school. Size class: 2 (7-8 cm). Sex: unknown. Number of animals: e"5. Observations frequency: 1. Observation time or season: summer. Comments: found by children after pond cleaning.

Reg. Number: 0032

Plausibility: 2. Observation year: 1985. Location: Ogre city, meliorative channel near to local canalisation cleaning ponds. Size class: 3. Sex:

unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: found in the channel.

Reg. Number: 0033

Plausibility: 1. Observation year: 1986 -1989. Location: Jelgava city, Mezciems region, near Vircava river, the old sawdust store. Size class: unknown. Sex: unknown. Number of animals: 1. Observations frequency: e"2. Observation time or season: summer. Comments: found on the coast of Vircava river.

Reg. Number: 0034

Plausibility: 3. Observation year: 1968. Location: Daugavpils city, Kimiku region. Size class: 4 (19 cm). Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: a local boy found and show on the pet show.

Reg. Number: 0035

Plausibility: 3. Observation year: 1960. Location: Daugavpils district, Skrudaliena region, Silene Nature Park, Silupite river near road. Size class: unknown. Sex: unknown. Number of animals: unknown. Observations frequency: e"3. Observation time or season: summer. Comments: observed many fishes bubbles.

Reg. Number: 0036

Plausibility: 3. Observation year: 1981-1985. Location: Kuldiga city, near Venta river, former Vulkans wood factory sawdust store. Size class: 3. Sex: unknown. Number of animals: unknown. Observations frequency: e"3. Observation time or season: summer. Comments: on the old sawdust.

Reg. Number: 0037

Plausibility: 3. Observation year: 1986-1987. Location: Kuldiga city, Central pond. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: e"3. Observation time or season: summer. Comments: in the city pond for two years.

Reg. Number: 0038

Plausibility: 2. Observation year: 1989. Location: Daugavpils city, Rugeli region, Elektroinstrument fish ponds. Size class: 4. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: was caught, after 1 month returned to the nature.

Reg. Number: 0039

Plausibility: 2. Observation year: 2005. Location: Daugavpils district, Kalkune region, Celtnieks village, Tarzanka pond system. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: in the water.

Reg. Number: 0040

Plausibility: 2. Observation year: 2001. Location: Daugavpils city, Esplanade region, pond near new Daugavpils University. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: in the pond.

Reg. Number: 0041

Plausibility: 1. Observation year: 2000. Location: Saldus district, near Lasupe river, poad factory. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: found carapax.

Reg. Number: 0042

Plausibility: 2. Observation year: 2002. Location: Saldus district, near Lasupe river, poad factory. Size class: 4. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: 05.2002. Comments: children found the animal.

Reg. Number: 0043

Plausibility: 2. Observation year: 1996. Location: Kraslava district, Dagda region, Vorzovo village, small river, under the bridge. Size class: 4. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: spring. Comments: children found the animal in water.

Reg. Number: 0044

Plausibility: 1. Observation year: 1986. Location: Kraslava district, Dredzds lake near Plocini village.

Size class: unknown. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: in the lake. Published in local newspapers.

Reg. Number: 0045

Plausibility: 2. Observation year: 2006. Location: Dobele district, Apgulde region, fish pond near to Apgulde lake. Size class: 2 (8 cm). Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: 14.06.2006. Comments: on the wood placed in water.

Reg. Number: 0046

Plausibility: 2. Observation year: 2002. Location: Daugavpils district, Demene region, Mezi village, pond system. Size class: 2. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: 07.2002. Comments: under stone in dry pond.

Reg. Number: 0047

Plausibility: 2. Observation year: 2001. Location: Daugavpils city, Jauna Forstate region, Sunu lake. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: after dog attack has dived into water.

Reg. Number: 0048

Plausibility: 2. Observation year: 2002. Location: Daugavpils city, Jauna Forstate region, Sunu lake coast. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: found died animal.

Reg. Number: 0049

Plausibility: 2. Observation year: 2004. Location: Liepaja district, Nica region, road Nica - Lithuania, 2 km., turn left 3 km, in the forest. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: on the road.

Reg. Number: 0050

Plausibility: 2. Observation year: 1968. Location: Kuldiga district, Ranki region, Savinieki village,

near to former Ranku school, 3 km to Venta river. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: on the coast of time little pond.

Reg. Number: 0051

Plausibility: 1. Observation year: 1980. Location: Liepaja district, Aizpute region, Kalvene city, Podnieku lake. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: unknown. Comments: in the water.

Reg. Number: 0052

Plausibility: 2. Observation year: 2001. Location: Kraslava district, Kumbuli region, Ots lake, coast nearest to Kusini village. Size class: 1. (2.5-3 cm). Sex: unknown. Number of animals: 3. Observations frequency: 1. Observation time or season: August. Comments: in the water, 20 cm deep.

Reg. Number: 0053

Plausibility: 2. Observation year: 1996. Location: Kraslava district, Dagda region, road near to Kromani village. Size class: unknown. Sex: unknown. Number of animals: 3. Observations frequency: 1. Observation time or season: summer. Comments: trace on the ground road.

Reg. Number: 0054

Plausibility: 2. Observation year: 2002. Location: Kraslava district, Dagda region, near to Kromani village, Dzeguze river. Size class: 15 cm. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: on the coast.

Reg. Number: 0055

Plausibility: 2. Observation year: 1998. Location: Kraslava district, Dagda region, near to Kromani village, Dzeguze river. Size class: 15 cm. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: early summer. Comments: in the fish net.

Reg. Number: 0056

Plausibility: 4. (checked by authors). Observation year: 2007. Location: Ventspils district, Ance region, Auzdarciems village, near Liepati village. Size class: 4 (17 cm). Sex: female. Number of animals: 1. Observations frequency: 1. Observation time or season: 03.06.2007. Comments: on the ground road in the damp forest.

Reg. Number: 0057

Plausibility: 1. Observation year: 2002. Location: Jekabpils city, Dambja street, pond near Justucuja house. Size class: unknown. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: unknown. Comments: on the pond coast.

Reg. Number: 0058

Plausibility: 1. Observation year: 2007. Location: Daugavpils city, Gubisce lake. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: 21.06.2007. Comments: on the marsh coast near little bridge.

Reg. Number: 0059

Plausibility: 3. Observation year: 2004. Location: Cesis district, Gauja National park, Sudas marsh, Zviedru lake. Size class: unknown. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: swimming in the water.

Reg. Number: 0060

Plausibility: 2. Observation year: 1979. Location: Riga district, Kangari region, Kangaru marsh, Kangaru lake. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: caught.

Reg. Number: 0061

Plausibility: 2. Observation year: 2004. Location: Preili district, Aglona city, way to Jaunaglona city, former childrens garden territory, little pond. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: 09.2004. Comments: on the coast, sun day.

Reg. Number: 0062

Plausibility: 2. Observation year: 1977. Location: Preili district, Aglona city, former childrens garden territory. Size class: 3. Sex: unknown. Number of animals: 2. Observations frequency: 1. Observation time or season: ex situ. Comments: in children garden as a pets. Probably eggs laying.

Reg. Number: 0063

Plausibility: 2. Observation year: 1981. Location: Daugavpils district, Demene region, Dervanisku lake. Size class: 4. Sex: unknown. Number of animals: 2. Observations frequency: 1. Observation time or season: summer. Comments: by fish net on the 2 m. deep water, with many plants.

Reg. Number: 0064

Plausibility: 2. Observation year: 2007. Location: Riga district, Varnu krogs village, near water cleaning ponds, on the road. Size class: 4. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: 07.2007. Comments: on the road.

Reg. Number: 0065

Plausibility: 1. Observation year: 1980. Location: Kraslava district, Dagda region, Bronki village. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: some days, summer. Comments: found, lived at home as a pet.

Reg. Number: 0066

Plausibility: 2. Observation year: 1995. Location: Kuldiga district, Mezvalde region, Blaku ponds. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: found by fishing.

Reg. Number: 0067

Plausibility: 3. Observation year: 2007. Location: Cesis district, Berzkrogs village, near to Berzinu pond and Kondratu pond. Size class: 4. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: 08.2007. Comments: on the asphalt road.

Reg. Number: 0068

Plausibility: 1. Observation year: 1995. Location: Saldus district, Blidene city, small river, under bridge. Size class: 4. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: unknown. Comments: under bridge.

Reg. Number: 0069

Plausibility: 1. Observation year: 1977. Location: Saldus district, Blidene city. Size class: unknown. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: unknown. Comments: no.

Reg. Number: 0070

Plausibility: 1. Observation year: 1965. Location: Dobele district, Biksti region, Upesmuiza village, Berze river, under bridge. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: unknown. Comments: children found under bridge.

Reg. Number: 0071

Plausibility: 1. Observation year: 1997. Location: Saldus district, Ezere city, Ezeres dzirnavu pond. Size class: unknown. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: unknown. Comments: unknown.

Reg. Number: 0072

Plausibility: 1. Observation year: 1967. Location: Dobele district, Zebrene region, near to Berze river, Zalkaju fish pond. Size class: unknown. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: unknown. Comments: unknown.

Reg. Number: 0073

Plausibility: 1. Observation year: 1987. Location: Saldus district, Remte region, Saulisu marsh. Size class: unknown. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: unknown. Comments: unknown.

Reg. Number: 0074

Plausibility: 1. Observation year: 1987. Location: Saldus district, Remte region, Tirelu marsh. Size class: unknown. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: unknown. Comments: unknown.

Reg. Number: 0075

Plausibility: 1. Observation year: 1997. Location: Dobele district, Apgulde region, Apgulde lake, the road near to lake. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: unknown. Comments: on the road.

Reg. Number: 0076

Plausibility: 1. Observation year: 1997. Location: Dobele district, Apgulde region, Apgulde lake. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: unknown. Comments: on the lake bridge.

Reg. Number: 0077

Plausibility: 2. Observation year: 1987. Location: Dobele district, Apgulde region, meliorateve channel near to Apgulde lake. Size class: unknown. Sex: unknown. Number of animals: 2. Observations frequency: 1. Observation time or season: unknown. Comments: on the channel coast.

Reg. Number: 0078

Plausibility: 4. (checked by authors). Observation year: 1988. Location: Dobele district, Apgulde region, meliorateve channel near to Apgulde lake. Size class: 3. Sex: unknown. Number of animals: 3. Observations frequency: 1. Observation time or season: summer. Comments: on the channel coast.

Reg. Number: 0079

Plausibility: 2. Observation year: 2002. Location: Aizkraukle city, Zvaidznu channel near to Plaviny basin. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: on the channel coast.

Reg. Number: 0080

Plausibility: 1. Observation year: 1992. Location: Talsi district, Vaides pond, near to sea. Size class: unknown. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: unknown. Comments: fish pond.

Reg. Number: 0081

Plausibility: 2. Observation year: 1975. Location: Liepaja district, Barta region, near to Slamsti village. Size class: 3. Sex: unknown. Number of animals: 1. Observations frequency: 1. Observation time or season: summer. Comments: found by driver.

In total have been registered 81 cases of observation of *Emys orbicularis* in Latvia in present research since 1982 until 09.2007.

DISCUSSION

On the plausibility of the received data. Undoubtedly, obtained data is not absolutely precise regarding chronology as, in some cases respondents specified a time interval of observation only. In some cases, respondents also could not name of a place of observation correctly, being limited to the area in the sub quadrant. At the same time, considering small density of *Emys orbicularis* population in Latvia and features of its ecology and ethology, we consider that the method of interrogation of the population is effective for a tentative estimation of *Emys orbicularis* distribution in Latvia and especially for precursory detection of small cryptic groups hardly found by other methods.

The factor, able to lower the plausibility of messages of respondents, there could be respondents not realized desire to give situationally socially approved affirmative answer to a question on observation of *Emys orbicularis* in Latvia. For preventive it, the methods of interrogation were created with participation of the professional psychologist, the precursory conversation and interrogation were also carried out with its participation.

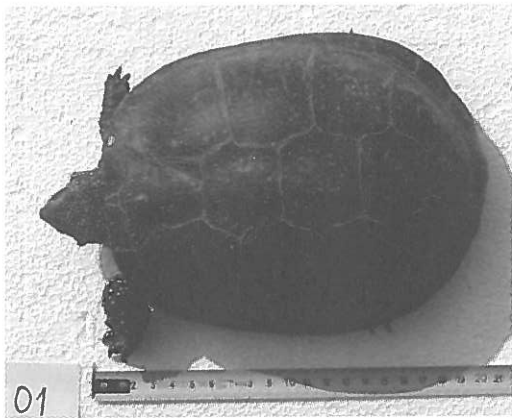


Fig.1. *Emys orbicularis* female, carapax. Latvia, Madona district, Jumurda region. Photo: M.Pupins.

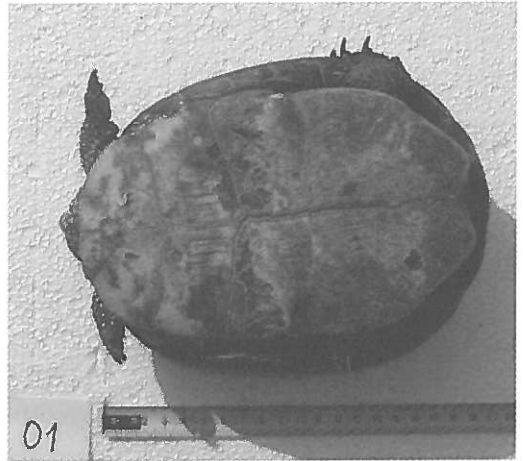


Fig.2. *Emys orbicularis* female, plastron. Latvia, Madona district, Jumurda region. Photo: M.Pupins.

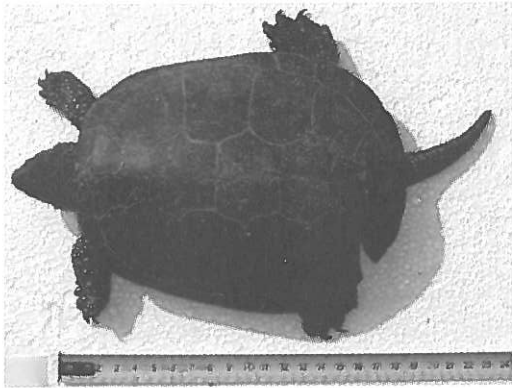


Fig.3. *Emys orbicularis* male, carapax. Latvia, Daugavpils. Photo: M.Pupins.



Fig.4. *Emys orbicularis* male, plastron. Latvia, Daugavpils. Photo: M.Pupins.

In general, plausibility of the received data is represented as high and appropriate to the mission of the research, that specify received for a number of registered observations repeated acknowledgement from independent sources (other respondents, workers of Riga Zoo etc).

During the research, there were not authentically found any stable populations of a pond turtle in Latvia. The analysis of the data received in research allows to designate areas of Latvia, potentially able to contain local stable groups of *Emys orbiculari*. with numerous observations

of turtles during several years (Dobele district, Apgulde area). Also, potential area of dwelling of turtles is the southeast of Latvia, Daugavpils and Krslava districts and separate potential territory on the northwest of Latvia.

The given research proceeds. The received data is used for the further studying of distribution,

condition of population and ecology of *Emys orbicularis* in Latvia.

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REFERENCES

- Berzins A. 2003. The European pond turtle *Emys orbicularis* Linnaeus, 1758. in: Andrusaitis G. (ed) *Red book of Latvia*. LU Biologijas instituts, Rīga: 96-97. (In Latvian and English)
- Lidaka I., Pupins M., Leimane D. 2005. *Look for pond turtle in Latvia*. Riga National Zoo, Riga. 8 p. (In Latvian)
- Meeske A.C.M., Pupins M., Rybczynski K. 2006. First results on the distribution and condition of the European pond turtle (*Emys orbicularis*) at the northern edge of its distribution in Lithuania and Latvia. *Zeitschrift für Feldherpetologie*. 13: 1-29.
- Ministru kabinets, 2000. Regulas #396 "On the rare species and protected species list" Vestnesis News papers 413/417 2000.11.17. (In Latvian)
- Pupins M., Pupina A. 1996. Pond turtle (*Emys orbicularis*) in Latvia. *Book of abstracts. Biologija plazow i gadow. IV Ogolnopolska Konferencja Herpetologiczna*. Wydawnictwo Naukowe WSR: 96b-96d. (In Polish)
- Pupins M. 2005. Research of the *Emys orbicularis* spreading in Latvia, preliminary assesment of factors limiting the number of the species. *Book of abstracts. 3rd International conference "Research and conservation of biological diversity in Baltic region"*. Baltis society of Coleopterology: 98.
- Silins J., Lamsters V. 1934. *Latvian Reptiles and Amphibians*. Rīga. 96 p. (In Latvian)

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CAN *EMYS ORBICULARIS* SURVIVE IN LITHUANIA?

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In Lithuania, *Emys orbicularis* is a threatened species being on the red list of the country because of its declining populations. Most of the local turtle populations are small with less than 10 up to 30 individuals, and they are more or less isolated. A few number of local populations have a short-term viability consisting of 50 or more individuals. Due to the habitat deteriorations in the last centuries, there is a big loss of suitable waters and open areas for nesting sites today. Until today the Lithuanian conservation measures for *Emys orbicularis* e.g. habitat improvements in existing "turtle"-reserves can be evaluated as insufficient. The viability of the species depends on establishing bigger suitable turtle habitats and connecting the small local populations which leads to an individual exchange with neighbouring populations. The establishment of a good working network of protected turtle habitats is the only way to guarantee the long-term survival of *Emys orbicularis* in Lithuania. With the still existing populations in southern Lithuania the country has a good basis for having viable populations in the future.

Key words: Testudines; Emydidae; *Emys orbicularis*; distribution; population biology; Lithuania

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INTRODUCTION

Emys orbicularis is strongly dependent on water and require furthermore different habitat types. In Lithuania, the species is threatened and on the red list of the country. In former times, *Emys orbicularis* was widespread in Lithuania (Meeske 2006, Meeske et al. 2006), but nowadays most of the 30 known populations exist only in South-Lithuania due to the fast extinction of many local populations during the last century (Vaiciunaite 1992, Balčiauskas et al. 1997). Today, the Lithuanian ministry acts on the assumption of a

total number of 1000 turtles for the whole country, but this estimation is not based on real studies and surveys. The deficit of investigations on turtle occurrences is responsible for the current low state of knowledge on the existence and distribution of local populations as well as their status. Exceptionally, few investigations on the biology and some small questionable conservation measures for *Emys orbicularis* were led between the end of the 70's and the beginning of the 90's in the herpetological reserve Kuciuliske (Alytus-District) (Snieskus 1994a, b, 1995, 1998). Newer facts about the status of *Emys-*

populations are available only for the Alytus-District in Southwest-Lithuania as well as several information about the population biology and the habitat requirements of the local population in Kuciuliske (Meeske 1997a, b, 1998, 2000a, b, 2006, Meeske et al. 2000, 2002, 2006, in prep., Meeske & Rybczynski 2001, 2006, Meeske & Mühlenberg 2004). In fact between 1999 and 2001, there were carried out some turtle surveys for the proposal of NATURA 2000-areas by the Institute of Ecology (Vilnius university), but the results do not give new actual information, and the proposals are more influenced by previous suggestions for the establishments of herpetological reserves in the 70's. Until now, four pSCI-areas for NATURA 2000 are proposed for *Emys orbicularis* (d. Pous & Beckmann 2004).

SITUATION OF *EMYS ORBICULARIS*

Status of the turtle populations

The population sizes of most of the local turtle occurrences are small consisting of some single specimens or with a maximum up to 30 animals. Additionally, most of the local populations are far dispersed and more or less isolated. Such local populations can be classified as endangered or in extreme cases with a small number of population members as becoming extinct. But the smaller local populations can have an important role as corridor between bigger neighbouring populations. By contrast, only few local populations seem to have a short-term viability with approximate 50 or more individuals. Young turtles of different age classes were noticed in several areas which indicates reproduction success under natural conditions (Meeske et al. 2002, Meeske 2006, Meeske et al. 2006).

In South-Lithuania, turtle populations live in very sparsely populated areas with extensive agricultural and forestal use and even near farms and settlements. In these areas, they inhabit different types of water bodies. Nowadays, the Lithuanian *Emys orbicularis* absolutely profit from the prevalent extensive land use (Meeske 2006, Meeske et al. 2006).

Generally, *Emys orbicularis*-populations have a low individual density in Lithuania e.g. in Kuciuliske 0,6-0,7 animals/has (Meeske 2006, Meeske et al. 2006). Clear fluctuations of population sizes can be excluded. Age structures with a bigger share in old individuals (49%) should be not classified as superannuated but rather should be understood as adaptation to the given circumstances at the northern edge of the species' distribution.

Threats of the turtle populations

Natural threats

In some Lithuanian areas, predators can destroy more than 70 % of all nests. For these areas, foxes (*Vulpes vulpes*) and racoon dogs (*Nyctereutes procyonoides*) are identified as main predators (Meeske et al. 2002, Meeske 2006, Meeske et al. 2006). The mortality rate of juveniles is unknown, but can be presumed as distinctly lower than of eggs and hatchlings. The general adult mortality and thus the predation on adults is rather low (Meeske 2006, Meeske et al. 2006).

Other threats

The habitat degradation is the main factor for a clearly diminished habitat quality and for the general deficite of suitable turtle habitats. Meliorations and overgrowth with bushes and trees are responsible for the drying out of waters. Particularly in the last century, the situation of the water bodies has constantly degraded.

A similar problem is the loss of open areas and nesting sites respectively, because of the overgrowth with bushes and trees as well as the intensive land use. Such a lack of suitable nesting sites reduces or prevents successful incubation of turtle clutches (Meeske 2006, Meeske et al. 2006). Human activities are the biggest danger for the turtles. Angling and fishing can harm or kill individuals through fishing hooks or animals can drown in bow nets. Turtles migrating on land can be killed during crossing pathes and roads e.g. reproductive females in the nesting period or animals changing water bodies.

Captures for private interests is another human influence what can be assumed to a minor degree. In some cases, single turtles found in areas without turtle populations or in unsuitable habitat conditions can be released or be runaway animals e.g. one turtle in Zuvintas Biosphere Reserve (Pranaitis oral information). One man reported Rybczynski (oral information) that he has captured two turtles for keeping at home. In few known cases turtles were relocated because of mistaken protection measures (Snieskus oral information).

The use of chemicals and pesticides can be estimated as less in areas with extensive agriculture use which occurs in the main parts of the south of the country. Clutches located on field- and forest paths can be smashed through tractors, other vehicles or workhorses as well as nests situated near or on pastures which can be crushed by cattle and horse steps.

Previous conservation efforts for the turtle populations

In 1976, *Emys orbicularis* was registered into the red list of the country because of the clear decline of its populations in the last century (Vaicunaite 1992, Balciauskas et al. 1997). In addition, the country emphasised its conservation measures with the establishment of three small and quite ineffective herpetological reserves in the south of the country (Kuciuliske: 50 ha, Straciunai: 24 ha, Juodobale: 9 ha). Later, the herpetological reserve Kuciuliske was enlarged up to 82 ha. Whereas the local population in Kuciuliske survived, within and around the two other reserves the individual number heavily decreased due to the appeared habitat deteriorations (Meeske 2006, Meeske et al. 2006). In Juodobale, the drying out of the waters caused the disappearance of the turtles but the reason for the decline of the Stracunai-population is still unclear.

In 1998, the Meteliai Regional Park initiated the first renaturation project in the herpetological reserve Juodobale. After implementing of the actions (tree cutting, pond digging), more than

30 pond turtles recolonized this area over the past years. Further activities concerning habitat improvements continued. In 1998 and 2002, similar but in this case more questionable actions for habitat improvements [tree cutting (1998, 2002), pond digging (2002)] were arranged in the herpetological reserve Kuciuliske under the control of the Meteliai Regional Park. In the years 1999-2001, 2004 and 2005 the situation of local *Emys*-populations in the Alytus district were carried out by the Meteliai Regional Park and the university of Göttingen/Germany as well as a public survey of the local people in the year 2000 (Meeske 2006, Meeske et al. 2006). In 2005, three countries (Lithuania, Poland and Germany) began the international LIFE-Nature-Projekt (LIFE05NAT/LT/000094 "Protection of *Emys orbicularis* and amphibians in the North European lowlands") under the direction of the Lithuanian Fond for Nature in Vilnius. Various activities for habitat improvement, public relations and international exchange will be led in the EU-LIFE-Projekt. Additionally to this project, other small "habitat management"-projects (predominant pond digging) for *Emys orbicularis* will be implemented by the Meteliai Regional Park and the Lithuanian Fond for Nature.

Survivability of the turtle populations in consideration of the actual population status and the current conservation measures

The south-lithuanian turtle populations occupy different types of water bodies in areas with extensive agricultural and forestal use and in the vicinity of farms and settlements as well. Some populations even exist in villages. Altogether, the situation of the turtle habitats is evaluated as very critical, because most of the original suitable turtle ponds are destroyed by habitat destruction, meliorations and overgrowth with bushes. Today, turtles are forced to move to artificial ponds, but such new ponds of residence can lie dispersed over big distances and can be very often unsuitable because of locality, size, general structure, vegetation structure and food supply. Such small artificial ponds can help a local population to survive in short-term, but for a long-term survival they need suitable conditions.

In Lithuania, no existing population of *Emys orbicularis* has a number of individuals which is essential for a long-term viability of a population (> 500 individuals). Most of the local turtle populations are even so small (< 10 individuals) and far dispersed. Fact is, that the existing turtle habitats with their quality and quantity of necessary habitat components are too small and does not allow bigger population sizes. The evidence of successful reproduction in different areas make clear, that the availability of adult specimens as well as the habitat quality (suitable nesting areas and ponds of residence for all age classes) made at least reproduction success during the last years in these areas possible. However, after evaluation of the first results of the surveys (1999-2005) it is assumable that the present reproduction success is not sufficient for the conservation of the south-lithuanian populations because of the small existent habitats, the small populations and the small number of reproductive females. Additionally, due to the low habitat capacity the local populations cannot grow.

Altogether, it is to be presumed that most of the still existing populations are in danger to extinct without conservation measures. Unfortunately, the previous species protection and the current conservation situation is not sufficient at all for the survival of *Emys orbicularis* in Lithuania (comp. Balciauskas et al. 1997, Meeske 2006, Meeske et al. 2006). The habitat requirements and the status of the local turtle populations in comparison with the given circumstances are not really considered in most of the project activities and even the importance and necessity of effective conservation measures for the last Lithuanian *Emys*-populations is not seriously understood in the Lithuanian organisations, institutions and authorities. Ministrys proposal for creating NATURA 2000-areas concerning *Emys orbicularis* is a good example to show how they trifle with threatened species. An indicator for creating protected areas for *Emys orbicularis* is an area with 10 individuals of pond turtles. In spite of surveys, the first proposals of protected areas for the Natura 2000-network were based only on the three previous established nature

reserves added with an area inhabited by one or two probable released turtles (Meeske 2004, d. Pous & Beckmann 2004). However, this was done without regarding to the current situation of the turtles. At the same time much more NATURA 2000-areas could and should be established for this species in consideration of ministrys proposal.

The protected areas in the range of NATURA 2000 are therefore a really good chance to establish the necessary network and to protect viable turtle populations and their habitats. Without this network the isolation of non growing populations with all the consequences e.g. inbreeding effects and extinction of smaller local populations will clearly increase. This means that an adequate improvement of the habitat situation (1. establishment of new protected areas for neighbour-populations of the previous protected populations and 2. enlargement of the previous protected areas) is the most effective conservation measure for *Emys*. The investigations until now show that the turtles reproduce under natural conditions in Lithuania. Other measures as breeding and rearing of young turtles can be effective for very small populations like in Germany, but in Lithuania the present habitat situation is not good enough for bigger populations sizes. Consequently, only the improvement of the habitats sizes and qualities with the enlargement of the number and sizes of the areas can really support the lithuanian turtle populations. Finally, in suitable and big enough habitats, the natural reproduction will support the population growth for bigger populations and additionally, with the connection of the neighbouring populations a long-term viability of the species is assured. For optimizing the protection success the awareness of local people concerning *Emys orbicularis* should be arised with different activities of public relations.

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REFERENCES

- Balčiauskas, L., G. Trakimas, R. Juskaitis, A. Ulevicius, & L. Balčiauskienė (1997): Lietuvos zinduoliu, varliagyviu ir ropliu atlasas. – Projekto „Lietuvos ekologine ivairove“ grupe Ekologijos institutas Vilnius: 112 pp.
- Meeske, M. (1997a): Nesting ecology of *Emys orbicularis* in South Lithuania. – Acta Zoologica Lituanica, Vol. 7 Biodiversity: 138-142.
- Meeske, M. (1997b): Nesting behaviour of *Emys orbicularis* in South Lithuania. – Acta Zoologica Lituanica, Vol. 7 Biodiversity: 143-150.
- Meeske, M.A.-C. (1998): Zur Biologie der Europäischen Sumpfschildkröte in Litauen. – Diploma Thesis, University of Göttingen, unpubl.: 145 pp.
- Meeske, A.-C.M. (2000a): Die Europäische Sumpfschildkröte (*Emys orbicularis*) an der nördlichen Grenze ihrer Verbreitung in Litauen. – Elaphe 8/4: 57-63.
- Meeske, A.-C.M. (2000b): Habitat requirements of the European pond turtle (*Emys orbicularis* L.) in South Lithuania. In: Buskirk, J., M. Cheylan, R. Duguy, U. Fritz, A. Jablonski, C. Keller, C. Pieau, R. Podloucky, J. Servan & E. Taskavak (ed.): Proceedings of the 2nd International Symposium on *Emys orbicularis*. – Chelonii 2: 27-32.
- Meeske, M. (2004): Vorläufiger Bericht zum Stand NATURA 2000 in Litauen. – <http://www.amphibienschutz.de/tagungen/natura2000.htm#Meeske>
- Meeske, M.A.-C. (2006): Die Europäische Sumpfschildkröte (*Emys orbicularis* L.) am nördlichen Rand ihrer Verbreitung in Litauen. – Bielefeld (Laurenti): 160 pp.
- Meeske, A.-C.M. & K.J. Rybczynski (2001): Migrationsverhalten bei der Europäischen Sumpfschildkröte (*Emys orbicularis* L.) in Litauen und Konsequenzen für Schutzmaßnahmen. In: Gottschalk, E., A. Barkow, M. Mühlenberg & J. Settele (ed.): Naturschutz und Verhalten, International Symposium in the Centre for Nature Conservation, University of Göttingen. – UFZ-Berichte 2/2001: 161-166.
- Meeske, A.-C.M. & M. Mühlenberg (2004): Space use strategies by a northern population of the European pond turtle, *Emys orbicularis*. In: Fritz, U. & P. Havas (ed.): Proceedings of the 3rd International Symposium on *Emys orbicularis*. – Biologia 59/ Suppl. 14: 95-101.
- Meeske, A.-C.M. & K.J. Rybczynski (2006): Telemetrija studij pri la mar a testudo en suda Litovio. – Sciencia Revuo 2/2006.
- Meeske, A.-C.M., E. Snieshkus & F. Welter-Schultes (2000): Aufzucht und Wachstumsanalysen der Europäischen Sumpfschildkröte (*Emys orbicularis*) aus Litauen. – Salamandra 36/2: 89-102.

- Meeske, A.-C.M., N. Schneeweiss & K.J. Rybczynski (2002): Reproduction of the European Pond Turtle *Emys orbicularis* in the northern limit of the species range. In: Vogrin, M. (ed.): Proceedings of the 11th Ordinary General Meeting of Societas Europaea Herpetologica (SEH). – Biota-Journal for Biology and Ecology 3/1-2: 91-101.
- Meeske, A.-C.M., M. Pupins & K.J. Rybczynski (2006): Erste Ergebnisse zur Verbreitung und zum Status der Europäischen Sumpfschildkröte (*Emys orbicularis* L.) am nördlichen Rand ihrer Verbreitung in Litauen und Lettland. – Zeitschrift für Feldherpetologie 13: 71-99.
- Meeske, A.-C.M., M. Mühlenberg & K.J. Rybczynski (in prep.): Strategies of reproduction and ecological requirements of nesting areas of *Emys orbicularis* at the northern border of the species range (Lithuania).
- d. Pous, P. & A. Beckmann (2004): Natura 2000 in the New EU Member States. – WWF EU Accession Initiative, NP Agentura.
- Snieskus, E. (1994a): Reaklimatisationsmöglichkeiten der Europäischen Sumpfschildkröte (*Emys orbicularis*). – Elaphe 2/3: 6-8.
- Snieskus, E. (1994b): Zum Verhalten der Europäischen Sumpfschildkröte *Emys orbicularis* (Linnaeus, 1758). – Elaphe 2/3: 11-14.
- Snieskus, E. (1995): Is it possible to preserve the Pond Turtle *Emys orbicularis* in the northernmost parts of its distribution? – Memoranda Societatis pro Fauna et Flora Fennica 71: 125-127.
- Snieskus, E. (1998): Some observations on secondary sexual characteristics, sex ratio, and reproductive aspects of European pond turtles, *Emys orbicularis* (Linnaeus, 1758), in the former USSR. In: Fritz, U., U. Joger, R. Podloucky & J. Servan (ed.): Proceedings of the EMYS Symposium Dresden 96. – Mertensiella 10: 253-258.
- Vaiciunaite, R. (1992): Balinis vezlys – *Emys orbicularis* L.. In: Balevicius, K, M. Lapele, S. Paltanavicius & A. Ladyga (ed.): Lietuvos raudonosios knygos komisija: 71 – Vilnius (Lietuvos Respublikos aplinkos apsaugos departamentas).

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ON THE PRESENCE OF *PLACOBDELLA SP.* LEECHES ON *EMYS ORBICULARIS*

César Ayres, Alberto Alvarez

Ayres C., Alvarez A. 2008. On the presence of *Placobdella sp.* leeches on *Emys orbicularis*. *Acta Biol. Univ. Daugavp.*, 8(1): 53 - 55.

In this work preliminary data are presented on the presence of *Placobdella sp.* leeches on *E. orbicularis* from two areas of Spain. The individuals with leeches attached were found in May 2003 in El Escorial pond, in Madrid region. One of the females presented up to thirteen leeches attached. The individuals affected by leeches in Arnoia river were juveniles and females, in this population up to five leeches could be found on turtles, always in the plastron as in Madrid region.

Key words: *Emys orbicularis*, *Placobdella*, Spain.

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INTRODUCTION

Emys orbicularis is found in East and Central Europe, the Mediterranean countries (including some islands) and North of Africa (Fritz, 1995). Formerly the range was most extensive, because postglacial remains have been found in North Europe, including England (Fritz, 1995).

In the Iberian peninsula, the species is common in some areas (Andreu, 1997; Andreu and López-Jurado, 1998; Fritz, 2001), but, with the exception of the work of Keller (1997), very little is known about its ecology and behaviour. Recent works presented preliminary data about parasitofauna of *E. orbicularis* in the Iberian Peninsula (Hidalgo et al., 2004; Segade et al., 2006), but there's little information about the presence of leeches in Iberian populations.

In this work we present preliminary data on the presence of *Placobdella sp.* leeches on *E. orbicularis* from two areas of Spain.

MATERIAL AND METHODS

In order to achieve information for both biometrical and genetical analysis of Iberian population of *E. Orbicularis* Cesar Ayres (CA) sampled populations in Spain and Portugal. CA only observed presence of leeches in one population from inland Galicia, Arnoia river valley in the northwest of Spain. And also in one population from Madrid region which was sampled with Alberto Alvarez (AA).

The galician population inhabits some streams and swamp areas closer to the Arnoia river, and

also the river, but only animals in the river presented leeches attached to their carapace. The population from Madrid region inhabits a small pond located in a cattle farm, there are other ponds closer to this (Alvarez & Guinea, 2005), but no individual presented leeches.

RESULTS

We found individuals with leeches attached in May 2003 in El Escorial pond, in Madrid region. We also sampled three more populations but we found no individuals parasited by leeches. The leeches appeared attached to the plastron of the individuals of *E. orbicularis*, never in the upper side of the carapace or in the soft parts of the body. One of the females presented up to thirteen leeches attached.

AA sampled all these populations from 2003 to 2006 but he didn't found any other population in Madrid region parasited by leeches, even in populations with *E. Orbicularis* sharing habitat with stripe necked turtle (*Mauremys leprosa*).

CA monitored galician population since 2001 but only found leeches in a small corner of the Arnoia river where *E. Orbicularis* is common in summer when the streams get nearly dry. The

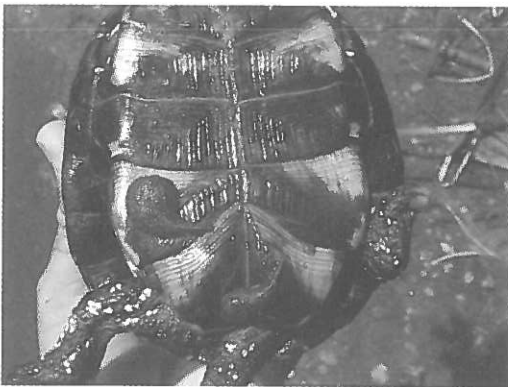


Fig.1 Two leeches attached to the plastron of *E. orbicularis* from Arnoia river.

individuals affected by leeches in Arnoia river were juveniles and females, in this population up to five leeches could be found on turtles, always in the plastron as in Madrid region (see Fig.1)

DISCUSSION

As we observed, it seems that leech parasitism is occasional in european pond turtles, maybe could be affected by the habitat use made by *E. orbicularis*. Ryan and Lambert (2005) stated that some species show a higher prevalence than others species, even under experimental conditions. The hypothesis that bottom-dwelling species are more affected by leeches does not explain the species-specific differences in leech load. Maybe that is the case, because populations of *E. orbicularis* and *M. leprosa* inhabiting similar habitat didn't show any leech load in Madrid region. But Madrid and Arnoia populations affected by leeches inhabit muddy bottoms with little options to sun bath, maybe this could be one factor. Another one could be the presence of wild boars, but this specie is also present in other areas. So, it's very difficult to explain the presence or ausence of leeches in every population.

Another interesting fact it's the similar behaviour as described by Siddal & Gaffney (2004) of *Placobdella ornata* on *Chelidra serpentina* and *Chrysemys picta*. This species of american *Placobdella* was found to fed on the blood sinuses of plastron and carapace bones. In our populations all leeches were found attached to the plastron, the junctions or over broken scutes, never on the soft parts of the body of the animal.

Preliminary studies were made to find if there were any blood parasites were transmitted to *E. orbicularis* by *Placobdella sp.* leeches, as was described in Stone (1976) for *C. Serpentina* and also Siddal & Burreson (1996), but no evidence of blood parasitism was detected. It is clear that this is only a preliminary approach to leeches presence on *E. orbicularis*, and further research will be necessary to achieve more information,

that could be useful for understanding the relationship between both species.

REFERENCES

- Alvarez, A., Esteban, I. (2005). Distribution and status of *Emys orbicularis* in Comunidad de Madrid, central Spain. *Abstracts 4th International Symposium on Emys orbicularis, Valencia*, 23.
- Andreu, A. C. (1997). *Emys orbicularis* (Linnaeus, 1758). In *Distribución y biogeografía de los anfibios y reptiles en España y Portugal*: 172-174. Pleguezuelos, J.M. (Ed.). Granada: Universidad de Granada-Asociación Herpetológica Española.
- Andreu, A. C., López-Jurado, L. F. (1998). *Emys orbicularis* (Linnaeus, 1758). Pp. 94-102. En: Salvador, A. (Coord.). *Reptiles*. En: Ramos, M. A. et al. (Eds.). *Fauna Ibérica*. Vol. 10. Museo Nacional de Ciencias Naturales, CSIC, Madrid.
- Fritz, U. (1995). Kritische Übersicht der Fossilgeschichte der Sumpfschildkröten-Gattung *Emys* A. Dumeril, 1806 (Reptilia: Testudines: Emydidae). *Zoologische Abhandlungen*, 48: 243-264.
- Fritz, U. (2001). *Emys orbicularis* (Linnaeus, 1758) – Europäische Sumpfschildkröte. Pp. 343-515. En:
- Fritz, U. (Ed.). *Handbuch der Reptilien und Amphibien Europas*. Band 3/IIIA. Schildkröten (Testudines) I (Bataguridae, Testudinidae, Emydidae). Aula Verlag, Wiebelsheim.
- Hidalgo-Vila, J., Martínez-Silvestre, A., Pérez-Santigosa, N., Díaz-Paniagua, C., Andreu, A.C., Ruiz, X., De Frutos, C., León, L. (2004) Primeros resultados del estado sanitario de poblaciones de galápagos autóctonos y exóticos en el SO de la Península Ibérica. VIII Congreso Luso-Español, XII Congreso Español de Herpetología. Málaga, España, pp 97-98
- Keller, C. (1997). Ecología de poblaciones de *Mauremys leprosa* y *Emys orbicularis* en el Parque Nacional de Doñana. Tesis doctoral. Universidad de Sevilla.
- Ryan, T. J. , Lambert, A. (2005). Prevalence and colonization of *Placobdella* on two species of freshwater turtles (*Graptemys geographica* and *Stemotherus odoratus*). *Journal of Herpetology*, vol. 39, nº2, pp. 284-287.
- Segade, P., Crespo, C., Ayres, C., Cordero, A., Arias, M. C., Garcza-Estévez, J. M., Iglesias Blanco, R. (2006). Eimeria species from the European Pond turtle *Emys orbicularis* (Reptilia: Testudines), in Galicia (NW Spain), with description of two new species. *Journal of Parasitology*, 92 (1): 69-72 .
- Siddall, M. E., E. M. Burreson. (1996). Leeches (Oligochaeta: Euhirudinea), their phylogeny and the evolution of life history strategies. *Hydrobiologia* 334: 277–285.
- Siddall, M.E., Gaffney, E.S. (2004). Observations on the leech *Placobdella ornata* feeding from bony tissues of turtles. *Journal of Parasitology*, 90, (5), 1186-1188.
- Stone, M. D. (1976). Occurrence and implications of heavy parasitism on the turtle *Chelydra serpentina* by the leech *Placobdella multilineata*. *Southwestern Naturalist* 20: 575–576.

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EUROPEAN POND TURTLE *EMYS ORBICULARIS* (LINNAEUS, 1758) – OCCURENCE IN NORTH-EASTERN POLAND (WARMINSKO-MAZURSKI PROVINCE)

Zofia Bogdaszewska

Bogdaszewska Z. 2008. European pond turtle *Emys orbicularis* (linnaeus, 1758) - occurrence in North-Eastern Poland (Warminsko-Mazurski Province). *Acta Biol. Univ. Daugavp.*, 8(1) : 57 - 62.

There are 25 known places when turtles can be found in the warminsko-mazurski province and in its immediate vicinity. Among these, two regions are of utmost importance for the existence of the species under research on this territory. The most northward position where the turtles have been seen is situated in the region of the Oświn lake (54°20' N). To date, 25 specimens have been tagged, basically females. In 1999, in the nesting site under observation traces of hatching of young turtles have been detected.

Key words: *Emys orbicularis*, Poland, occurrence.

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INTRODUCTION

In the post-war era, the first study on the occurrence of the European pond turtle in North-Eastern Poland was due to Professor Marian Młynarski, who carried out his research in the 50's of the 20th century. He gathered and organized the historical data on the places where these animals are found. He conducted a questionnaire, as a result of which he managed to corroborate this information and indicate other places from which new data originated. Later, during many years, no consistent research on this issue followed.

During the recent years, on account of the initiation in Poland of a wider campaign aimed at evaluating the current status of the species,

several researches have been carried out, also in this part of the country.

MATERIALS AND METHODS

Within the current study, all available pieces of bibliographic information on the up-to-date, confirmed places of occurrence of the European pond terrapin have been gathered and checked.

Some specific field works have been also conducted, such as:

- making an inventory of some of the positions,
- executing bio-metric measurements and tagging of captured animals.

The inventory of the positions was aimed at gathering all data on the current places of occurrence of the turtles and on the numbers of specimens encountered. Due to technical reasons, specific field observation was conducted only in the two regions of the province from which most of the reports originated. The specimens found at different positions were measured according to the same methodology and tagged with a cut on the side of the carapace featuring a numeral. The turtles caught in places situated more than 100 kilometers away from one another were tagged with a number indicating the order of their appearance at the position. Tagging with a number facilitates identification of the specimen from a distance and allows checking the information from the local population about its re-appearance. Moreover, in 2001 a new way of tagging was introduced which involves making small cuts in the bridges of the shell according to a uniform code. It aims at the unification of the tagging system in Eastern Poland.

RESULTS

Currently, in the warminsko-mazurski province and in its immediate vicinity there are 25 known places when turtles can be found. Among these, two regions are of utmost importance for the existence of the species under research on this territory. The first is located between the source of the Łyna river and Olsztynek. It includes the

European pond turtle protected area, called „Orłowo Małe”, and a few cities, where turtles occasionally can be found. The surroundings of the Waplewo village are of particular interest. A few places, where each year some known specimens live, have been identified there. In one area two nesting sites of six (out of eight encountered) individually tagged females are located.

An attempt to incubate the deposits of eggs from the region of Waplewo did not succeed, due to minor development of the embryos and their subsequent death. In 1999, in the nesting site under observation traces of hatching of young turtles have been detected. The presence of young hatchlings in the vicinity of the nesting site was confirmed the following year by a local forester.

The second region is composed of marshy meadows, small in-field ponds and wetlands between Mragowo and Mikołajki. In 1998, in the region of Kosewo, members of the Scientific Association of the Zoologists of the Academy of Agriculture and Technology, who met on the holiday camp, captivated 5 specimens, however, did not tag any of them.

The catch in 2003 of one (young!) specimen in the Prawdowski Marsh confirms the existence of the species also in this area, despite the fact that the marsh had undergone serious degradation for many years (since year 2000), which resulted

Table 1. Measurements of the turtles from the region of Waplewo

Female no.	CL /mm/	CB /mm/	PL /mm/	PB /mm/	mass /g/
1.	210	210	190	110	1050
2.	210	195	190	110	1000
3.	185	180	170	85	850
4.	215	205	180	110	1100
5.	180	180	175	100	850
6.	205	195	180	105	1150
7. *	205	192	180	110	1100

*Measurement number 7 refers to a female encountered in the region of Prabuty.

Table 2. Measurements of selected turtles from the region of Kosewo – year 1988

Number	sex	CL /mm/	CB /mm/	PL /mm/	PB /mm/
1	female	210	200	183	109
2	female	218	203	183	108
3	male	190	173	150	90

*All measurements have been executed following the curve of the carapace

Table 3. Measurements of turtles from the region of Baranowo in 2000 and 2001

	sex	sign	CL /mm/	CB /mm/	PL /mm/	PB /mm/	mass /g/
1	F	A*	230	200	200	115	1300
2	F	---	200	170	160	95	-
3	F	1*	200 / 180	180 / 142	184 / 182	104 / 103	1100 / 950
4	F	2*	235	210	200	113	1500
5	F	3	200	145	190	10.5	1000
6	F	4	190	143	183	104	1400
7	F	5	195	157	190	112	1400
8	F	6	185	145	180	102	1500
9	F	7	190	150	190	108	1500
10	F	8	195	155	193	112	1550
11	M	9	153	124	138	83	600
12	F	10	200	153	205	107	1250
13	M	11	141	111	136	80	b.d.
14	F	12	189	147	186	102	1200
15	F	13	195	149	186	107	1250
16	F	14	220	153	197	106	1550

from sewage waste having been released from a near-by hotel. In the spring of 2005, an adult female was observed on its way from the Prawdowski Marsh (around 1 kilometer westward from Mikołajki) towards lowland bogs situated on the edge of the forest in the Prawdowo (Kolonia) village. This area has been known for being rich with waters for the last two years due to the activity of a beavers family and men-made rehabilitation of a few previously completely overgrown in-field ponds. Furthermore, in May 2005, an adult European pond terrapin (a female) was spotted on the road in the Wesołowo (about 1,5 kilometers Eastwards from the Oświn lake). This area is the most northward confirmed position of the existence of these species in our country.

The most thorough researches have been carried out in the surroundings of the Baranowo village where in small local ponds as many as 14 specimens appear at a time. However, not all of

them have been tagged so far. Due to the necessity of limiting human interference during the period when turtles prepare to lay their eggs, for example some of the females seen on their way to the nesting sites have not been tagged. Given the fact, that for example during simultaneous observation of as many as 11 specimens, only 6 of them had been tagged, it can be assumed that the local population is far more numerous than 30 specimens. In this area a few nesting sites have also been identified.

The research carried out in the recent years (Bogdaszewska et al., 2004) allowed to make an inventory and tag a part of the adult specimens living among others in the surroundings of the Cudnochyl village.

The measurement number 2 (without sign) refers to a shell of a male turtle encountered next to a fox den.

Table 4. Bio-metric measurements of young turtles.

	sign			
	X	T	K	----
mass (g)	120	130	120	160
Pa H (mm)	39	39	37	43
PB I (mm)	44	48	43	48
PB II (mm)	55	51	50	56
PL (mm)	84	85	83	93
CB (mm)	82	80	76	87
CL (mm)	95	94	92	102

- * the measurements of specimens A, 1 and 2 in 2000 were executed with the use of a tape and following the curve of the carapace and the second measurement of female specimen number 1 was performed in 2001 with a calliper.
- All the other measurements have been executed using a calliper.

For many years no data had been gathered on the observation of very young specimens. It probably indicated lack of successful reproduction process and the aging of the population. It was only in 2004 that a young specimen was found walking through the yard of a farm in the Cudnochy village. On June 8, 2005, in the same farm, during cleaning-up works of a small pond located 30 meters away from the house 4 young specimens of similar size were encountered (Bogdaszewska, Bogdaszewski, 2006). Detailed results of the most significant bio-metric measurements can be found in table number 4.

However, it proved impossible to establish with adequate certainty the sex of the studied specimens. One of them (marked as X) showed an interesting anomaly in the stomach part of the shell. There are relatively few anomalies of the plastron and they appear far more rarely than the anomalies of the carapace (Najbar, 2001). In the above mentioned case both, stomach (abdominal) disks were missing.

In May 2006, on a road next to the above mentioned position a dead turtle was found. Its dimensions indicated that it was a young hutchling. Then, in August 2006, during field works a turtle nesting site was ploughed-up. It

contained several eggs of the European pond turtle. Most of them contained dead embryos, however 5 had young hatchlings. An attempt to re-incubate was made and, as a result, 4 specimens survived and 3 days later they were let free in a small pond located 50 meters from the place in which they had been found.

Altogether during the research period on the territory of North-Eastern Poland 25 alive specimens have been tagged.

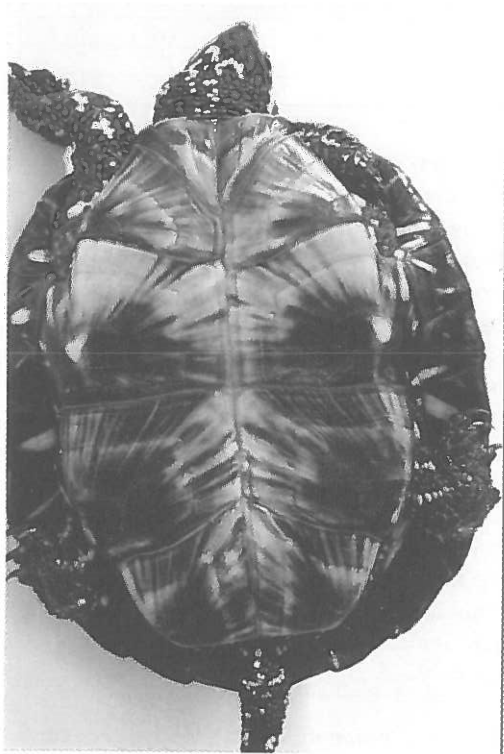


Fig. 1 The sight of plastron of young turtle captured on June 8, 2005

Moreover, on a dirt road, a few kilometers away from Olsztyn, one dead turtle was found. Another shell of a male was found next to a fox den in the forest in the area of Baranowo and two shells have been delivered by the inhabitants of the Cudnochy village. According to one of the finders, one of the shells was found in 1988 and another in 1991. The size and the shape of the carapaces indicate that these were probably female turtles. It is an interesting detail that both shells had clear signs of tagging. The shell of the specimen found in 1988 featured a Roman numeral VII, and the one found in 1991 – an Arabic 19. As there is no information on any research and tagging carried out in the village Cudnochy during the post-war period, the origin of this tagging remains unknown.

Current places of turtles occurrence

1. Orłowo
2. Orzechowo near Dobre Miasto
3. Nadrowo
4. Waplewo
5. Pawłowo
6. Śmietki near Baranowo
7. Cudnochy near Baranowo
8. Prawdowo and Nowe (Prawdowski Marsh)
9. Klón near Zęłwąg
10. Kosyń near Dobre Miasto
11. Drozdowo near Łomża
12. Zawada and Kosewo
13. Wielbark
14. Matyty (Jeziorak Lake)
15. Warlity Forest
16. Tarda Forest nar. Miłomłyn
17. Rostek near Krutyń
18. Klebark Mały, Klebark Wielki
19. Wierzbowskie Lake
20. Jedwabno
21. Prusinowo
22. Machary
23. Sypanica near Prabuty - Pomorskie province
24. Kwidzyn – Pomorskie province
25. Wesołowo (Oświn Lake)

DISCUSSION

It is of the utmost interest that the examined region offers specific climate conditions, which are basically unfavourable for correct incubation of the turtle hatchlings. The fact that in 2000 some young specimens out of a natural hatch were encountered in the region of Waplewo proves that these animals demonstrate high adaptation capabilities. It was the first documented case of having encountered a hatchling in the region. The finding of both very young and a few-years-old specimens in the Cudnochy village confirms successful incubation of the hatchlings, at least during the years of more favourable climate conditions.

Appropriate weather conditions in recent years, and in particular high temperatures in the summer have offered suitable conditions for the incubation of eggs laid by the females of the European pond turtle. This is of decisive importance for the reproduction and survival of the local populations of these species (Berger, 2000).

The curbing of the process of deliberate drainage of the fields also positively affected the number of the local turtle population. Significantly enough, numerous projects, carried out by a variety of non-governmental organizations, are aimed at rehabilitating local marshes. The state forests authorities are also carrying out considerable projects with a view to increase the retention on the forest flows.

The phenomenon of the natural rehabilitation of local, small water bodies, observed in North-Eastern Poland, should also be attributed to the activities of the rapidly growing population of European beaver *Castor fiber*. Therefore, the improvement of the small water bodies status, offers favourable conditions for the existence of numerous species of the local herpetofauna, including the population of the European pond turtles. In this situation, it does not seem appropriate to endeavour the removal of the turtles from the places, in which they occur in larger populations. The latest research (Mitrus, 2006) does not provide conclusive results with

regard to the usefulness of maintaining the young turtle husbandries in artificial conditions for a few months following the hatch.

CONCLUSIONS

During the research period, it was revealed that the population of the European pond terrapin on the studied territory is larger than expected. The region where the turtles are found stretches between 20°E and 22°E. The most northward position where the turtles have been seen is situated in the region of the Oświn lake (54°20' N). To date, 25 specimens have been tagged, basically females. It should, however, be assumed that among those specimens that had not been tagged but only observed in the region there are also males. Females leave their water environment far more often than males, which makes it easier to catch them.

The observations carried out in the recent years give hope that despite far more difficult conditions encountered in North-Eastern Poland as compared against those of Central Poland, there are big chances of survival of the Mazuria's *Emys orbicularis* population. The data collected during this research was then applied to prepare a description of the boundaries of the proposed environmental reserve called „Cudnochoty”. Expectedly, it shall be established in 2007, with the aim of protecting places where the European pond turtle lives and is reproduced.

REFERENCES

- Berger L. 2000, Płazy i gady Polski – klucz do oznaczania, Wydawnictwo Naukowe PWN, Warszawa – Poznań
- Bogdaszewska Z., Bogdaszewski M., Majcher K. 2004 – Występowanie żółwia błotnego *Emys orbicularis* Linnaeus 1758 w północno – wschodniej Polsce; Materiały VII Ogólnopolskiej Konferencji Herpetologicznej. Biologia płazów i gadów – ochrona herpetofauny: 11 – 15. Kraków 28 – 29 września 2004
- Bogdaszewska Z., Bogdaszewski M. 2006 – Nowe doniesienie na temat występowania żółwia błotnego *Emys orbicularis* Linnaeus 1758 w północno – wschodniej Polsce; Materiały VIII Ogólnopolskiej Konferencji Herpetologicznej. Biologia płazów i gadów – ochrona herpetofauny: 11 – 13. Kraków 27 – 28 września 2006
- Mitrus S. 2006. – Wielkość kilkuletnich żółwi błotnych (*Emys orbicularis*) – „dzikich” i wypuszczanych w ramach czynnej ochrony gatunku , Materiały VIII Ogólnopolskiej Konferencji Herpetologicznej. Biologia płazów i gadów – ochrona herpetofauny: 75 – 76. Kraków 27 – 28 września 2006
- Najbar B., 2001. - Żółw błotny, Wydawnictwo Lubuskiego Klubu Przyrodników, Świebodzin

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RELOCATION OF THE EUROPEAN POND TURTLE *EMYS ORBICULARIS* CLUTCHES DID NOT INFLUENCE THE HATCHING RATE

Ślawomir Mitrus

Mitrus S. 2008. Relocation of the European pond turtle *Emys orbicularis* clutches did not influence the hatching rate. *Acta Biol. Univ. Daugavp.*, 8(1): 63 - 66.

Six clutches of the European pond turtle *Emys orbicularis* deposited on hazardous areas in central Poland were relocated in 1999 and 2000, to the nearest egg laying areas (used by other females in the same season). The eggs were moved up to 12h after laying, and were not rotated. There were no statistical significant differences in the proportion of hatched turtles from clutches relocated vs. no relocated ($F = 0,76$, $df = 1$, $P = 0,39$). However, the effectiveness of such methods for protection of the turtle populations is small, and if the larger proportion of clutches in any population were be relocated, it could have a negative effect on the turtle population.

Key words: *Emys orbicularis*, protection, clutch size, predation.

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INTRODUCTION

The European pond turtle (*Emys orbicularis*) is an endangered species in many parts of its territorial range, mostly because of changes in its natural habitats (Fritz 2003). Presently, a considerable number of turtle protection programmes are being undertaken (Seigel & Dodd 2000). Protection of turtles natural habitats is - without reservations - a good method for protection of the animals (cf. Maciantowicz & Najbar 2004), but other methods (reintroduction, headstarting etc.) are controversial (cf. Heppell et al. 1996, Seigel & Dodd 2000, Mitrus 2005). Under some protection programmes, activities

aimed at nest protection or relocations are being undertaken (Maylan & Ehrenfeld 2000).

In central Poland clutches of the European pond turtle *Emys orbicularis* are typically deposited on xerothermic slopes and barrens. However, some of them are deposited in agricultural fields, on roads across fields, or other hazardous locations (Mitrus 2006a, b). In such situations they could be destroyed by agricultural vehicles. During an active protection programme in central Poland such clutches were relocated to other areas (Mitrus 2005). The objective of this study was to compare the hatching rate for non-manipulated and relocated clutches.

MATERIALS AND METHODS

The fieldwork was conducted in the Zwoleńka River Valley from 1997 to 2001 (Borowiec Nature Reserve (BNR) and the Barycz village region (central Poland, in the Radom District); the location was presented in Mitrus & Zemanek 2004, with more details about BNR in Zemanek 1992). Each year during the egg laying period (mid-May to mid-June), I observed the female turtles on their way to their nesting sites and during nesting using binoculars. When possible, I counted the eggs during the egg laying process. I marked the nests by placing pegs at the corners of a 50 cm square centred on the nest.

For the years 1998–2000, there were no statistical differences between the BNR and Barycz village region in the average number of eggs laid ($t = 1,24$, $df = 22$, $P = 0,23$), and the size of the females that laid eggs (for the straight carapace length: $t = 1,16$, $df = 25$, $P = 0,26$; Mitrus 2002). One adult female marked in the BNR several years later was caught in the Barycz region (cf. Mitrus and Zemanek 2004). Thus, I analysed the data from the two areas together.

Some clutches were deposited in agricultural fields, on roads across fields, or other hazardous locations (cf. Mitrus 2006a, b). Based on my experience from studies of the turtle in the BNR from 1990 to 1997, it is evident to me that they would be destroyed by agricultural vehicles. Thus, I relocated these clutches to safer places; generally the nearest area used by other nesting females in the same season.

In central Poland the turtle lays eggs in the evening (Zemanek 1988, Mitrus & Zemanek 1998). Moving the eggs from hazardous locations, was made on the following morning, up to 12 hours after laying. I opened a nest from the top. Each located egg was numbered on the top, placed in a container with moistened soil, and moved to a new place. The eggs were not rotated, because in the early part of incubation the embryo attaches to the upper eggshell above the yolk mass and could be distorted or die if the egg is turned (cf. Ewert 1989). Then I started to make an

artificial breeding chamber, which for the European pond turtle has been described as “pear-shaped” (Zemanek 1988, Andreas & Paul 1998). Using a small spoon I made a breeding chamber resembling such a shape, approximately 15 cm in depth, with a chamber width of 10 cm, and a 5 cm hole (cf. sizes of the turtle breeding chamber in: Zemanek 1988, Andreas & Paul 1998). Afterwards, I placed the eggs into the artificial chamber using the spoon, keeping the original order of the eggs as they were laid (eggs found in the bottom of the chamber were placed first in the artificial chamber), and the original position of the eggs (top-bottom). I then closed the hole to the artificial chamber using the soil removed during construction of the chamber.

I checked all the nests irregularly over the spring for signs of predation. At the end of the summer I checked them every 10 to 14 days for signs of hatchling emergence (= moving from the nest chamber to ground level). In winter I checked the marked nests irregularly (depending on snow cover), and in the following spring, every 10 to 14 days. If there were signs of hatchling emergence (a hole in the chamber), I opened the nest immediately, and counted the hatchlings (dead and alive), eggs, and eggshells. I calculated the hatching success separately for each nest; the calculation was made in the same way for moved and unmoved clutches (for details of the calculation see: Mitrus 2005). I analysed the data with STATISTICA for Windows version 5.5 (StatSoft, Inc., 1999).

RESULTS

The mean clutch size of the turtle in the Zwoleńka River Valley was 14.5 eggs (SD = 2.79, range 9–23; data from four seasons, 47 clutches from 24 different females). Seven known clutches were deposited on hazardous places: two of the 20 in 1999, four of the 15 in 2000, and one of the 17 in 2001. Of the seven clutches that were relocated, one of them (in 2000) was destroyed by man.

For years 1999 and 2000 there were no statistical significant differences in the proportion of

hatched turtles from relocated clutches vs. not relocated ($F = 0,76$, $df = 1$, $P = 0,39$), but there were differences between the two years ($F = 8,45$, $df = 1$, $P < 0,01$).

DISCUSSION

The relocation of nests is used in protection programmes (e.g. of marine turtles). However, there are some essential problems concerning the relocation of nests; namely that for many turtle species (including the European pond turtle; Pieau & Dorizzi 1981), the sex determination is temperature dependent, and the temperature in the artificial chamber would probably be different as we do not know how to shape the artificial breeding chamber, how to arrange the eggs, and so forth (Meylan & Ehrenfeld 2000).

In an extremely small population, destroying nests may become a serious problem to the very survival of the population (Andreas 2000). But, in central Poland only a small part of the nests is deposited in hazardous locations (13 of 118 nests, Mitrus 2006a), and the predation rate (including destroying nests from such localities) is not high: during spring and summer 0.20 and during winter for nests containing overwintering hatchlings 0.07 (details see: Mitrus 2005).

During the research I opened nests deposited in hazardous locations up to 12 hours after of the eggs were laid, and relocated to the nearest nesting areas. The eggs were moved with the moist soil were not rotated. Each of the factors (in addition to probably others, e.g. depth of artificial breeding chamber, temperature during moving) could affect the hatching rate. In the research, no statistical differences in the hatching rate between relocated and non-relocated clutches were found, although the analysed probe was small. Other subjects (e.g. sex ratio in nests) were not studied.

Results of the study show, that it is possible to protect nests from hazardous locations by relocating them to safer areas. However, if a larger

proportion of clutches in any population were relocated it could have a negative effect on the turtle population (Meylan & Ehrenfeld 2000, Nordmoe et al. 2004), and protection of nests without additional conservation efforts that reduced adult mortality will be probably ineffective (cf. Heppell et al. 1996, Mitrus 2005). What is more, for the relocation or protection of endangered clutches, precise information about their location is necessary, although gathering such information is time-consuming and costly (cf. Joyal et al. 2000). Thus, the method is not particularly useful for the protection of the European pond turtle population, although such activities could draw peoples attention to the problems of protection of the species.

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REFERENCES

- Andreas B. 2000. Reproductive ecology and conservation of *Emys orbicularis* in Brandenburg (NE-Germany). In: SOPTOM (eds.): Proceedings of the 2nd International Symposium on *Emys orbicularis*, June 1999. *Chelonii* 2: 58–62.
- Andreas B., Paul R. 1998. Clutch size and structure of breeding chambers of *Emys o. orbicularis* in Brandenburg. In: Fritz U. et al. (eds.): Proceedings of the EMYS Symposium

- Dresden 96. Mertensiella, Rheinbach **10**: 29–32.
- Ewert M.A. 1989. The embryo and its egg: development and natural history. In: Harless M., Morlock H.R.E. (eds.): Turtles. Perspectives and research. Kreiger Publishing Company, Malabar, Florida, pp. 333–413.
- Fritz U. 2003. Die Europäische Sumpfschildkröte. Bielefeld, Laurenti, 224 pp.
- Heppell S.S., Crowder L.B., Crouse D.T. 1996. Models to evaluate headstarting as a management tool for longlived turtles. Ecol. Appl. **6** (2): 556–565.
- Joyal L.A., McCollough M., Hunter M.L.Jr. 2000. Population structure and reproductive ecology of Blanding's turtle (*Emydoidea blandingii*) in Maine, near the northeastern edge of its range. Chelonian Conserv. Biol. **3** (4): 580–588.
- Maciantowicz M., Najbar B. 2004. Distribution and active conservation of *Emys orbicularis* in Lubuskie province (West Poland). Biologia, Bratislava, **59** (Suppl.): 177–183.
- Meylan A.B., Ehrenfeld D. 2000. Conservation of marine turtles. In: Klemens M.W. (ed.): Turtle conservation. Smithsonian Institution Press, Washington and London, pp. 96–125.
- Mitrus S. 2002. Historia życiowa żółwia błotnego, *Emys orbicularis* - implikacje dla ochrony gatunków długożyjących. PhD Thesis, Jagiellonian University, Kraków, 101 pp.
- Mitrus S. 2005. Headstarting in the European pond turtles - does it work? Amphibia-Reptilia **26** (3): 333–341.
- Mitrus S. 2006a. Fidelity to nesting area of the European pond turtle, *Emys orbicularis* (Linnaeus, 1758). Belg. J. of Zool. **136** (1): 25–30.
- Mitrus S. 2006b Spatial distribution of nests of the European pond turtle, *Emys orbicularis* (Reptilia: Testudines: Emydidae), from long-term studies in central Poland. Zool. Abh. **55** (7-8): 9–16.
- Mitrus S., Zemanek M. 1998. Reproduction of *Emys orbicularis* (L.) in Central Poland. – In: Fritz, U. et al. (eds.): Proceedings of the EMYS Symposium Dresden 96. Mertensiella, Rheinbach **10**: 187–192.
- Mitrus S., Zemanek M. 2004. Body size and survivorship of the European pond turtle *Emys orbicularis* in Central Poland. Biologia, Bratislava **59** (Suppl.) 14: 103–107.
- Nordmoe E.D., Sieg A.E., Sotherland P.R., Spotila J.R., Paladino F.V., Reina R.D. 2004. Nest site fidelity of leatherback turtles at Playa Grande, Costa Rica. Anim. Behav. **68**: 387–394.
- Pieau C., Dorizzi M. 1981. Determination of temperature sensitive stages for sexual differentiation of the gonads in embryos of the turtle, *Emys orbicularis*. J. Morphol. **170**: 373–382.
- Seigel R.A., Dood K.C. Jr. 2000. Manipulation of turtle populations for conservation: halfway technologies or viable options? In: Klemens M.W. (ed.): Turtle conservation. Smithsonian Institution Press, Washington and London, pp. 218–238.
- StatSoft Inc. 1999. STATISTICA for Windows [Computer program manual]. – Tulsa, OK: StatSoft, Inc., 2300 East 14th Street, Tulsa.
- Zemanek M. 1988. Składanie jaj przez żółwie błotne, *Emys orbicularis* (L.), w Polsce Środkowej w warunkach naturalnych. Przegl. Zool. **32** (3): 405–417.
- Zemanek M. 1992. Rezerwat przyrody Borowiec w dolinie Zwoleńki. Ochr. Przyr. **50** (II): 73–195.

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THE NEW DATA ON DISTRIBUTION, BIOTOPES AND SITUATION OF POPULATIONS OF *BOMBINA BOMBINA* IN THE SOUTH-EAST PART OF LATVIA

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Pupina A., Pupins M. 2008. The new data on distribution, biotopes and situation of populations of *Bombina bombina* in the South - East part of Latvia. *Acta Biol. Univ. Daugavp.*, 8(1): 67 - 73.

As a result of conducted in 1995 - 2007 investigation the distribution and state of the population of *Bombina bombina* in the South-East part of Latvia are described. 3 new populations of *Bombina bombina* are found and described by authors: Ainavas, Demene, Medumi. A preliminary evaluation of biotopes and number of populations is made.

Key words: *Bombina bombina*, population, Latvia.

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INTRODUCTION

Bombina bombina (Fig.1.) is the rare amphibian of Latvia, which dwells on the northern boundary of its natural habitat (Gasc et al. 1997). *Bombina bombina* is registered in the Red Book of Latvia (Berzins 2003) and has a status of the species of the first category of protection. *Bombina bombina* is also listed among the guarded animals of Latvia (Ministry 2000) and is included in the II application of Bern Convention. Until 2004 it was known for certain about two small stable populations of *Bombina bombina* in Latvia only.

Bombina bombina population "Bauska". One of the first known messages about *Bombina bombina* in Latvia was the message of 1929 made by A.Grose and N.Tranze about the existence of small stable population in Bauska district (Tirmanis 1990). In 1934 this message was

confirmed by the investigations of Silins J. and Lamsters V. (Silins, Lamsters 1934). I.Tirmanis wrote that in 1990 the given population the only stable population of *Bombina bombina* in Latvia (Tirmanis 1990). In 2005 not more than 7 vocalizing males were registered in this population (Deicmane M., pers.obs.).

Bombina bombina population "Ilgas". The given population was discovered in 70's by G.Kasparsons (Kasparsons, pers.obs.). In 1992 in the short message it was mentioned about stable existence of this population (Pupins and Skute 1992). This population was constantly observed during the subsequent years (Barsevskis et al. 2002).

Attempts at the creation of the new populations of *Bombina bombina* in Latvia. In 1922 J.Silins made the attempt to create a new population of *Bombina bombina* in Rembate; animals were

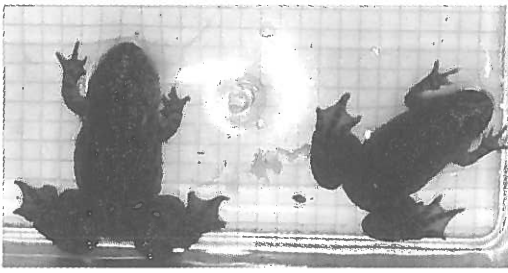


Fig. 1. Adults *Bombina bombina* from the population Demene. The male is on the left, the female is on the right. Size of the cells of the background is 565 mm. Photo: A.Pupina (2007).

observed for 4 years, but they were not observed during the subsequent years. At the same time the introduction of *Bombina bombina* into the reservoirs of Riga city was produced, where they also were not observed subsequently (Tirmanis 1990). In 1992-93 Riga Zoo released more than 300 juvenile individuals of *Bombina bombina* into Dobeles district, Tervete Nature Park. Animals were observed for 2 years, later they were not observed (Zvirgzds J., unpubl.data). According to the project Life NATURE "Protection of habitats and species in Nature Park "Razna"", (applicant: Daugavpils University), Latgale Zoo released 120 juvenile individuals of *Bombina bombina* in 2006 and 420 in 2007 on the territory of the Nature Park "Razna". At present the realization of project continues.

In spite of available data, the distribution of *Bombina bombina* in Latvia is not studied sufficiently. Thus, until 2004 it was known only about 2 actually existing small populations of *Bombina bombina* in Latvia: Bauskas and Ilgas. This makes the study of the distribution of the species in Latvia of current importance.

MATERIALS AND METHODS

The investigation of the distribution and ecology of *Bombina bombina* began in 1985, the main research of the distribution was carried out during 1995 - 2007. The research continues at present. In the course of the study the search and the

description of the new populations of *Bombina bombina* in South-East part of Latvia were conducted, as well as the monitoring the number of *Bombina bombina* and the description of the biotopes of the existing populations. In the course of the study different methods were used.

Interrogation of the inhabitants. The preliminary collection of information about the observations of *Bombina bombina* was carried out by the interrogation of inhabitants during the purposeful radio- and the telecasts with the demonstration of the sound signals of *Bombina bombina*, also with the attraction of local and republic newspapers. The instruction in determining the species in nature during the visit of biotopes together with the representatives of the purposeful audience: the teachers of biology, workers of the protection of nature, students, journalists, etc also was conducted.

Field studies. According to the results of the messages of inhabitants and independent of them field studies were conducted. They included the visual search for animals and the audio calculation of the vocalizing males throughout the entire extent of the coast of reservoirs during their active reproductive period (Zimmerman 1994). The number of species was evaluated by account of a quantity of vocalizing males in the discovered and known populations (Zimmerman 1994), also by the visual account of *Bombina bombina*. The account of animals was produced in the spring-summer period, in the warm clear weather, in the day and evening hours. The inspection of reservoirs with the aid of the catching by net for the purpose of the detection of tadpoles and the visual calculations of laying of roe was also produced. The general inspection of each biotope, in which *Bombina bombina* were discovered, took approximately 20 man-hours.

A study of biotopes was conducted according to the standard procedures of the description of the biotopes observing the amphibians (Inger 1994). The nature of reservoir, its depth, flowage, structuring of coastline, soil of the bottom, electrical conductivity, level of eutrophia, degree of overgrowing, temperature conditions and

other factors were described. Simultaneously the sympatric species of amphibians, fishes, flora and origin of reservoir were investigated.

RESULTS

As a result of conducted investigation the new reliable data about the distribution, the number and the biotopes of *Bombina bombina* in South-East part of Latvia are obtained. Some characteristics of biotopes and micros-biotope are described; some additional data about the concrete population are indicated.

The list and the characteristics of the populations of *Bombina bombina* in South-East part of Latvia, known until September 2007

Population “Ilgas”

Location. Daugavpils district, Skrudaliena region, Silene Nature park, Ilgas village. Found / registered by: G.Kasparson. Data of registration: 1975 (G.Kasparson, unpubl.data). The source of first info: G.Kasparson. Protection: “Silenes” Nature Park territory, “Ilgas” Nature Reserve, Nature 2000 territory.

Number of vocalizing males in 2007. In 2007 *Bombina bombina* were observed in 2 biotopes only: Ameliorative channel (9 vocalizing males) and Round pond (1 juvenile individual at the age of 1 year).

Biotopes of localizations. In 1983 - 1985 the authors observed *Bombina bombina* in 8 biotopes: Round pond, Forest pond, Dark pond, Valley pond, Clayey pond, Nut basin, Shallow pond, Swampy pond (Pupina, Pupins 2005b). In 2007 almost all mentioned biotopes are uninhabited, majority of which are strongly overgrown with trees and bushes and dried completely. In connection with this the general progressive reduction in the number of population is noted (Pupins, Pupina 2006).

The biotope Round pond is a small natural pond with the diameter of 30 m, it is located in the forest, has the drying up inflow. Depth is 20-60 cm., bottom is clayey, reservoir dries up in summers

during the arid years. The coasts of pond are overgrowing with bushes. Until 2006 *Bombina bombina* in the biotope Round pond were observed constantly. In 2006 in the biotope the invasive species of fishes *Perccottus glehni* were observed in a quantity up to 20 individuals to 1m², after the desiccation of pond, in summer, more than 80 *Perccottus glehni* with the length of 6-9 cm were found (Pupins, Pupina 2006). In the same year in the same biotope not a single tadpole of *Bombina bombina* was found. In 2006 - 2007 in this biotope not a single vocalizing male was observed.

The biotope Ameliorative channel (Fig.2.) is actually the last inhabited biotope of population in 2007. It is the weakly-flowing meliorated channel with a width of 2-8 m., passing along the damp meadow and dammed by beavers. Depth is 20-80 cm., in the places of beaver channels is deeper-up to 120 cm., bottom is clayey. At present channel is strongly overgrown with reed, willow bushes, alder-tree, it is darkened and is not optimal for the inhabiting of *Bombina bombina*.

Situation. Undoubtedly, this population is in the extremely threatened state. Overgrowing and degradation of earlier inhabited biotopes led to the progressive reduction of population as a



Fig. 2. Biotope of the population of *Bombina bombina* Ilgas. Zoogenic biotope: the meliorated channel dammed by beavers. Photo: M.Pupins (2006).

whole. Appearance of the invasive species of fishes *Percottus glenii* in the most optimal biotope Round pond led to the actual disappearance of *Bombina bombina* in this pond.

In 2006-2007 Latgale Zoo and Latgale Ecological Society were cutting down bushes (cut 9m³) in the biotope Round pond and mowing reed in the biotope Ameliorative channel (mowed 200 m²). In 2006 120 juvenile individuals of *Bombina bombina* from the same population were reintroduced into the biotope Ameliorative channel by Latgale Zoo for replenishment of the population (Pupins, Pupina 2006).

Population "Ainavas"

Location. Daugavpils district, Kalkune region, Ainavas village. Found / registered by: M.Pupins, A.Pupina (Pupina A., Pupins M. 2005a). Data of registration: 22.06.2004. Protection: no official protection.

Number of vocalizing males in 2007. 22.06.2004, in the only biotope the Ainavas pond one vocalizing male of *Bombina bombina* was observed (Pupina A., Pupins M. 2005a). Subsequently in 2005 and 2006 not a single individual was observed. In 2007 again one vocalizing male of *Bombina bombina* was observed (Pupina A., Pupins M. 2005a).

Biotope of localizations. *Bombina bombina* were observed in only one pond - Ainavas pond (Fig.3.). This is non-flow home pond of artificial design, overgrown with reed, by water thyme, with bushes and trees of willow on the shore. Soil is clayey; with the mud layer up to 30 cm. Depth is up to 80 cm. The biotope is situated in 50 m from the apartment house and in 40 m from the cattle shed. The biotope is settled by a large quantity of *Carassius carassius* (4-8 specimen on transect 2 m.). Moist meadow and vegetable-garden of local resident surround the pond.

Situation. Probably, the observed adult individuals of *Bombina bombina* migrated from other reservoirs. The carried out audio and visual search for the individuals of *Bombina bombina* in the surrounding biotopes did not give any



Figure 3. Biotope of the population of *Bombina bombina* Ainavas. Home pond. Photo: M.Pupins (2006).

results. It is possible to assume that a small local cryptic population exists in this region. At present the biotope Ainavas pond is not favorable for *Bombina bombina*, since it is overgrown abundantly with reed and is populated by *Carassius carassius*. In 2006 a new pond was dug up by Latgales Zoo with the support of Latvian Environment Protection Foundation (LVAFA) near to the Ainavas pond with the purpose of the retention of this population. In 2007 the natural formation of the biocenosis of this pond takes place.

Population "Demene"

Location. Daugavpils district, Demene region. Registered by: A.Pupina, M.Pupins (Pupins, Pupina 2006). Data of registration: 21.06.2006. Protection: no official protection.

Number of vocalizing males in 2007. In 2007, 196 vocalizing males of *Bombina bombina* were observed during the research in the population Demene.

Biotope of localizations. *Bombina bombina* were observed in the population Demene in 29 biotopes of various origins. Out of them 20 biotopes are zoogenic and are formed as a result of damming of channel by beavers (Fig.4.); 4 fish-farming ponds with the adjustable water level; 3

home ponds; 2 natural ponds. One should note also that the use of some biotopes by *Bombina bombina* on the territory of population has an expressed dynamics, which depends on ambient conditions. Thus, in the biotope Lauru fish pond 25 males were registered in 2006, in Gravu fish pond - 5 males and a large quantity of juvenile individuals. In 2007, after the partial descent of water and draining of coastal zone, not a single individual of *Bombina bombina* was observed in these biotopes.

Situation. At present the population Demene is the largest known population of *Bombina bombina* in Latvia both according to the total number of observed in 2007 vocalizing males ($n=196$) and in a total quantity of inhabited biotopes ($m=29$) as well as total area in which *Bombina bombina* were registered. This makes this population the most stable of the known populations of *Bombina bombina* in Latvia. Nevertheless, it should be noted that at present this population is not included in the guarded territory. It should be also noted that a number of the biotopes of *Bombina bombina* are inhabited by fishes (not less than 8 biotopes), hydrological condition in the fish-farming ponds undergoes changes, for a number of biotopes it is characteristic the overgrowing by bushes and by reed.



Fig. 4. One of the characteristic biotopes of the population of *Bombina bombina* Demene. Zoogenic biotope: the meliorated channel dammed by beavers. Photo: M.Pupins (2006).

Population "Medumi"

Location. Daugavpils district, Medumi region, Ozolaine village. Registered by: A.Pupina, M.Pupins. Data of first registered observation: 02.08.2007. Protection: Aukszeme protected landscape territory.

Number of vocalizing males in 2007. In 2007 there were observed 21 individuals of *Bombina bombina* in this population, 12 of which were vocalizing males and one juvenile individual.

Biotopes of localizations. *Bombina bombina* were observed in 5 biotopes, from them 1 biotope of zoogenic origin, 3 are home ponds and 1 channel (Fig.5.). Two inhabited ponds were dug up in July 2007. All biotopes are located in the territory of the gardening cooperative Ozolaine. Reservoirs are used for the economic needs. In 2 biotopes *Perccottus glenii* were observed: in meliorated channel 1 adult individual and in one of the dug up ponds, on the surface water with an area of 3 sq.m., 97 individuals of *Perccottus glenii* are counted with the length of 7-10 cm. Coasts of the reservoirs are overgrown by near-aqueous vegetation. Reservoirs are surrounded by summer-resort sections and structures, as well as the mixed forest.



Fig.5. One of the biotopes of the population of *Bombina bombina* Medumi. Ameliorative channel. Photo: M.Pupins (2006).

Situation. The population Medumi is the recently discovered population. Its study continues. At present it is possible to establish that existence of this population is unstable due to a small quantity of biotopes suitable for the inhabiting, the high level of the urbanization of territory, as well as due to the inhabiting of the reservoirs by *Perccottus glenii*.

DISCUSSION

Despite the fact that *Bombina bombina* is the rare and guarded animal of Latvia, for a long time, until 2004, in Latvia it was reliably known only about two populations of *Bombina bombina*: Bauska and Ilgas. In the course of the conducted investigation until September 2007 3 new populations were found by authors in South-East part of Latvia: Ainavas, Demene, Medumi (Table 1.).

The comparative proximity of the populations Ainavas, Demene, Medumi, possibly, also Ilgas (Fig.2.), and also the large area, occupied by the population Demene, makes it possible to assume the existence in Latvia of metapopulation of *Bombina bombina* with the code name "Daugavpils" (on the name of location in Daugavpils district) and with the probable interchange of individuals on the boundaries of the areas of these populations.

After the examination of the map of the distribution of the populations of *Bombina bombina* in South-East part of Latvia, it is evident

that all reliably observed populations of *Bombina bombina* are located in immediate proximity from the boundary with Lithuania and Byelorussia (0.2-13 km), that makes contacts and exchanges of individuals with the Lithuanian and Byelorussian populations of *Bombina bombina* and also the existence of general populations or metapopulations possible (Fig.2.).

In spite of the discovery of new populations of *Bombina bombina* in Latvia, the protection of the species in Latvia remains urgent as before (Pupins, Pupina 2006). The especially significant negative factors are the natural degradation of the biotopes as a result of overgrowing by reed and by bushes and swallowing, destruction of the biotopes as a result of human activity. One of the most dangerous factors for existence of the Latvian populations of *Bombina bombina*, according to the data of study, is the progressive settling in the biotopes of the invasive predatory Far-Eastern species of fishes *Perccottus glenii*.

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Table 1. Comparative characteristics of populations (n=4) of *Bombina bombina* in South-East part of Latvia in 2007

Name of the population	Year of registering	Number of vocalizing males	Number of populated biotopes	Average number of males in the biotope
<i>Ilgas</i>	1975	9	1	9
<i>Ainavas</i>	2004	1	1	1
<i>Demene</i>	2006	196	29	6.8
<i>Medumi</i>	2007	12	5	2.4
Total:		218	36	4.8

REFERENCES

- Barsevskis A., Savenkovs N., Evarts - Bunders P., Daniele I., Petersons G., Pilats V., Zviedre E., Pilate D., Kalnins M., Vilks K., Poppels A. 2002. *Fauna, flora and vegetation of Silene Nature Park*. Baltic Institute of Coleopterology. Daugavpils, 107 pp. (In Latvian)
- Berzins A. 2003. The Fire-bellied toad *Bombina bombina* Linnaeus, 1761. in: Andrusaitis G. (ed) *Red book of Latvia*. LU Biological faculty, Rīga, pp. 82-83. (In Latvian and English)
- Gasc J.P., Cabela A., Crnobrnja-Isailovic J., Dolmen D., Grossenbacher K., Haffner P., Lescure J., Martens H., Martz Rica J.P., Maurin H., Oliveira M.E., Sofianidou T.S., Veith M. & Zuiderwijk A. (eds), 1997. *Atlas of amphibians and reptiles in Europe*. Collection Patrimoines Naturels, 29, Societas Europaea Herpetologica, Mus. National d'Histoire Naturelle & Service du Patrimoine Naturel, Paris, 496 pp.
- Inger R. 1994. Description of microbiotope. -in: *Measuring and Monitoring Biological Diversity Standard Methods for Amphibians*. Foster Smithsonian Institution Press, Washington & London. Russian Translation 2003: KMK, pp. 64-70. (in English, transl. in Russian).
- Ministru kabinets, 2000. Regulas #396. **About rare speciess and protected speciess list**. Vestnesis News papers, 413/417, 2000.11.17. (In Latvian)
- Pupina A., Pupins M. 2005a. New data on spreading and ecology of *Bombina bombina* L. in Latvia. -in: *Book of abstracts. 3rd International conference „Research and conservation of biological diversity in baltic region”* Daugavpils University, Daugavpils, Latvia, pp 99.
- Pupina A., Pupins M. 2005b. The condition of *Bombina bombina* L. population “Ilgas” (Latvia) and the change of localization ecosystems. Possible measures on stabilizing of the population. -in: *Book of abstracts. 3rd International conference „Research and conservation of biological diversity in baltic region”* Daugavpils University, Daugavpils, Latvia, pp. 97.
- Pupins M., Skute A. 1992. Herpetofauna of Ilgas region. - in: *LDPAB DPI informativais biletens*, Nr 2. (1992), Daugavpils, pp. 15-16. (In Latvian)
- Pupins M., Pupina A. 2006: *The Plan of protection of Bombina bombina in Latvia*. Nature protection administration, Latgales ecological society. Riga, Latvia, 82 pp. (<http://www.dap.gov.lv/?objid=288>) (In Latvian)
- Silins J., Lamsters V. 1934. *Latvian Reptiles and Amphibians*. Rīga, 96 pp. (In Latvian)
- Tirmanis I. 1990. *Our Amphibians*. Zinātne, Rīga, 88 pp. (In Latvian).
- Zimmerman B. 1994. The account of voices on the tape transects. -in: *Measuring and Monitoring Biological Diversity Standard Methods for Amphibians*. Foster Smithsonian Institution Press, Washington & London. Russian Translation 2003: KMK, pp. 98-104. (in English, transl. in Russian).

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A MARK-RECAPTURE STUDY OF THE FIRE-BELLIED TOAD (*BOMBINA BOMBINA*) USING PHOTOGRAPHIC RECOGNITION AND DYE MARKING TECHNIQUES IN NORTH-WESTERN TURKEY

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Cevik I. E., Baskale E., Kaya U. 2008. A Mark-recapture study of the fire bellied toad (*Bombina bombina*) using photographic recognition and dye marking techniques in North - Western Turkey. *Acta Biol. Univ. Daugavp.*, 8(1): 75 - 79.

We estimated population size of Fire-bellied Toad, *Bombina bombina* in a temporary pond, located in the vicinity of Edirne using Mark-Recapture (CMR) method with Petersen and Chapman's Modification methods. In addition to this, we used and compared vital dye marking and photographic recognition techniques, since identifying individual anurans is an important step in CMR studies. Vital dye marking technique is a common method of marking anurans after toe clipping for population studies. Recently, photographic recognition techniques have been improved by a few scientists. Individuals of *B. bombina* were not affected negatively by the two marking techniques, but it was found that population size and standard error of population size are high in vital dye marked individuals because of losing vital dye marks. Owing to probable long-term reading reliability, we recommend photographic recognition techniques to mark individuals of *B. bombina* from belly patterns

Key words: *Bombina bombina*, population, Turkey.

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INTRODUCTION

Fire-bellied Toad, *Bombina bombina*, inhabits central and Eastern Europe is also present in Turkey. This species is primarily an aquatic toad and prefers shallow stagnant lakes, ponds, swamps, temporary pools, ditches and flooded fields. Sometimes the toad inhabits semi-flowing

waters: springs, irrigation channels, rivers and stream pools. Fire-bellied Toad has been included in the IUCN Red List of Threatened Species and categorized as a Least Concern (LC).

Amphibians play an important role in many aquatic and terrestrial environments, and also, they are very sensitive to any alteration in their habitats. Fluctuation or decline of these

amphibian populations can be significant because they can show any negative effect on ecosystem function (Stebbins and Cohen, 1995; Davic and Welsh, 2004). For this reason, we have to conserve amphibians with their habitats. A fundamental step in conserving biodiversity is estimation of population status of target species. In this respect, it is required to initiate CMR and Presence/Absence studies in open and closed populations or metapopulations of species to estimate their population sizes, densities and site occupancy of amphibians. Besides, it is required to find a suitable marking technique. The marking techniques were explained by Donnelly et al. (1994) under five main titles. These are; 1) Pattern Mapping, 2) Marking and Tagging, 3) Polymers and Pigments, 4) Transponders and 5) Toe Clipping. All of these techniques are still questioned by several authors, either negative effects can occur on their survival and/or breeding behavior (Bloch and Irschick, 2004; Borges-Landaez and Shine, 2003; Gittins, 1983; May, 2004; Parris and McCarthy, 2001) or loss of tags. Toe clipping, among these marking techniques, is the most widely used for marking amphibians and reptiles, and its potential detrimental effects are well documented (Clarke, 1972; Golay and Durer, 1994; McCarty and Parris, 2004; Parris and McCarty, 2001). The other techniques are still being investigated to find out their possible effects. For these purposes, the goals of this study are; to utilize the marking techniques using vital dye and digital photography on individuals of *B. bombina*, to compare the standard errors between vital dye and digital photography marking techniques, and to estimate the population size with CMR data in the same locality.

MATERIALS AND METHODS

The study site is a temporary pond, located in the vicinity of Edirne (41° 02' N, 30° 37' E) and has an area of approximately 1792 m². The maximum depth was 1.5 m and the elevation was 44 m a. s. l. The pond was formed by overflowing of Tunca River and heavy rains. For this reason, water level is generally high in spring seasons while it

decreases in mid summer and gets dry in late summer depending on temperature.

This CMR study was performed as a two day study on April 20-21st 2005. To estimate the population size of *B. bombina*, we captured as many individuals as we can, marked and released them on the same capture place. The next day, we again captured many individuals. They were marked by coloring the venter of the the left foot with vital dye eosin (see Kaya et al. 2005) and also they were digitally photographed utilizing a Nikon D70 digital camera. Population sizes were estimated using the Petersen Method (see Donnelly and Guyer, 1994). We also used Chapman's Modification to provide a formula for calculating standard error of the population size (SE_N) (Begon, 1979).

Results and Discussion

A total of 45 individuals were captured, marked by both vital dye eosin and digital photography techniques and released on day-1, and 63 individuals were captured on day-2. Of these 63 frogs, 31 individuals had digital photography marks while only 30 had vital dye eosin marks, i.e., somehow one specimen had lost its dye mark. Population sizes of *B. bombina* were estimated as 95 according to the Petersen Method and 94 according to the Chapman's Modification, using vital dye marking techniques. But population sizes were estimated as 92 according to the Petersen Method and 91 according to the Chapman's Modification, using digital photography techniques. Standard errors were calculated as 6,88 and 6,24 with Chapman's Modification due to vital dye eosin and digital photography techniques respectively.

Worldwide declines and losses of amphibian populations have been reported from many countries in last the decade and have increasingly become a global concern (Alford and Richards 1999; Barinaga, 1990; Blaustein and Wake, 1990; Gardner, 2001; Houlahan et al., 2000; Lips, et al., 2005; Wake 1991). The global decline of amphibians has forced to understand amphibian

population dynamics in detail (Meyer et al., 1998; Wake, 1998). In recent years, estimating population size and survival probabilities based on CMR methods and these are currently the most useful and reliable methods (e.g., Bradford et al., 2004; Buckland et al., 2000; Lebreton et al., 1992; Measey et al., 2003). 22 amphibian species live in Turkey but we lack detailed information on their population sizes and demographics (Baran and Atatür, 1998). Recently, some studies were done on a population of *Rana ridibunda* (Kaya and Erişmiş, 2001) and *Rana holtzi* (Kaya et al. 2005).

We compared two different marking techniques in our study. We did not observe any injury and detrimental effects on marked individuals and they continued to their normal activities. However, one vital dye mark was lost (deleted) by an unknown cause on a marked individual. Because of this lost, population size of vital dye marked animals was higher than that of photographic marked individuals. Similarly, standard error of the population size was higher than photographic marked individuals.

Different techniques are used to mark amphibians; but none of them is accepted to be perfect. Many investigators, studied CMR method, aimed to clarify potential effects of marking techniques (Bloch and Irschick, 2004; Borges-Landaez and Shine, 2003; McAllister et al., 2004; McCarthy and Parris, 2004; Parris and McCarthy, 2001; Perret and Joly, 2002; Reaser, 1995; Regester and Woosley, 2005; Revela and Gamble, 2004). Vital Dyes (i.e., Fluorescent elastomers VIE) are the most widely used Marks alternative to toe clipping. Retention time and effect on embryonic development in salamander egg masses with fluorescent elastomers were investigated and did not detect an impact on marked amphibians (Regester and Woosley, 2005). Photographic recognition techniques, firstly, was defined for pattern mapping and then largely practiced during the late 20th century (Loafman, 1991), and these photographic methods have been improved recently (Bradfield, 2004; Doody, 1995; Kelly, 2001; Markowits et al. 2003; Mazzoil et al. 2004).

In conclusion, long-term monitoring studies are needed to evaluate possible fluctuations of population sizes of amphibians during long periods, to facilitate their conservation, and digital photography techniques are more reliable than vital dye techniques for recognizing individuals of some amphibian species.

REFERENCES

- Alford, R.A., Richards, S.J., 1999. Global amphibian declines: a problem in applied ecology. *Annual Reviews of Ecology and Systematics* 30, 133–165.
- Baran, Z., Atatür, M.K., 1998. Turkish Herpetofauna (Amphibians and Reptiles). T.C. Çevre Bakanlızş Yay., Ankara.
- Barinaga, M., 1990. Where have all the froggies gone? *Science* 247, 1033–34.
- Blaustein, A.R., Wake, D.B., 1990. Declining amphibian populations: a global phenomenon. *Trends in Ecology and Evolution* 5, 203–204.
- Begon, M., 1979. *Investigating Animal Abundance: capture-recapture for biologist*. London: Edward Arnold, 97 pp.
- Bloch, N., Irschick, D.J., 2004. Toe-clipping dramatically reduces clinging performance in a pad-bearing lizard (*Anolis carolinensis*). *Journal of Herpetology* 37(3), 293-298.
- Borges-Landaez, P., Shine, R., 2003. Influence of toe-clipping on running speed in *Eulamprus quoyii*, a scincid lizard. *Journal of Herpetology* 37, 592-595.
- Bradfield, K.S., 2004. Photographic identification of individual Archey's frogs, *Leiopelma archeyi*, from natural markings. DOC Science Internal Series 191. Department of Conservation Wellington, New Zealand. 36 pp.

- Bradford, D.F., J.R. Jaeger, and R.D. Jennings. 2004. Population Status and Distribution of a Decimated Amphibian, The Relict Leopard Frog (*Rana onca*). The Southwestern Naturalist 49:218-228.
- Buckland S. T., Goudie I. B. J., Borchers D. L. 2000. Wildlife population assessment: Past developments and future directions. Biometrics, 56:1-12.
- Clarke, R.D. (1972) The effect of toe-clipping on survival in Fowler's toad *Bufo woodhousei fowleri*. Copeia 1972 182-185.
- Davic R.D., Welsh H.H. Jr. 2004. On the ecological roles of salamanders. *Ann. Rev. Ecol. Syst.* 35:405-434.
- Donnelly, M.A., Guyer, C., 1994. Mark-recapture. In: Heyer, W.R., Donnelly, M.A., McDiarmid, R.W., Hayek, L.C., Foster, M.S., (Eds), *Measuring and Monitoring Biological Diversity: Standard methods for Amphibians*. Smithsonian Institution Press, Washington D.C., pp. 183-200.
- Donnelly, M.A., Guyer, C., Juterbock, J.E., Alford, R.A., 1994. Techniques for marking amphibians. In: Heyer, W.R., Donnelly, M.A., McDiarmid, R.W., Hayek, L.C., Foster, M.S., (Eds), *Measuring and Monitoring Biological Diversity: Standard methods for Amphibians*. Smithsonian Institution Press, Washington D.C., pp. 277-284.
- Doody, J.S., 1995. A photographic mark-recapture method for patterned amphibians. *Herpetological Review* 26, 19-21.
- Gardner, T., 2001. Declining amphibian populations: a global phenomenon in conservation biology. *Animal Biodiversity and Conservation* 24 (2), 25-44.
- Gittins, S. P., 1983. Population dynamics of the common toad (*Bufo bufo*) at a lake in mid-Wales. *Journal of Animal Ecology* 52, 981-988.
- Golay, N. and Durrer, H., 1994. Inflammation due to toe-clipping in natterjack toads (*Bufo calamita*). *Amphibia-Reptilia* 15 (1): 81-83.
- Houlahan, J.E., Findlay, C.S., Schidt, B.R., Meyer, A.H., Kuzmin, S.L., 2000. Quantitative evidence for global amphibian population declines. *Nature* 404, 752-755.
- Kaya, U., Erişmiş, U.C., 2001. Marsh frogs, *Rana ridibunda* in Lake Akören -26 August National Park (Afyon): A preliminary study of population size and a taxonomical evaluation. *Turkish Journal of Zoology* 25, 31-34.
- Kaya, U., Ėevik, Ž.E., Erižmiž, U.C., 2005. Population status of the Taurus frog *Rana holtzi* Werner (1898), in its terra typica: Is there a decline? *Turkish Journal of Zoology* 29, 317-319.
- Kelly, M.J., 2001. Computer-aided photograph matching in studies using individual identification: an example from Serengeti cheetahs. *Journal of Mammalogy* 82, 440-449.
- Lebreton, J. D., Burnham, K. P., Clobert, J., Anderson. D. R., 1992. Modeling survival and testing biological hypotheses using marked animals: A unified approach with case studies. *Ecological Monographs* 62, 1-118.
- Lips, K.R., Burrowes, P.A., Mendelson, J.R., Parra-Olea, G., 2005. Amphibian population declines in Latin America: A Synthesis. *Biotropica* 37(2), 222-226.
- Loafman, P., 1991. Identifying individual spotted salamanders by spot pattern. *Herpetological Review* 22(3), 91-92.
- Markowitz, T.M., Harlin, A.D., Wursig, B., 2003. Digital photography improves the efficiency of individual dolphin identification. *Marine Mammal Science* 19, 217-223.

- May, R. M. 2004. Ethics and amphibians. *Nature* 431, 403.
- Mazzoil, M., McCulloch, S. D., Defran, R. H., Murdoch, E., 2004. The use of digital photography and analysis for dorsal fin photo-identification of bottlenose dolphins. *Aquatic Mammals* 30, 209-219.
- McAllister, K.R., Watson, J.W., Risenhoover, K., McBride, T., 2004. Marking and radiotelemetry of Oregon spotted frogs (*Rana pretiosa*). *Northwestern Naturalist* 85(1), 20-25.
- McCarthy, M.A., Parris, K.M., 2004. Clarifying the effect of toe clipping on frogs with Bayesian statistics. *Journal of Applied Ecology* 41, 780-786.
- Measey, G.J., Gower, D.J., Oommen, O.V., Wilkinson, M., 2003. A mark-recapture study of the caecilian amphibian *Gegeneophis ramaswamii* (Amphibia: Gymnophiona: Caecilidae) in southern India. *The Zoological Society of London* 261, 129-133.
- Meyer, A.H., Schmidt, B.R., Grossenbacher, K., 1998. Analysis of three amphibian populations with quarter-century long time-series. *Proc R Soc Lond B Biol Sci* 265, 523-528.
- Parris, K.M., McCarthy, M.A., 2001. Identifying effects of toe-clipping on anuran return rates: the importance of statistical power. *Amphibia-Reptilia* 22, 275-289.
- Perret, N., Joly, P., 2002. Impacts of tattooing and pitting on survival and fecundity in the Alpine newt (*Triturus alpestris*). *Herpetologica* 58, 131-138.
- Reaser, J., 1995. Marking Amphibians By Toe-Clipping: A Response To Halliday. *Froglog* 12, 2.
- Regester, K.J., Woosley, L.B., 2005. Marking salamander egg masses with visible fluorescent elastomer: retention time and effect on embryonic development. *The American Midland Naturalist* 153(1), 52-60.
- Ravela, S. and Gamble, L. 2004. On Recognizing Individual Salamanders. *Proc. Asian Conference on Computer Vision* (2), 741-747.
- Stebbins, R. C., and N. W. Cohen. 1995. A natural history of amphibians. Princeton University Press: i-xvi, 1-316.
- Wake, D.B., 1991. Declining amphibian populations. *Science* 253(5022), 860.
- Wake, D. B. 1998. Action on amphibians. *Trends Ecol. Evol.* 13, 379-380.

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EVALUATION OF GENETIC DIVERSITY OF PERCH (*PERCA FLUVIATILIS*) AND PIKEPERCH (*SANDER LUCIOPERCA*) POPULATIONS FROM CURONIAN LAGOON AND INSHORE WATERS OF THE BALTIC SEA

Aniolas Sruoga, Dalius Butkauskas, Isaak Rashal

Sruoga A., Butkauskas D., Rashal I. 2008. Evaluation of genetic diversity of Perch (*Perca fluviatilis*) and Pikeperch (*Sander lucioperca*) populations from Curonian Lagoon and inshore waters of the Baltic Sea. *Acta Biol. Univ. Daugavp.*, 8(1): 81 - 88.

Objective of the study was to carry out investigation of genetic variability of different populations of commercially important freshwater and diadromous-like behaving populations of pikeperch (*Sander lucioperca*) and perch (*Perca fluviatilis*) inhabiting Lithuanian part of Curonian Lagoon based on data derived from microsatellite assay. Four polymorphic loci were amplified for pikeperch (*Pfla-L8*, *Pfla-L9*, *Svi-L8*, *Svi-L10*) and three for perch (*Pfla-L1*, *Pfla-L2*, *Svi-L10*) out of 8 primer pairs investigated. Mean number of alleles per locus was similar in both fish species - 2.66 and 2.33 in perch and pikeperch respectively. Genotype distribution corresponded to the Hardy-Weinberg equilibrium in the most loci. Significant deficit or excess of heterozygotes wasn't detected at any locus for both fish species investigated. The level of genetic variability and observed heterozygosity calculated for both species was higher among perch population in comparison with pikeperch population. Despite different salinity conditions typical for sample collection sites both for perch and pikeperch significant genetic differentiation wasn't ascertained. Thus, investigated samples of perch and pikeperch could be considered as representatives of non-differentiated populations.

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INTRODUCTION

Many interpretations of phylogeographical and population genetic studies of fish suffer from uncertainty arising from artificial stocking, intensive fishing or because of lack of information about migrating behaviour of species of interest. Recent development of such methods of investigation as assay of microsatellites gives us an opportunity to evaluate intraspecific

genetic variability in order to describe genetic structure of population, establishment of existence of subpopulations reflecting strategy of species adaptation could be proved by microsatellite analysis. In addition, new modern method of detection of Sr/Ca ratio in the otoliths allows us to get essential information dealing with seasonal habitat of commercially important fish species (Englbrecht et al. 2002, Swan et al.

2003, Campana and Thorrold 2001). Application of above mentioned modern methods provides researchers with tools for evaluation of condition of populations of endangered commercial fish species. Changes in genetic structure of fish populations could be monitored basing on data obtained using genetic analysis.

The assay of microsatellite is carried out by polymerase chain reaction (PCR) amplification of a specific microsatellite as defined by the unique primers. Usually microsatellite loci are detected by radiolabelling. The use of fluorescent detection may be either in a real time reading format as employed by systems such as the Li-Cor or PE Applied Biosystems fluorescent sequencer or delayed in which a conventional gel apparatus is used to separate PCR products and the gel is scanned following completion of the separation a technology used by the Molecular Dynamics FluorImager. An alternative separation of amplified DNA fragments in conventional electrophoresis apparatus followed by staining with etidium bromide.

The objective of this study was to carry out investigation of genetic variability of different populations of commercially important freshwater

and diadromous-like behaving populations of pikeperch (*Sander lucioperca*) and perch (*Perca fluviatilis*) inhabiting Lithuanian part of Curonian Lagoon based on data derived from microsatellite assay.

MATERIAL AND METHODS

Blood and tissue samples of pikeperch and perch originating from different sites in estuary of Nemunas River, Curonian Lagoon and inshore Lithuanian territorial water sites of the Baltic Sea were collected during first stage of the study in June-August of 2004 (Fig. 1). Samples of DNA were extracted by using proteinase K and salt-extraction method (Aljanabi & Martinez, 1997).

Amplification of DNA fragments was carried out by using microsatellite primers (Table 1.). The PCR has been performed in 25ml final volume containing the following: 100-200 ng of genomic DNA; 200 ng of a single primer; 0.75 unit of Taq DNA polymerase (MBI Fermentas, Lithuania) and 200ml each of dATP, dCTP, dGTP and dTTP. The reaction buffer contained 1.5 mM MgCl₂, 10 mM Tris-HCL pH 8.8 (at 20°C), 50 mM KCL and 0.08% NP-40. Amplifications have been carried out in

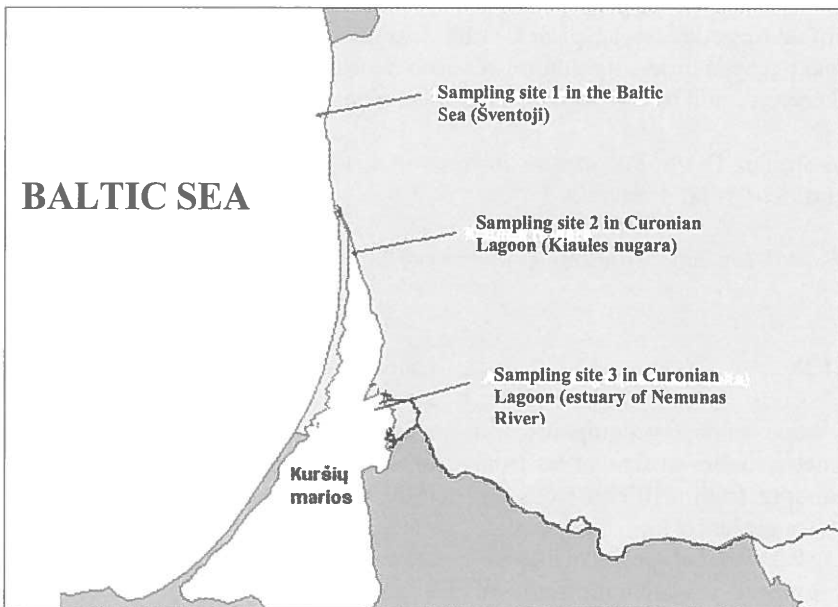


Fig. 1. Sampling of material in estuary of Nemunas River, Curonian Lagoon and inshore Lithuanian territorial water sites of the Baltic Sea

Table 1. Specification of oligonucleotides used in the study

Primer pairs	Sequences of oligonucleotides	Melting temperature
<i>Svi-L2 (F)</i>	5'-3' – TAAGACATAAACATACTCTG	51.8°C
<i>Svi-L2 (R)</i>	5'-3' – TATACTGAGAGTGGAGACAT	56.4°C
<i>Svi-L7(F)</i>	5'-3' – GATGTGCATACATTTACTCC	59.8°C
<i>Svi-L7 (R)</i>	5'-3' – GCTTTAATCTGCTGAGAAC	59.6°C
<i>Svi-L8 (F)</i>	5'-3' – GCTTATACGTCGTTCTTATG	59.2°C
<i>Svi-L8 (R)</i>	5'-3' – ATGGAGAAGCAAAGTTGAG	61.1°C
<i>Svi-L10 (F)</i>	5'-3' – GGTAATGTATTTTCAGTTATTGC	60.5°C
<i>Svi-L10 (R)</i>	5'-3' – GCTGTTCTCCAAGTAAAGCC	65.6°C
<i>Pfla-L1 (F)</i>	5'-3' – AAGCAGCCTGATTATATATC	49.0°C
<i>Pfla-L1 (R)</i>	5'-3' – CAGACAATTAACATGCAAC	49.0°C
<i>Pfla-L2 (F)</i>	5'-3' – GTAAAGGAGAAAGCCTTAAC	58.8°C
<i>Pfla-L2 (R)</i>	5'-3' – TAGCATGACTGGCAAATG	64.2°C
<i>Pfla-L8 (F)</i>	5'-3' – GCCTATTGTGTGACTTATCG	63.8°C
<i>Pfla-L8 (R)</i>	5'-3' – GGATCTTTTCACTTTTCTTTCAG	64.4°C
<i>Pfla-L9 (F)</i>	5'-3' – GTTAGTGTGAAAGAAGCATCTGC	66.6°C
<i>Pfla-L9 (R)</i>	5'-3' – TGGGAAATGTGGTCAGCGGC	77.9°C

Table 2. Species specificity of primers set used in the study

Locus	Species used for primer development	Pikeperch-Curonian Lagoon (Kiaulės nugara)	Pikeperch-Curonian Lagoon (estuary of Nemunas river)	Perch (Baltic sea, Šventoji)	Perch (Curonian Lagoon, estuary of Nemunas river)
<i>Pfla-L1</i>	<i>Perca flavescens</i>	m	m	p	p
<i>Pfla-L2</i>	<i>Perca flavescens</i>	m	m	p	p
<i>Pfla-L8</i>	<i>Perca flavescens</i>	p	p	m	m
<i>Pfla-L9</i>	<i>Perca flavescens</i>	p	p	-	-
<i>Svi-L2</i>	<i>Stizostedion vitreum</i>	m	m	-	-
<i>Svi-L7</i>	<i>Stizostedion vitreum</i>	-	-	-	-
<i>Svi-L8</i>	<i>Stizostedion vitreum</i>	p	p	-	-
<i>Svi-L10</i>	<i>Stizostedion vitreum</i>	p	p	p	p

(m – monomorphic locus, p – polymorphic locus, - - no amplification)

Eppendorf Gradient Mastercycler (Eppendorf, Germany). Following the initial denaturation step at 95 °C for 2 min., the reaction was subject to 30 cycles of amplification denaturing at 94 °C (30 sec), annealing at various temperatures depending on primer specificity (45 sec), elongation at 72 °C (45 sec) and final elongation at 72 °C (5 min).

Samples of the amplification products (15 ml) have been dissolved electrophoretically on 10%

polyacrilamide gels in the TBE buffer for 4 hours. DNA fragments have been stained with etidium bromide, photographed, saved and analysed by means of MiniDoc™ Documentation System (Herolab) and TotalLab V1.10 software.

Estimation of parameters of genetic variability and differences between populations were evaluated by standard measures using software TFPGA, FSTAT and GENEPOP.

Table 3. Frequencies of alleles, expected (He) and observed (Ho) heterozygosity of perch and pikeperch samples

Locus	Pikeperch			Perch		
	Alleles (bp)	Curonian Lagoon (Kiaulės nugara)	Curonian Lagoon (estuary of Nemunas river)	Alleles (bp)	(Baltic sea)	(Curonian Lagoon)
Pfla-L1	204	1.000	1.000	119	0.5833	0.6000
				128	0.1667	0.4000
				143	0.2500	0.0000
Ho					0.8333	0.8000
He					0.6212	0.5333
Pfla-L2	234	1.000	1.000	250	0.0938	0.1000
				265	0.4688	0.5500
				271	0.4375	0.3500
Ho					0.3125	0.5500
He					0.5988	0.5650
Pfla-L8	165	0.1875	0.6875	107	m	m
	153	0.8125	0.3125			
Ho		0.3750	0.3750			
He		0.3250	0.4297			
Pfla-L9	184	-	-	-	-	-
	196					
	221					
Ho						
He						
Svi-L2	238	1.000	1.000	-	-	-
Svi-L8	107	0.6250	0.6071	-	-	-
	142	0.3750	0.3929			
Ho		0.5000	0.6429			
He		0.5000	0.4947			
Svi-L10	230	0.0625	0.0000	172	0.9286	0.9063
	236	0.5625	0.5714	180	0.0714	0.0938
	243	0.3750	0.4286			
Ho		0.3750	0.0000		0.1429	0.0625
He		0.5391	0.4898		0.1376	0.1699

RESULTS AND DISCUSSION

Species specificity of primers, which originally were developed for taxonomically close fish species – yellow perch (*Perca flavescens*) and walleye (*Stizostedion vitreum*), were investigated first of all (Table 2). Application of primer pair *Svi-L8* allowed amplification of polymorphic locus in all individuals of pikeperch investigated in this study (Figure 2). Optimization of PCR conditions for primer pairs *Pfla-L8*, *Pfla-L9* and

Svi-L10 also allowed us to detect separate polymorphic loci for pikeperch (Figure 3 and Figure 4). Number of alleles and allele sizes were identified by comparative mobility of amplified DNA fragments using TotalLab v1.10 software. Totally four polymorphic loci with 2-4 alleles per locus and three monomorphic loci were amplified for all samples of pikeperch (Table 2).

Following similar optimisation procedures the same primer set was screened for specificity to

Table 4. Significance values calculated for testing of deviation from Hardy-Weinberg equilibrium among fish samples investigated

Loci	Significance values at different samples			
	Pikeperch Curonian Lagoon (Kiaulės nugara)	Pikeperch Curonian Lagoon (estuary of Nemunas river)	Perch (Baltic Sea)	Perch (Curonian Lagoon)
Pfla-L1	-	-	0.6502	0.4270
Pfla-L2	-	-	0.0262	0.5317
Pfla-L8	1.0000	1.0000	-	-
Pfla-L9				
Svi-L2	-	-	-	-
Svi-L8	1.0000	0.3268	-	-
Svi-L10	0.4387	0.0162	1.0000	0.1009

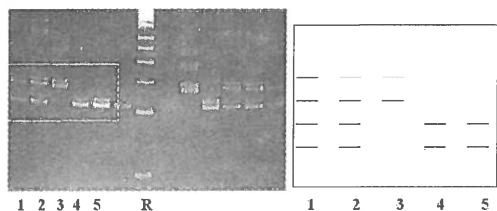


Fig. 2. Schematically illustrated (right picture) fragments reflects spectrum of amplified DNA fragments (left picture, spectrum in white frame) by using pikeperch samples and primer pair *Svi-L8*: 1 and 2 – heterozygous individuals, 3 – homozygous ind. (slow moving allele), 4 – 5 – homozygous ind. (fast moving allele), R – GeneRuler™50bp DNA Ladder, MBI Fermentas)

perch DNA. On the contrary to pikeperch the same primer pair *Pfla-L8* allowed us to amplify monomorphic DNA fragment at locus *Pfla-L8* for all perch samples (Figure 5). Opposite to above mentioned case primer pair *Pfla-L2* allowed amplification of polymorphic loci using perch

DNA samples (Figure 6) when for pikeperch samples all individuals were monomorphic (data not shown).

As it is common for microsatellites we could confirm that in our case based on amplified DNA spectrum analysis all polymorphic loci for fish species investigated are codominant features with both alleles could be distinguishable in heterozygous individuals.

Four polymorphic loci were amplified for pikeperch (*Pfla-L8*, *Pfla-L9*, *Svi-L8*, *Svi-L10*) and three for perch (*Pfla-L1*, *Pfla-L2*, *Svi-L10*) out of 8 primer pairs investigated (Table 3). Further analysis was carried out using polymorphic loci only. Totally 66 individuals of perch and pikeperch from two different sites were genotyped after evaluation of comparative allele sizes. Allele frequencies were calculated using TFPGA software.

Comparing products of amplification for pikeperch and perch differences of allele sizes at the homologous loci between two fish species became evident (see Table 3). Mean number of alleles per locus (A) was similar in both fish species - 2.66 and 2.33 in perch and pikeperch respectively.

Genotype distribution corresponded to the Hardy-Weinberg equilibrium in the most loci except *Pfla-L2* ir *Svi-L10* where significant deviation ($p < 0.05$) was detected in perch population sampled in the Baltic Sea and in pikeperch population sampled in the Curonian Lagoon, estuary of Nemunas river (Table 4)

Table 5. Mean heterozygosity in pikeperch and perch populations

Species	Sampling site	Mean heterozygosity	
		Observed	Expected
Pikeperch	Curonian Lagoon (Kiaulės nugara)	0.4167	0.4375
Pikeperch	Curonian Lagoon (estuary of Nemunas river)	0.3393	0.4655
Perch	Baltic Sea	0.4296	0.4274
Perch	Curonian Lagoon	0.4708	0.4294

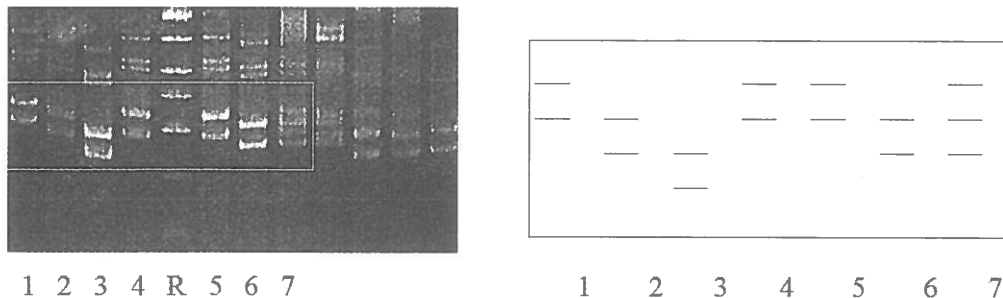


Fig. 2. Schematically illustrated (right picture) fragments reflects spectrum of amplified DNA fragments (left picture, spectrum in white frame) by using pikeperch samples and primer pair *Svi – L8*: 1 and 2 – heterozygous individuals, 3 – homozygous ind. (slow moving allele), 4 – 5 – homozygous ind. (fast moving allele), R – GeneRuler™ 50bp DNA Ladder, MBI Fermentas)

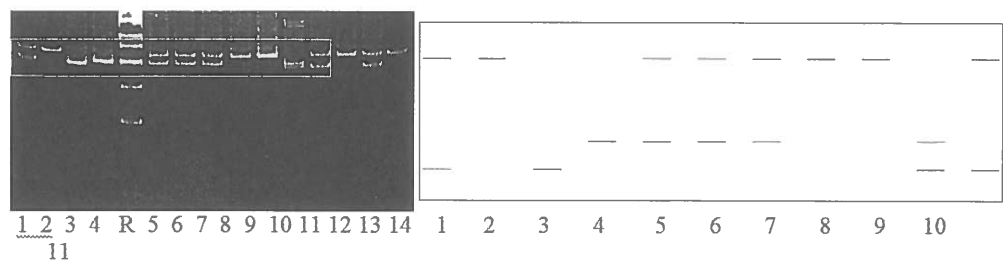


Fig. 3. Schematically illustrated (right picture) fragments reflects spectrum of amplified DNA fragments (left picture, spectrum in white frame) by using pikeperch samples and primer pair *Pfla–L8*: lines 1, 2, 3, 4, 5 and 6 – homozygous individuals with alleles of three different length, 7 – heterozygous individual, R – GeneRuler™ 50bp DNA Ladder, MBI Fermentas)

respectively. This deviation might be caused by insufficient sample size or gene drift.

(0.8461) between two pikeperch samples collected in different areas of the Curonian Lagoon.

Significant deficit or excess of heterozygotes wasn't detected at any locus for both fish species investigated. The level of genetic variability and observed heterozygosity calculated for both species was higher among perch population in comparison with pikeperch population. Otherwise, in pikeperch population observed heterozygosity was higher than expected contrary to perch population (Table 5).

Genetic differentiation between two samples of the same fish species was estimated using Raimond and Rousset test (1995). Despite different salinity conditions typical for sample collection sites both for perch and pikeperch significant genetic differentiation wasn't ascertained (p values of significance were 0.7614 and 0.1805 for perch and pikeperch respectively). Thus investigated samples of perch and pikeperch could be considered as representatives of non-differentiated populations. Insufficient differentiation of perch and pikeperch samples was confirmed by theta P coefficient corresponding to Wright's F_{ST} fixation index (coefficient of inbreeding). For perch this

Based on data obtained (allele frequencies at microsatellite loci) calculated Nei's (1972) genetic distance between two perch samples collected in the Curonian Lagoon and the Baltic Sea was 0.9623 and it was lower than genetic distance

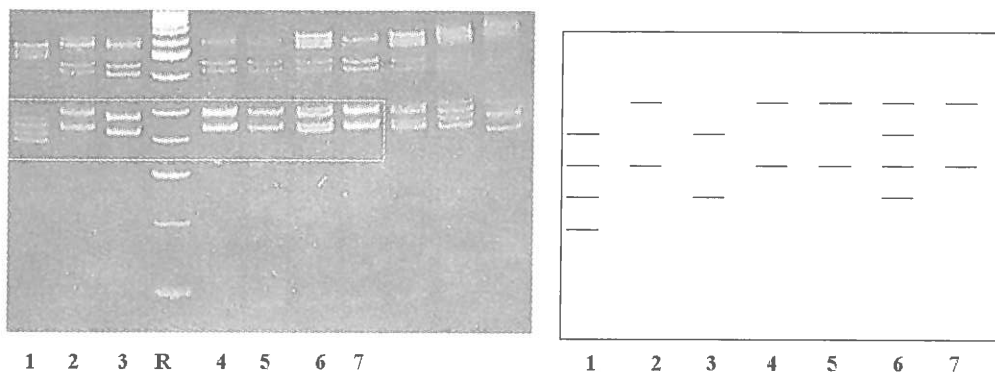


Fig. 4. Schematically illustrated (right picture) fragments reflects spectrum of amplified DNA fragments (left picture, spectrum in white frame) by using pikeperch samples and primer pair Pfla-L9: *lines-1 and 11 – heterozygous individuals with slowest and most fast alleles; lines 2, 8 and 9 – homozygous individuals with slowest allele; line 3 - homozygous individual with most fast allele, line 4 - homozygous individual with intermediate allele; lines 5,6 and 7 – heterozygous individuals with intermediate and slowest alleles; R –GeneRuler™50bp DNA Ladder, MBI Fermentas*

coefficient was equal to 0.085 and for pikeperch it was 0.0842. Using theta P values number of migrants per generation ($N_m = (1-\theta P) / (4\theta P)$) [DeSalle, Giribet, Wheeler, 2001] was calculated as parameter which could reflect relatively high gene flow between pikeperch populations ($N_m = 2.69$) and even more high gene flow ($N_m = 29.16$) between perch populations.

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Perch population of the Curonian Lagoon is characterized by higher heterozygosity in comparison to the sample representing the Baltic Sea perch population. It might be caused by partial migration of individuals of similar age composing shoal of perch moving through the Klaipėda waterfront to more advantageous feeding areas spreading along inshore. If this behavioural model is true then perch population of the Curonian Lagoon should be characterized by higher heterozygosity as it is confirmed by our calculations.

REFERENCES

- Claudia C. Englbarcht, Ulrich Schliewen and Diethard Tautz; The impact of stocking on the genetic integrity of Arctic charr (*Salvelinus*) populations from the Alpine region; *Molecular Ecology* 2002. 11, 1017–1027.
- S.C.Swan, J.D.M.Gordon and T.Schimmiel; Preliminary Investigations on the Use of Otolith Microchemistry for Stock Discrimination of the Deep – water Black Scabb – a rdfich (*Aphonopus carbo*) in the North East Atlantic; *J.Northw. Atl. Fish. Sci.*, Vol.31., 2003.
- Steven E. Campana and Simon R. Thorrold; Otoliths, increments, and elements keys to a comprehensive understanding of fish

Further investigation of genetic diversity of perch and pikeperch populations should involve additional sampling sites for both species as well as samples representing different years. Application of additional type of genetic markers as partial sequences of control region of mtDNA could add valuable information for comparison of different populations.

populations?; *Con. I. Fish. Aquat., Sci.*
Vol.58., 2001.

Received: 20.10.2008.

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D.Tautz; Hyper variability of simple sequences as a general source for polymorphic DNA markers. *Nucleic Acids Research* 1989. 17: 6463-6471.

M.V.Katti, P.K.Ranjekar, and V.S.Gupta; Differential Distribution of Simple Sequence Repeats in Eukaryotic Genome Sequences; *Molecular Biology and Evolution* 2001.18:1161-1167.

D.Dieringer, C.Schlötterer; Two distinct modes of microsatellite mutation processes: evidence from the complete genomic sequences of nine species; *Genome Research* 2003. 13: 2242-2251.

J.Zhu, K.E.Nestor, R.A.Patterson, D.J.Jackwood and D.A.Emmerson; Measurement of genetic parameters within and between turkey lines using DNA fingerprinting; *Poultry Science* 1996. 75: 439-446.

Salah M. Aljanabi and Iciar Martinez; Universal and rapid salt – extraction at high quality genomic DNA for PCR – based techniques; 4692 – 4693 *Nucleic Acids Research* , 1997, vol.25, no.22.

MBI Fermentas; Catalogue and product application guide 2004.

David Leclerc, Thierry Wirth and Louis Barnatchez; Isolation and characterization of microsatellite loci in the yellow perch (*Perca flavescens*), and cross – species amplification within the family Percidae; Blackwell Science Ltd, *Molecular Ecology* 2000, 9, 993 – 1011.

Techniques in molecular systematics and evolution / edited by R. DeSalle, G. Giribet, W. Wheeler, 2001. p.166.

WILDLIFE-VEHICLE ACCIDENTS IN LITHUANIA, 2002–2007

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Balčiauskas, L., Balčiauskienė, L. 2008. Wildlife-vehicle accidents in Lithuania, 2002–2007. *Acta Biol. Univ. Daugavp.*, 8 (1): 89 - 94.

The data compiled by the Lithuanian police traffic supervision service show that in 2002–2007 ca. 3.5 thousand of accidents involving mammals and birds were registered on roads outside cities, and three thousand of accidents involved wildlife species. The number of such accidents was growing from 259 in 2002 to 648 in 2006 and 913 in 2007. The main wildlife species involved were the roe deer, wild boar and moose, i.e. ungulates comprised more than half of accidents and thus such accidents were the most detrimental. Analysis revealed seasonal and diurnal regularities of wildlife accidents, depending on the species involved. Road fencing and underpasses were introduced on the main highways from 2005; however, their effectiveness on lower accident rates is not known.

Key words: wildlife-vehicle accidents, seasonal dynamics, daytime of accidents

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INTRODUCTION

The number of wildlife-vehicle accidents (WVA) in Lithuanian roads is growing almost exponentially in the last years. In the year 2002, the number of registered accidents with wild animals was 259, in 2003 already 316, and in 2004 as many 423. From 2004, the fencing program for Lithuanian highways was started, but the number of registered accidents did not diminish. In 2005, this number was 499. The first wildlife overpasses started to be built on the highway Vilnius-Kaunas. In the year 2006, the number of registered accidents with wild animals was 648. Some accidents raised hot debates in Lithuania mass media. The Institute of Ecology of Vilnius University was hired by the Ministry of Environment to evaluate the effectiveness of five wildlife underpasses built under three highways. The number of accidents in 2007 reached 913.

This year we started a study of animal and amphibian migration crossing roads of national and local importance. The first wildlife overpass started to be built. In 2002–2007, a network of roads with a high number of wildlife-vehicle accidents covered almost all the country.

It is known that larger mammals do not depend strictly on specific habitat types. Their mobility and range are so big that prediction of possible road crosses is difficult (Madsen et al. 1998). Local roads are just a filter for wildlife movements deterring small mammals, but serving as corridors for larger wildlife. Minor roads with traffic intensity of up to 1000 vehicles per day may cause incidental accidents. Roads with up to 5000 vehicles per day may represent a barrier to certain species; they deter small as well as larger animals. Heavy traffic, between 5000 and 10000 vehicles per day, is a significant barrier, though the number

of roadkills remains stable. The main issues here are traffic safety and killed animals. On the highways with the traffic volume of over 10000 vehicles per day the main issues remain the same, but road barrier is almost impermeable, and all crossing animals are killed (COST 2003).

In Lithuania there are only few highway stretches with the traffic volume of over 5000 vehicles per day (Traffic 2008). The evaluation of existing wildlife underpasses was done as preliminary investigation (Balčiauskas & Balčiauskienė 2007). Further, there are no data for comparison from other Baltic countries, Latvia and Estonia.

The aim of this paper is to present species composition of wild animals hit by vehicles in Lithuania in 2002–2007, and to analyse temporal dynamics of wildlife-vehicle accidents.

MATERIAL AND METHODS

In this paper we analysed data on WVA registered by the Lithuanian police traffic supervision service in 2002–2007. Accidents involving domestic animals were excluded from analysis. The main groups of mammals involved in WVA were defined as ungulates (moose, red deer, roe deer and wild boar), carnivores (fox, raccoon dog, badger, wolf) and others (brown hare and beaver). Data were computerized into MS Access and analyzed via standard queries. We used Spearman's rank correlation and chi-square statistics. The data were processed using software package Statistica for Windows, ver. 6.0 (Statsoft 2004).

RESULTS AND DISCUSSION

The number of WVA on Lithuanian roads was growing every year (Table 1). It should be noted, though, that only registered accidents were covered. Also, in the period of 2002–2007, as many as 859 domestic animals and poultry were killed or just involved in vehicle accidents (475 dogs, 175 cattle, 89 horses, 23 cats etc.).

The composition of the roadkill toll was relatively stable for the ungulates and carnivores. The main group of animals killed in WVA were ungulates averaging 73.3% of the total roadkill in 2002–2007 (from 69.6% in 2003 to 78.3% in 2004). In the last year, this share was diminishing due to the rise of percentage of unidentified mammals (Table 1). Wild boar formed 9.8% on average (8.9% in 2002 up to 11.1% in 2003, and diminishing constantly from 2004). The share of moose in the roadkill was 6.0% on average (from 3.5% in 2003 to 7.3% in 2006, and rising from 2004). And the average share of red deer in 2002–2007 was merely 1.3% (0.8% in 2005 and 2.2% in 2003). Thus, ungulates formed a rather stable group of animals involved in wildlife-vehicle accidents, with no yearly differences from the expected average share ($\chi^2=3.6$, $df=5$, NS)

The number of accidents with moose clearly reflects the population status in the country; moose population is now recovering from the drastic decrease in the year 2000. Most of the wildlife-vehicle accidents involving moose were registered in the eastern part of Lithuania, also on the road across the Kuršių Nerija Spit. The share of the red deer is underrepresented compared to the animal number. Quite probably, the knowledge of species composition of unidentified animals may change the shares of separate ungulates inside the group.

The share of carnivores in police registered WVA was merely 1.5% on average, fluctuating from 0.8% in 2006 to 2.1% in 2007. The carnivore share in wildlife-vehicle accidents is also stable, with no yearly differences from expected average share ($\chi^2=5.7$, $df=5$, NS). Here it should be noted that the real number of carnivore-vehicle accidents is much higher, especially that involving raccoon dogs. Our unpublished data from 2006–2008 show that in Lithuania there were hundreds of raccoon dogs killed each year.

Beavers are rarely roadkilled, and the number of hares registered in WVA is diminishing in recent years, and this deviation from the expected average is statistically significant ($\chi^2=19.4$, $df=5$, $p<0.002$).

Table 1. Changes in the composition of mammals and birds killed in wildlife-vehicle accidents on Lithuanian roads, 2002–2007

Species	2002	2003	2004	2005	2006	2007	Total
Roe deer (<i>Capreolus capreolus</i>)	151	166	265	295	356	484	1717
Wild boar (<i>Sus scrofa</i>)	23	35	44	51	62	84	299
Moose (<i>Alces alces</i>)	19	12	15	26	47	64	183
Brown hare (<i>Lepus europaeus</i>)	16	21	19	30	21	19	126
Red deer (<i>Cervus elaphus</i>)	5	7	7	4	7	11	41
Red fox (<i>Vulpes vulpes</i>)	3	1	7	4	4	17	36
Raccoon dog (<i>Nyctereutes procyonoides</i>)	–	4	1	1	1	–	7
Beaver (<i>Castor fiber</i>)	–	1	1	1	1	2	6
Stork (<i>Ciconia ciconia</i>)	–	–	–	1	1	2	4
Wolf (<i>Canis lupus</i>)	–	–	–	1	–	1	2
Goose (<i>Anser</i> sp.)	–	1	–	–	–	–	1
Badger (<i>Meles meles</i>)	–	–	–	–	–	1	1
Partridge (<i>Perdix perdix</i>)	–	–	1	–	–	–	1
Unidentified mammals	40	65	61	83	146	227	622
Unidentified birds	2	3	2	2	2	1	12
Total per year	259	316	423	499	648	913	3058

The number of unidentified mammals in WVA during 2006 and 2007 was bigger than the expected average, while in 2002–2005 it was smaller than the expected average. This difference is also statistically significant ($\chi^2=24.2$, $df=5$, $p<0.001$).

Seasonally, moose were most frequently killed in May–October, red deer in September–December, roe deer in May–June and then in October–December, wild boar in September–December (Table 2). The biggest number of foxes was killed on roads in October to January, hares in April to July, though in the latter species seasonality of roadkills was expressed quite weakly. Generally, the number of wildlife-vehicle accidents was the highest in April–May, then in October–December. Seasonal dynamics of accidents with wild animals characterized as “wild”, “unknown wild”, “not

identified wild” is the most similar to that of roe deer ($rs=0.57$). Spearman’s correlation coefficients are of the same order with other ungulate species, moose ($rs=0.44$), red deer ($rs=0.52$) and wild boar ($rs=0.55$), thus, species of “unknown” ungulates cannot be prognosticated reliably.

The share of all ungulates in the wildlife-vehicle accidents was the highest in August (79.5%), May (76.5%), while the smallest in February (62.4%), March (68.2%) and April (68.1%). These changes are not significant statistically, thus we may state that the ungulate share is seasonally stable (Fig. 1).

Among ungulates, the share of moose in the roadkill toll was notably higher in September (20.5% from all ungulates), February, June and July (21.2–12.6%). The only month with a higher

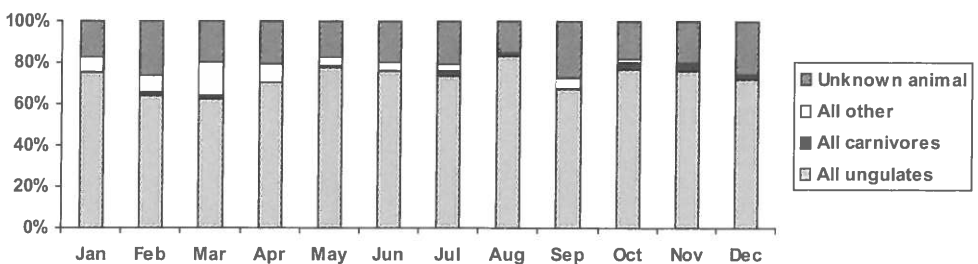


Fig. 1. Seasonal dynamics of mammal groups roadkilled in Lithuania 2002–2007

Table 2. Seasonal dynamics of mammals and birds killed in wildlife-vehicle accidents on Lithuanian roads, 2002–2007

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Moose	4	12	7	5	24	25	19	17	30	12	15	13
Red deer	2	1	–	3	3	1	2	4	9	7	5	4
Roe deer	117	77	85	134	273	173	122	136	62	168	215	155
Wild boar	15	8	9	12	15	8	8	21	45	58	59	41
Fox	1	3	2	–	3	–	3	2	–	9	7	6
Raccoon dog	–	–	–	–	–	–	1	1	1	1	2	1
Badger	–	–	–	–	–	–	–	1	–	–	–	–
Wolf	–	–	–	–	1	–	–	–	–	–	1	–
Hare	9	13	7	26	20	14	11	7	–	10	5	4
Beaver	–	–	5	–	–	–	–	–	–	1	–	–
Wild birds	2	2	1	1	1	1	4	3	1	–	1	1
Unknown animal	32	41	32	45	72	55	43	32	59	58	77	76
Total	182	157	148	226	412	277	213	224	207	324	387	301

toll of red deer was also September (6.2%). Wild boar shares among killed ungulates were the highest in September (30.8%), then in October–December (19.2–23.7%). Seasonal shares of roe deer were the most stable (Fig. 2). From January to July they were ca. 80 percent and higher (78.6–87.0%), then in August to December ca. 70 percent (68.6–76.4%), excluding only September (42.5%).

The share of carnivores killed in WVA was the highest in October (3.1%), November (2.6%) and December (2.3%); In February, July and August their share was close to 2% (1.8–1.9%).

The daytime of accidents is presented in Table 3. The distribution of WVA did not correspond to the expected hourly average ($\chi^2=1302$, $df=23$, $p<0.001$). Generally, two peaks of higher numbers of WVA were distinguished – a smaller peak at dawn, 5–

8 AM, and a bigger one at dusk, from 5 PM till midnight. The highest probabilities of WVA were calculated for 9–11 PM ($p<0.001$), and the lowest for 10 AM – 14 PM ($p<0.001$).

The morning peak of WVA involving roe deer was at 7–8 AM (5.5–6.5% of all accidents with this species), and the evening peak was at 5–11 PM (5.4–10.7%). For moose, only the evening peak was registered. The highest probability of WVA involving moose occurred at 8–11 PM (9.8–14.2% of all accidents with this species); at 6–7 PM and 12PM the probability was also high (5.5–6.0%). As to the red deer, no regularities were found. The highest probabilities of WVA involving red deer were expected at night, 1–3 AM (7.3–9.8%), in early morning, 5–7 AM (the same 7.3–9.8%), and at dusk, 7–8 PM (9.8% of all accidents involving red deer). For the wild boar,

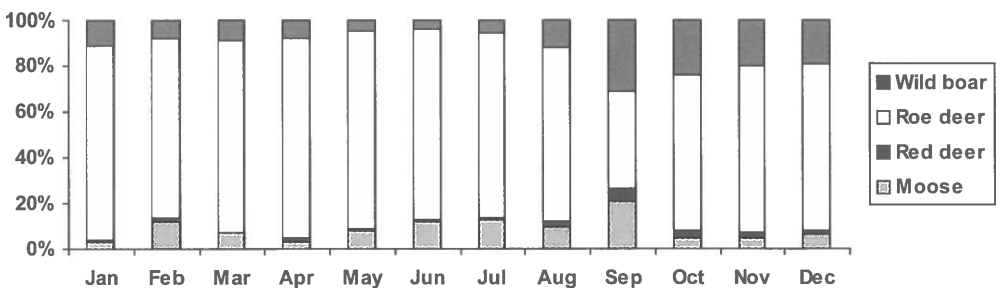


Fig 2. Seasonal dynamics of ungulate species roadkilled in Lithuania, 2002–2007

Table 3. Daytime of mammals and birds killed in wildlife-vehicle accidents on Lithuanian roads, 2002–2007

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Moose	6	3	4	4	8	5	6	6	–	–	–	2	6	1	–	6	7	10	10	19	18	26	25	11
Red deer	4	4	3	1	3	4	3	–	–	–	–	–	1	1	–	–	2	2	4	4	1	1	1	2
Roe deer	36	26	36	56	63	78	111	94	41	32	28	20	30	30	29	66	120	101	92	100	164	183	143	38
Wild boar	15	8	7	4	12	15	5	3	3	–	1	–	2	2	1	–	12	24	29	32	35	43	22	24
All ungulates:	61	41	50	65	86	102	125	103	44	32	29	22	39	34	30	72	141	137	135	155	218	253	191	75
Fox	1	–	1	1	1	–	2	2	1	1	3	–	–	–	–	–	1	1	5	1	3	4	5	2
Raccoon dog	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–
Badger	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Wolf	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
All carnivores:	1	0	1	1	2	1	2	2	1	1	4	1	0	0	1	1	1	5	1	3	6	6	4	1
Hare	4	7	4	1	2	2	10	4	7	1	5	5	3	4	5	3	3	8	1	7	10	10	14	6
Beaver	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	1	2
All other:	4	7	4	1	3	2	10	4	7	1	5	5	3	4	5	3	3	8	1	7	11	11	15	8
Wild birds	–	–	–	–	–	–	3	–	2	1	1	–	2	–	2	1	1	2	1	1	–	–	–	1
Unknown animal*	23	8	15	23	15	26	33	23	15	9	16	5	7	7	5	18	32	42	46	44	64	66	46	32
Total	89	56	70	90	106	131	173	132	69	44	55	33	51	45	43	95	178	194	184	210	299	336	256	117

* – for two of these, the hour of WVA was not recorded

the evening peak (at 6–12 PM) was best expressed, when 7.4–11.7% of all accidents were registered hourly.

To generalise our results, the species composition of roadkilled animals on Lithuanian roads was rather stable (ca. three quarters of them were ungulates). For some species, like moose or European hare, the road annual kill dynamics seemed to be connected with population numbers in the country (moose is recovering, hare is still in depression, at least in NE Lithuania). In the future, the data on registered WVA should be supplemented with data on unregistered roadkills.

We also analysed WVA from the point of view of problematic areas according to the scheme given in A. Seiler (2003). In Lithuania, there are no mammal species for which roadkills are worsening their protection status. For example, a limited quota for wolf hunt is 20 individuals per year in 2006–2008, thus no more than 5 percent overkill may be added from WVA (1 animal per year registered so far). We have no data on the transport killed lynxes or otters in the country.

When considering wildlife management problems, it should be noted that the number of roadkilled moose should be taken into account in the years when hunting was forbidden due to population depression after 2000. In 2006 and 2007, the number of lost moose individuals should be included into the planned quota, as it forms more than 10 percent of the harvest. Discussions if other ungulate species management strategy requires estimation of the roadkilled animals is still on the way.

The measures for reducing WVA rates in Lithuania are fuelled mostly by traffic safety issues. Economic estimations from the point of view of wildlife are planned under the National Science Strategy for 2009–2012. Public opinion at the moment is formed by negative publications in popular press and TV. In Scandinavian countries, where the number of WVA is higher, public opinion was evaluated recently on a scientific basis (Seiler et al. 2004, Seiler 2005).

References

Balčiauskas, L., Balčiauskienė, L. 2007. First data on the usage of wildlife underpasses in

Lithuania. Acta biologica universitatis
Daugavpiliensis. Supplement, 1: 28–36.

Received: 12.05.2008.

Accepted: 06.06.2008.

COST 341 – Habitat Fragmentation due to
Transport Infrastructure. 2003. European
commission, Luxembourg. 153 pp.

Seiler, A. 2003. The toll of the automobile: Wildlife
and roads in Sweden. Doctoral thesis. Acta
Universitatis Agriculturae Sueciae,
Silvestria, 295.

Madsen, A.B., Fyhn, H.W. and Prang, A. 1998.
Traffic killed animals in landscape ecological
planning and research. In: Danish:
*Trafikdræbte dyr i landskabsøkologisk
planlægning og forskning.* – DMU Rapport
228, Århus, DK.

Seiler, A., Helldin, J.-O., Seiler, C. 2004. Road
mortality in Swedish mammals: results of a
drivers' questionnaire. *Wildlife Biology*, 10
(3): 225-233.

Seiler, A. 2005. Predicting locations of moose–
vehicle collisions in Sweden. *Journal of
Applied Ecology*, 42: 371–382. doi: 10.1111/
j.1365-2664.2005.01013.x

StatSoft, Inc. 2004. STATISTICA (data analysis
software system), version 6.
www.statsoft.com.

Traffic volumes. 2008. Lithuanian road
administration under the ministry of
transport and communications. [http://
www.lra.lt/en.php/lithuanian_roads/
traffic_volumes/1848](http://www.lra.lt/en.php/lithuanian_roads/traffic_volumes/1848) (accessed 18 July
2008).

WOLF NUMBERS AND PUBLIC ACCEPTANCE IN DIFFERENT REGIONS OF LITHUANIA

Linus Balčiauskas, Martynas Kazlauskas

Balčiauskas L., Kazlauskas M. 2008. Wolf numbers and public acceptance in different regions of Lithuania. *Acta Biol. Univ. Daugavp.*, 8(1): 95 - 100.

In 2005–2006, the population of wolves in Lithuania was nearly 200 individuals, with the damage level much less than in the last decade of 20th century and the quota of wolf hunt limited to 20 individuals. In the future, species management on the population level is planned to be pursued. In this connection we checked if there were differences in species acceptance between regions of Lithuania. We found that in general the Lithuanian population was adequately informed about the presence of wolves in their area. The place of residence of the respondent and species dynamics in the region had a decisive influence on the acceptability of the species: respondents living in wolf-free regions were the most positive towards wolf numbers, while those supporting extermination or considerable wolf number reduction were from the regions which had undergone such process in the near past. On the other hand, respondents from wolf-free regions were the most resolved against the presence of wolves near places of their residence (no closer than 10 km and not even in their district). Thus, the NIMBY syndrome was obvious even at the regional scale in Lithuania. The second factor which influenced species acceptance on the regional level was the spatial and temporal wolf population dynamics. Both factors should be used as a tool for the manipulation of public opinion in preparing a species conservation plan.

Key words: wolves, public acceptance, attitude survey, Lithuania.

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Introduction

The wolf is one of large carnivores which in Lithuania as in many Western countries have been persecuted for centuries because of competition for wild game, depredation on livestock, fear and for trophy. As a result, in most West European countries, wolf populations have declined in numbers or become extinct. Lithuania is one of the countries still having a viable wolf population within. As a species, the wolf is valuable not only as a top predator with an

overwhelming effect on ecological communities but also as part of national identity, as a character of tales and stories, as an object of courtesy and fear. As an evidence of interrelation between wolf and development of Lithuania is the fact that at least 97 names of towns and villages came from the word "wolf" (Balčiauskas, Volodka 2001). Nowadays, low public acceptance of wolves in the country is mainly due to their conflicts with farmers with no issue mediation system (Balčiauskas, 2008).

In 2005–2006 the population of wolves in Lithuania was nearly 200 individuals, with the damage level much lower than in last decade of 20th century. For the last three years, the quota of wolf hunt was limited to 20 individuals, what is almost tenfold less than in neighboring Latvia. In the future, species management at the population level is intended to be pursued. The national policy of carnivore management covers all regions equally, but differences exist in relation to wolf presence history, farming types due to soil conditions, and wolf stock determined by forest and farmland cover rates (Jędrzejewski et al. 2004). The main question of this article is: Do wolf neighborhood and numbers play a role with public knowledge and attitude towards wolves?

MATERIAL AND METHODS

Based on the questionnaire data and annual wolf inventory, the public acceptance of wolves was compared and explained for five regions of Lithuania – northwest Lithuania (NW), north Lithuania (N), south Lithuania (S), central Lithuania (C), and the capital city Vilnius (V).

The questioning was done in 2003–2005 within the framework of the project "Large Carnivores in Northern Landscapes: an Interdisciplinary Approach to Their Regional Conservation". Questionnaires were distributed through schools in a standard way (Balčiauskas et al. 2005): pupils were instructed to give a questionnaire to a family member whose birthday was coming next, except persons younger than 15. Questions were of a close type, i.e., respondents had to choose one of the presented answer options. Along with personal data and many other topics, 1419 respondents (363 from NW, 247 from N, 263 from SE, 232 from S and 314 from C) expressed their views on natural environment and wildlife, wolf acceptance according their numbers, acceptable distances, and tolerable forms of predatory behavior. The latter two views are analyzed in this paper. The return rate was very high, over 90% in all regions.

A short description of each region sampled:

NW – Mainly small towns and villages neighboring on a plenty of wolf settled territories where livestock depredation rates were always high. Wolves inhabited the region in the last decades and their numbers have not decreased. The region is not considered to be rich.

N – Mainly small towns and villages scattered near the Biržų giria, one of the large forest units in Lithuania. Wolf numbers were high in the region until the year 2000 and then significantly decreased. People from this sample have experience in wolf numbers and their reduction. S – Small towns and villages in a highly afforested wolf-occupied territory. Several decades ago wolf numbers were high in the territory, but in 2004–2006 they were recorded only in very few numbers there. Thus, according to wolf presence and exterminating experiences, region sample is close to the preceding one. The difference is that region S is considered poor (agriculture is not developed on poor and afforested lands).

C – Mainly small towns in a rich region with highly developed agriculture. According to the survey data, wolves are absent in this region or their numbers are extremely low.

V – Capital city of Vilnius (population around 0.6 million) where wolves were absent.

The collected data were organized as a database in MS ACCESS and processed through a series of queries. The reliability of differences between samples by regions was assessed with the standard χ^2 method from 2x2 tables. The data were processed using the software package Statistica for Windows, ver. 6.0 (Statsoft 2004).

RESULTS AND DISCUSSION

The answers of respondents to the question "Is it possible to meet wolves where you live?" revealed significant differences. Most people who stated positively were from N, NW and S regions (77.2%, 60.6%, 64.7%, respectively), whereas such positive statements made only a minor proportion of answers from C and V regions

(36.3% and 33.1%, respectively). Differences between samples in pairs from these groups were statistically highly significant: $\chi^2=39.46-99.91$ with all $p<0.001$.

Negative answers distributed in the same manner. The biggest numbers of respondents who were sure that wolves did not inhabit their place were from C and V regions (46.8% and 54.4%), while in NW, S and N regions the percentage negative answers was significantly smaller (28.3%, 19.0% and 17.1% respectively): $\chi^2=24.59-76.44$, with $p<0.001$.

In general, public knowledge truly agrees with wolf distribution in Lithuania – there are no wolves in C and V regions. It could mean that people are well informed by ear-to-ear communication, especially in villages. However, topics regarding large carnivores are made over-popular by mass media, where damage incidents are given in detail. Thus, media helps to form a negative public attitude towards wolves and spreads information related to wolf caused accidents; hence people feel danger and mistrust.

The result might be an exaggeration of wolf numbers as in C and V regions, where more than 30% of answers are misleading. We found difference of opinion about the presence of wolves between wolf-rich regions (NW and N): less people in NW region know about wolves in

their region ($\chi^2=18.48$, $p<0.001$). It is possible that during the wolf number reduction campaign in N region, people were informed of a hunting bag. Besides, only 5.7% of respondents in N region were not sure about wolf situation, while in other regions this proportion was 11.1–16.9%.

The intentions of respondents as to the wolf population numbers show that most people suggest keeping the current number of carnivores or reducing it (Fig. 1). The largest part of people who called for a wolf number increase was from C and V regions, i.e. the regions where carnivores are absent. The number of wolf-positive respondents in C and V regions statistically differed from N region ($\chi^2=23.59$, $p<0.001$ and $\chi^2=14.29$, $p<0.001$ respectively) and C vs. NW ($\chi^2=9.23$, $p=0.002$).

An option to exterminate wolves was chosen mostly by the respondents from N and S regions (6.9% and 5.7% respectively), that is, from the regions which had undergone a considerable wolf number reduction in the nearest past. A negative position of the respondents from N region was stronger than that of respondents from C and NW regions (3.8% and 3.6%, $\chi^2=2.61$ and $\chi^2=3.28$, respectively, $p<0.10$). The negativity of respondents from S region was similar to that from C and NW regions.

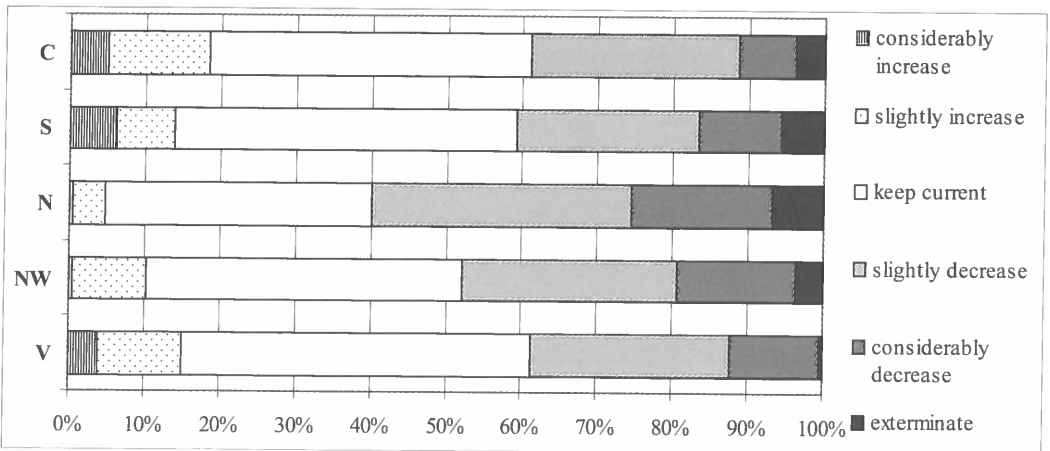


Figure 1. Opinion of respondents from different regions in Lithuania towards wolf number management

The number of respondents from V region who called for wolf extermination was negligible (0.4%). Such situation was strongly different from that in other regions (χ^2 between 7.20 and 15.69, $p < 0.01-0.001$).

Such situation is according with the possibility of respondents to undergo negative wolf encounter in the region. Obviously, people who make decisions under the influence of conservation ideas are city dwellers, in our case the citizens of V region. It is known that people who had lost a domestic animal to any predator are less tolerant of wolves, they are also more likely to favor lethal control (Naughton-Treves et al. 2003). Evidently, support for wolves is the strongest among affluent urban residents (Williams et al. 2002). In all studies, the most hostile attitudes toward wolves were found among farmers and ranchers living near wolf populations or proposed reintroduction sites (Naughton-Treves et al. 2003). By comparing Estonia and Lithuania we found that a negative opinion of respondents might be based on the place of their residence and possible property loss (Balčiauskas et al. 2005).

We also tested if there were regional differences as to the tolerable distance from the place of residence of respondents to the areas inhabited by wolves. The general result was that people did not accept neighborhood with wolves (Fig.

2). More than 50% of respondents from all regions were against wolves living closer than 10 km. In this respect most hostile were respondents from regions where wolves were absent, namely V and C. Both latter samples stood out by the highest share of respondents who were against the presence of wolves even in their district (39.9% and 38.4% respectively) and closer than 10 km (38.4% and 39.9%). In this respect the position of respondents from S region was the most exceptional; people from south Lithuania were more tolerable compared to respondents from regions where wolves were absent: S vs. V ($\chi^2 = 10.80$, $p < 0.001$) and S vs. C ($\chi^2 = 13.62$, $p < 0.001$).

As an explanation to this peculiarity may serve the fact that farmers from S region live in a wooded and wolf-inhabited territory. We are also working on the hypothesis that rich inhabitants are more hostile to carnivore presence than poor ones.

Respondents from S region were also outstanding from the general sample for their tolerance to close distances with wolves in their neighborhood. Statistically significant was the share of respondents of S region (38.5%) who accepted the existence of wolves closer than 10 km from the place of their residence compared to V region (22.1%, $\chi^2 = 15.97$, $p < 0.001$) and C region (24.9%, $\chi^2 = 11.57$, $p < 0.001$). A quite high number of respondents from S region (22.9%) would

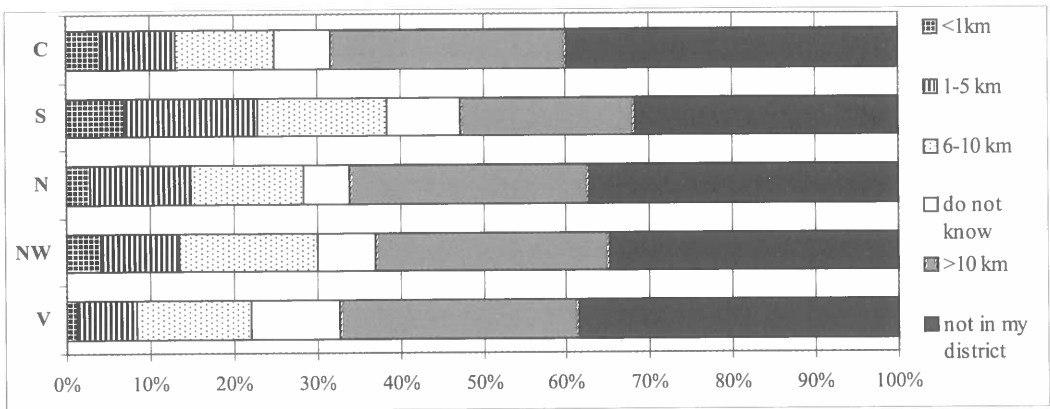


Figure 2. Tolerable distance of wolf existence for respondents from different regions of Lithuania

accept wolves inhabiting less than 5 km from their residence and it was statistically different from V (8.4%, $\pm^2=20.30$ $p<0.001$), C (13.1%, $\pm^2=9.01$ $p<0.003$), NW (13.5%, $\pm^2=8.85$ $p<0.003$) and N (15.0%, $\pm^2=4.95$ $p<0.03$) regions.

The same regularities were found concerning the closest acceptable distance, namely less than 1 km, which means “wolves living in the yard”. For S region, the situation was quite possible, as many of the questioned respondents were living at the forest edge. Thus, the greatest share of wolf-tolerant respondents was in S region (6.9%). It was higher than in V region (1.1%, $\pm^2=11.13$ $p<0.001$) and N region (2.8%, $\pm^2=4.36$ $p<0.05$). In NW and C regions, the proportion of wolf-tolerant respondents was about the same as in S region (4.1%, difference from S is not significant).

Thus, wolf neighborhood was not tolerated by respondents from regions where wolves were absent whereas residents of wolf inhabited forest margins were the most tolerant towards these carnivores. We had already singled out NW residents in respect of low wolf acceptance and high depredation level (Balčiauskas, Volodka 2001). This study shows that south Lithuania should also be distinguished for wolf tolerance. Wolf depredation in south Lithuania was always low due to particular cattle keeping practices that are different from the rest of Lithuania. In the daytime, cattle are semi-free ranging with a herdsman and a dog always present, but at nighttime all animals are shed. In the rest of the country, cattle are chained and often left in the pasture for the nighttime. Loose cattle near forest edges are the basis for high wolf depredation rates (Balčiauskas 2001, 2002, 2006, 2008)

The previous analysis gave ground for the suspicion of the NIMBY (Not In My Back Yard) syndrome (Balčiauskas et al. 2005, 2007), when people are accepting environment protection only in case it occurs somewhere else (Bath 2000). The current analysis confirmed the presence of the NIMBY syndrome: respondents from V and C regions were supporting higher wolf numbers and at the same time were against their presence near places of their residence.

Within the framework of the current study we have defined a temporal and spatial gradient of wolf presence in Lithuania: NW region (wolves were present in the last decades, no experience of their eradication) – N and S regions (wolves were present, later their number were reduced by hunting, now recovering) – C region (only occasional contacts with wolves, as their numbers were marginal for decades) – V region (wolves never present). Residents from the regions where wolves underwent a considerable number reduction in the nearest past were the most eager to support species extermination as a measure of population management.

Thus, we can sum up that the knowledge of the spatial and temporal wolf population dynamics in the country may be used as a tool to influence public opinion – identify target groups and conceptualize the driving forces of their attitudes.

CONCLUSIONS

1. In general, Lithuanian people were adequately informed about the presence of wolves in their area. Over-conviction of wolf presence might be related to the activities of mass media.
2. Respondents living in the regions where wolves were absent were found to be the most positive towards wolf numbers. Those who supported extermination or considerable wolf number reduction were from the regions, which had undergone such process in the near past. Thus, the place of residence of respondents and species dynamics in the region had a decisive influence on the acceptability of the species.
3. Respondents from wolf-free regions were the most resolved against the presence of wolves near their place of residence (no closer than 10 km and not even in their district). Residents from wooded and wolf-inhabited regions

were less sensitive to close neighborhood with wolves.

4. The last two conclusions clearly demonstrate the presence of the NIMBY syndrome concerning wolf numbers and acceptance of close living carnivores. The second factor influencing species acceptance on the regional level is the spatial and temporal dynamics of wolf population. Both issues should be used as a tool for the manipulation of public opinion in the species conservation plan.

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REFERENCES

- Balčiauskas L. 2001. Human dimensions of the large carnivores in Lithuania – general overview of the survey results from 1999–2001. In: proceedings of BLCI symposium "Human dimensions of large carnivores in Baltic countries": 7–27.
- Balčiauskas L. 2002. Possibilities of the development of the wolf population management plan for Lithuania. Acta Zoologica Lithuanica, 12(4): 410–418.
- Balčiauskas L. 2006. Assessment of wolf population in Lithuania and recommendations for preparation of population management plan (in Lithuanian). <http://www.ekoi.lt/uploads/docs/4.pdf>
- Balčiauskas L. 2008. Wolf numbers and distribution in Lithuania and problems of species conservation. Ann. Zool. Fennici 45: 00–00.
- Balčiauskas L., Volodka H. 2001. Some aspects of human dimensions of large carnivores in North-west Lithuania. In: Proceedings of BLCI symposium "Human dimensions of large carnivores in Baltic countries": 92–102.
- Balčiauskas L., Randveer T., Volodka H. 2005. Influence of place of residence and possible property loss on large carnivore acceptance in Estonia and Lithuania. Acta Biologica Universitatis Daugavpiliensis 5(1): 47–53.
- Balčiauskas L., Volodka H., Kazlauskas M. 2007. Wolf conservation and acceptance: comparison of South East Lithuania and North East Poland. Acta biologica universitatis Daugavpiliensis Supplement 1: 20–27.
- Bath A. 2000. Human Dimensions in Wolf Management in Savoie and Des Alpes Maritimes, France. Report.
- Jędrzejewski W., Niedziałkowska M., Nowak S., Jędrzejewska B. 2004. Habitat variables associated with wolf (*Canis lupus*) distribution and abundance in northern Poland. Diversity and Distributions, 10: 225–233.
- Naughton-Treves L., Grossberg R., Treves A., 2003. Paying for Tolerance: Rural Citizens' Attitudes toward Wolf Depredation and Compensation. Conservation Biology, 17(6): 1500–1511.
- StatSoft, Inc. 2004. STATISTICA (data analysis software system), version 6. www.statsoft.com.
- Williams C. K., Ericsson G., Heberlein T. A., 2002. A quantitative summary of attitudes toward wolves and their reintroduction. Wildlife Society Bulletin 30: 575–584.

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HABITAT INFLUENCE UPON THE DIET OF TAWNY OWL: GIS ANALYSIS

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Balčiauskienė, L., Balčiauskas, L., Kučas, A., Vaitkus, G. 2008. Habitat influence upon the diet of Tawny Owl: GIS analysis. *Acta Biol. Univ. Daugavp.*, 8 (1): 101 - 106.

Habitat influence upon the diet of the Tawny Owl (*Strix aluco*) in the breeding period was assessed using data from 13 nest-boxes (central Lithuania, 2000–2005) and GIS approach. Percentages of forest/open areas from the land cover data obtained from ORT10LT images as well as habitat types from CORINE land cover were calculated around nest-boxes in the radius of 250, 500 and 1000 m. We tested if proportions of prey in the diet composition of *S. aluco* correlated with habitat structure. The share of *Microtus* voles was positively correlated with the open land share (the strongest correlation was in the radius of 250–500 m.). The share of the bank vole (*Myodes glareolus*) in the diet increased with increase of the forest share and decreased in areas where nest-boxes were surrounded by open land. The share of the yellow-necked mouse (*Apodemus flavicollis*) was negatively correlated with the forest share. The shares of shrews, birds and amphibians in the diet were not influenced by habitat composition around nest-boxes. Correlations obtained were much higher using smaller-scale CORINE land cover data than larger-scale ORT 10LT data.

Key words: breeding Tawny Owl, diet, habitat, GIS

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INTRODUCTION

In ecological research of raptor birds and owls, GIS is being exploited in various ways. For the Northern Spotted Owls (*Strix occidentalis caurina*), prey availability and landscape influence onto home ranges was studied using GIS as early as in the beginning of the 1990's (Carey et al. 1992, Murphy & Noon 1992). For the Tawny Owl (*Strix aluco*), GIS analysis was used to estimate population dynamics and dispersal from the ringing data (Saurola & Francis 2004). In the Little Owl (*Athene noctua*), GIS was a tool for the estimation of territory occupancy and population abundance (Zabala et al. 2006), as well as social behaviour and spatial patterns (Zuberogoitia et al. 2007). Scientific advances in

GPS and GIS methods combined with telemetry will inevitably determine future trends in ecological research.

Though, the influence of landscape or habitat features also was and still is being analysed with the means of purely statistical approach (Carey et al. 1992, Salvati et al. 2001, Balčiauskienė 2006, Balčiauskienė & Dementavičius 2006). Both methods simultaneously were also exploited for several owl species – Pygmy Owl (*Glaucidium passerinum*), Tengmalm's Owl (*Aegolius funereus*) Tawny Owl, Long-eared Owl (*Asio otus*), etc. (Sergio et al. 2006).

The aim of this study is to find if there are any correlations between prey in *S. aluco* diet and

habitat components in the breeding period of owls when they are most sedentary.

Material and methods

We used prey remains of *S. aluco* collected from nest-boxes after the breeding period in central Lithuania, Rumšiškės forest, near the Kauno Marios Reservoir. For the location of nest-boxes, habitat description of the surrounding territory and prey composition see Balčiauskienė & Dementavičius (2006).

For the first GIS analysis we used CORINE Land Cover GIS database of the year 2000 (hereafter, "CLC2000") at the scale of 1:50 000 and standard classification of CORINE habitat types. The national CLC2000 database of Lithuania contains 32 (from the total of 44) standard land cover classes in the 3rd level of CLC nomenclature.

By using GIS proximity tools, habitat metrics were identified in the radius of 250, 500 and 1000 m around each nest-box. First of all, we tested a hypothesis if (a) percentage of forest area in the total area and (b) percentage of open land in the total area were correlated with the shares of the main small mammal groups in *S. aluco* diet. Non-irrigated agricultural lands, plantations of fruit trees and berries, pastures, areas of complex agriculture, fragmented agricultural and natural land, clear-cuts in the forests and shrubby areas were defined as "open land". Raw data are presented in Table 1.

From the above-mentioned buffer data, diet dependence on the percentage of forest area inside the buffer zone as well as on the percentage of open area (including agricultural lands, meadows, pastures and clear-cuts) was assessed. Habitat types singled out according to CLC2000 classification included: built-up territories (code 1.1.2), non-irrigated agricultural lands (2.1.1), plantations of fruit trees and berries (2.2.2), pastures (2.3.1), areas of complex agriculture (2.4.2), fragmented agricultural and natural land (2.4.3), deciduous (3.1.1), coniferous (3.1.2) and mixed (3.1.3) forests, transitional forests and shrubby areas (3.2.4), peatlands (4.1.2), streams

(5.1.1) and water bodies (5.1.2). Data on habitat presence near nest-boxes are presented in Table 3.

Also, location coordinates of the nest-boxes were mapped by using the aerial photo imagery ORT10LT database images (© Nacionalinė žemės tarnyba, 1996–2006) as background data. A circle buffer with a radius of 250, 500 and 1000 m around each nest-box (according to *S. aluco* home range size from literature) was formed. Polygon layers of rivers, lakes, forests, urban territories and open land were interactively vectorised inside the buffer, using ORT10LT images as a reference. Then, percentage of forested and open areas (including agricultural lands, meadows, pastures and clear-cuts) was assessed. Percentages of open and afforested habitats did not differ significantly from those obtained from CLC2000, and the difference was dependent on the digitalisation of the ORT10LT map when the smallest patches were omitted.

For all of spatial and proximity analyses, ARCINFO software was used and later the data were transferred into MS ACCESS database for attribute analysis and processed by standard queries. Correlations between diet composition and habitat structure were calculated (Pearson's r).

Results

Forest and non-forest habitat proportions in the specified radius around the nest-box according CLC2000 data and shares of the main prey groups in the diet of breeding *S. aluco* are presented in Table 1.

We found that proportions of the main habitat types (forest vs. open land) were strongly correlated with several prey groups (Table 2). The share of *Microtus* voles in the diet was negatively correlated with the percentage of forest area in the surrounding habitat and, on the contrary, positively correlated with the percentage of open land around the nest-boxes. Correlation was the strongest in the radius of 500 and 250 m. The same regularity was found with amphibians – the

Table 1. Data on the habitat from CORINE landcover database and the main prey groups (%) in *S. aluco* food remains from Rumšiškės forests.

Nest-box No	Forest in the radius of			Open areas in the radius of			<i>M. glareolus</i>	<i>A. flavicollis</i>	<i>Microtus</i> voles	<i>Sorex</i> shrews	Birds	Amphibians
	1000 m	500 m	250 m	1000 m	500 m	250 m						
1	57.68	84.70	94.47	17.74	24.59	5.53	50.6	28.6	13.0	0.0	0.0	1.3
2	69.25	24.96	65.16	21.97	24.96	34.84	25.4	42.8	3.5	13.9	1.2	5.2
3	50.44	69.43	84.57	40.82	30.42	15.43	31.7	28.5	13.0	11.4	4.9	7.3
4	53.56	92.75	91.09	42.25	34.69	41.00	12.0	8.3	20.4	9.3	6.5	31.5
5	54.53	89.63	100.00	22.17	33.08	52.32	17.2	23.3	21.6	13.8	1.7	9.5
6	72.70	72.76	85.05	17.84	7.48	8.39	30.0	0.0	10.0	20.0	40.0	0.0
7	19.61	33.58	48.36	78.62	66.42	51.64	14.0	19.3	32.7	8.7	0.7	21.3
8	43.61	82.77	100.00	26.83	3.84	0.00	25.0	29.5	0.9	19.6	0.0	18.8
9	62.44	100.00	100.00	35.93	50.98	97.60	17.6	2.0	27.5	5.9	3.9	39.2
10	21.22	69.55	60.42	78.58	69.72	55.36	14.3	20.6	23.8	4.8	6.3	23.8
11	42.80	61.45	67.96	57.20	41.10	32.04	17.1	34.1	22.0	4.9	2.4	14.6
12	41.24	72.91	87.91	9.08	27.09	12.09	11.5	50.8	6.6	18.0	1.6	6.6
13	36.51	68.04	85.64	25.41	0.37	0.00	14.3	60.0	8.6	8.6	5.7	2.9

closer the nest-box the stronger the positive correlation of the share of amphibians with the percentage of open land and the stronger its negative correlation with the percentage of forest around the nest-box. In a few cases such relation was almost linear (Fig. 1), confirming habitat influence on prey composition. Other correlation coefficients were of lower significance as the sample size was limited ($n=13$), but in general, the shares of *M. glareolus* and *A. flavicollis* in the diet of *S. aluco* were increasing with increase of a forest share and decreasing in the areas where nest-boxes were surrounded by open land (including meadows, agricultural and shrubby areas). Shrews, another prey, were also related to the presence of forests. Again, such correlations were the strongest in the radius of 500 and 250 m. Involving finer habitat types into diet analysis also confirmed the influence of the surrounding

habitat on owl foraging. The significance of the correlation was lower due to a small number of nest-boxes in the surrounding of which a certain habitat type was present, but coefficients were quite high (Table 3).

The share of *Microtus* voles in the diet was positively correlated with the presence of agricultural lands (CLC2000 codes: 211, 242) and shrubby areas (code 324), while correlations between the share of *Microtus* and the presence of built-up areas (code 112), also deciduous and coniferous forests (codes 311, 312) was negative. The share of amphibians was negatively correlated with the presence of deciduous and mixed forests (codes 311, 313), and positively with the presence of shrubby areas (code 324). The share of *Sorex* shrews – secondary prey, which was significant when preferable prey became

Table 2. Correlations between the main *S. aluco* diet components from the nest-boxes in Rumšiškės forests ($n=13$ in all cases) and habitat elements from CORINE landcover database.

Habitat, radius	<i>M. glareolus</i>	<i>A. flavicollis</i>	<i>Microtus</i> voles	<i>Sorex</i> shrews	Birds	Amphibians
Forest 1000	0.48*	-0.29 ^{NS}	-0.38 ^{NS}	0.27 ^{NS}	0.41 ^{NS}	-0.23 ^{NS}
Forest 500	0.48*	0.33 ^{NS}	-0.88****	0.47*	0.12 ^{NS}	-0.55**
Forest 250	0.45 ^{NS}	0.50*	-0.77****	0.36 ^{NS}	0.13	-0.74****
Open 1000	-0.37 ^{NS}	-0.27 ^{NS}	0.727***	-0.47 ^{NS}	-0.17 ^{NS}	0.53*
Open 500	-0.34 ^{NS}	-0.36 ^{NS}	0.84****	-0.52*	-0.29 ^{NS}	0.60**
Open 250	-0.41 ^{NS}	-0.53*	0.77****	-0.35 ^{NS}	-0.19 ^{NS}	0.77****

Note: NS – not significant; * – $p<0.1$; ** – $p<0.05$; *** – $p<0.01$; **** – $p<0.001$.

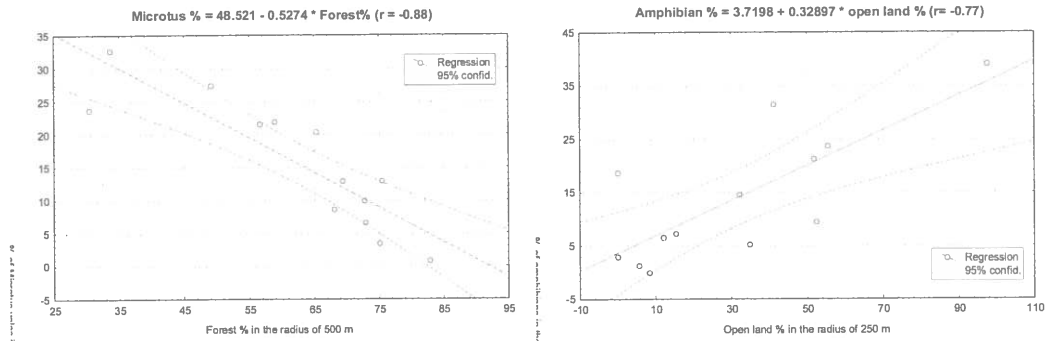


Fig. 1. Relation of the shares of *Microtus* voles and amphibians to habitat composition around the nest-boxes in the radius of 250 and 500 m.

scarce – was correlated to the presence of coniferous forests.

Proportions of the main habitat types (forest vs. open land) obtained from the data based on ORT10LT map in the radius of 250, 500 and 1000 m around each nest-box were slightly different from those of CLC2000. The averages for each category were as follows: the proportion of forest area was $48.1 \pm 4.5\%$ in CLC2000 vs. $55.7 \pm 6.0\%$ in ORT10LT within a 1000 m radius; $71.0 \pm 6.0\%$ vs. $71.5 \pm 5.3\%$ within a 500 m radius; and $82.4 \pm 4.6\%$ vs. $79.0 \pm 6.2\%$ within a 250 m radius, respectively (differences not significant). The proportion of open land differed more, i.e. 36.5 ± 6.3 vs. $35.6 \pm 6.4\%$ within a 1000 m radius, 31.9 ± 6.0 vs. $23.6 \pm 5.9\%$ within a 500 m radius and 31.2 ± 7.9 vs. $19.0 \pm 6.0\%$ within a 250 m radius, respectively (differences not significant). Though we found the same general dependencies of the diet on habitat

composition as in case of CLC2000, the coefficients of correlation in ORT10LT were considerably smaller (Table 4).

DISCUSSION

In addition to the main topic of this paper – if the diet of *S. aluco* correlates to the surrounding habitat structure – there are two more questions to discuss: what are the territories that *S. aluco* prey over and, technically, are vectorised maps suitable for ecological analysis?

As to the first question, the minimum home range of *S. aluco* is equal to 12 ha in fragmented hardwoods and fens of the United Kingdom (Redpath 1995). The critical path size, i.e., size of the territory which can support species presence for *S. aluco*, is just 4 ha (Carlsen et al. 2004).

Table 3. Strongest correlations between third level land cover classes from CORINE land cover database and diet composition (n – number of nest-boxes).

Habitat code	Radius, m	n	<i>M. glareolus</i>	<i>A. flavicollis</i>	<i>Microtus</i> voles	<i>Sorex</i> shrews	Birds	Amphibians
112	1000	7		0.74	-0.65			
211	250	6			0.84*			
	1000	6	-0.62		0.84*			
231	1000	5					0.70	
242	500	5			0.86			
311	500	4	0.81		-0.63			-0.84
312	250	5			-0.63	0.69		
	1000	8	0.70*					
313	250	12	0.50					-0.63*
	1000	12		-0.60*			0.85*	
324	250	4	0.74	-0.63	0.70			
	500	6	-0.87*	0.62				0.67
511	1000	4		0.73				

From the data of other authors it is known that in Central and Western Europe individual territories of *S. aluco* rarely exceed 40 ha (for data see Balčiauskienė & Dementavičius 2006). The radiuses we used for analysis cover bigger territories: 250 m – ca 20 ha, 500 m – ca 80 ha and 1000 m – more than 300 ha.

Habitat preferences of small mammal and amphibian species in Lithuania are summarized in the *Atlas of Lithuanian Mammals, Amphibians and Reptiles*. *M. glareolus* is mostly related to afforested habitats and shrubby areas, *Microtus arvalis* and other *Microtus* voles to open lands, including fields and meadows, forest glades and reedbeds. *A. flavicollis* is most common in forest habitats, but in summertime may use open areas also. *Sorex* shrews inhabit various habitats (Balčiauskas et al. 1999). Of amphibians, *Rana* frogs are prevailing in the diet of *S. aluco* in Lithuania (Balčiauskienė 2006). These amphibians inhabit a wide array of open as well as forested habitats (Balčiauskas et al. 1999). From this point of view, if our hypothesis on diet determination by habitat were true, correlations should be the strongest using radiuses of 250 m and 500 m around the nest-box and at least some species' share should be in accordance with the prevailing habitat.

Results of analysis using CLC2000 database fully confirm the hypothesis of habitat influence upon the diet (see Tables 2, 3). The share of *M. glareolus*, *A. flavicollis* and *Sorex* shrews in the diet is positively correlated with the presence of forests, and negatively with the presence of open habitats. The share of *Microtus* voles and amphibians is positively correlated with the presence of open land, and negatively with the presence of forest area). Correlation coefficients Table 4. Correlations between *S. aluco* diet components and forest/open land area from ORT10LT around the nest-boxes (N=13 in all cases).

are the strongest in the radius of 250–500 m from the nest-box.

The peculiarities of the biology of small mammals determine that even small (> 1 ha) patches of forest or open land habitats may have a significant influence on the community structure (Šinkūnas & Balčiauskas 2006). In CORINE maps (CLC2000 database), the spatial resolution of 3 ha is available. In a vectorised ORT10LT map with the scale of 1:10 000 the objects having a radius of 100 m (equalling 1 mm on the map) cannot be represented in a distinguishable way. Of course, such small details in ORT10LT images might have been omitted in our analysis. We may conclude that CLC2000 was more suitable for our aim and reflected habitat structure more exactly. Fine-grained habitat peculiarities should have resulted in better correlations (compare Tables 2 and 3 with Table 4). Thus, the resolution of CLC2000 database was sufficient for species-habitat analyses. The results obtained are biologically sound.

CONCLUSIONS

The diet of *S. aluco* in the breeding period is related to the surrounding habitat. High diversity of mammalian prey is positively influenced by the presence of clear-cuts and re-growing forest glades within 0.5 km around the nest-box and by the position of the nest-box with respect to the forest edge. Habitat influence on prey composition was confirmed by GIS analysis.

CLC2000 database in the scale of 1:50 000 and CORINE land cover classes as habitat types were more applicable for the analysis of the diet

Habitat, radius	<i>M. glareolus</i>	<i>A. flavicollis</i>	<i>Microtus</i> voles	<i>Sorex</i> shrews	Birds	Amphibians
Forest 1000	0.45	-0.41	-0.15	0.05	0.30	-0.06
Forest 500	0.26	-0.32	-0.10	-0.11	0.01	0.21
Forest 250	0.48*	-0.33	-0.03	-0.21	0.02	0.10
Open 1000	-0.37	0.10	0.44	-0.19	-0.21	0.14
Open 500	-0.16	0.05	0.30	0.02	0.00	-0.10
Open 250	-0.42	0.19	0.10	0.21	-0.01	-0.04

Note: * – $p < 0.1$

composition dependencies on the surrounding habitat. Vectorised maps were less suitable for ecological analyses, as small details were inevitably lost in the digitising (vectorising) process.

The comparison of the diet and habitat structure indicates that in Lithuania breeding *S. aluco* are hunting near the nests, mainly in the radius of 0.5 km or less.

REFERENCES

- Balčiauskas, L., Trakimas, G., Juškaitis, R., Ulevičius, A., Balčiauskienė, L. 1999. Lietuvos žinduolių, varliagyvių ir roplių atlasas. Antras papildytas leidimas. [Atlas of Lithuanian mammals, amphibians and reptiles. 2nd ed]. Vilnius: 120 p.
- Šinkūnas, R., Balčiauskas, L. 2006. Small mammal communities in the fragmented landscape in Lithuania. *Acta Zoologica Lituanica*, 16 (2): 130–136.
- Balčiauskienė, L. 2006. Feeding ecology of Tawny Owl (*Strix aluco*) and Long-eared Owl (*Asio otus*), based on craniometry of prey. Abstract of doctoral dissertation. Vilnius: Institute of Ecology of Vilnius University.
- Balčiauskienė, L., Dementavičius, D. 2006. Habitat determination of tawny owl (*Strix aluco*) prey composition during breeding period. *Acta biologica universitatis Daugavpiliensis*, 6(1–2): 1–12.
- Carey, A.B., Horton, S.P., Biswell, B.L. 1992. Northern spotted owls: influence of prey base and landscape character. *Ecological Monographs*, 62 (2): 223–250.
- Carlsen, T.M., Coty, J.D., Kercher, J.R. 2004. The spatial extent of contaminants and the landscape scale: an analysis of the wildlife, conservation biology, and population modelling literature. *Environmental toxicology and Chemistry*, 23 (3): 798–811. DOI: 10.1897/02-202.
- Murphy, D.D., Noon, B.R. 1992. Integrating scientific methods with habitat conservation planning: reserve design for northern spotted owls. *Ecological Applications*, 2: 3–17.
- Redpath, S. M. 1995. Habitat fragmentation and the individual: Tawny Owls *Strix aluco* in woodland patches. *Journal of Animal Ecology*, 64: 625–661.
- Salvati, L., Manganaro, A., Pucci, L. and Ranazzi, L. 2001. Distribution of woodland raptors along a Mediterranean-temperate gradient in Latium (central Italy). *Ornis Hungarica*, 11: 1–7.
- Saurola, P. & Francis, C. M., 2004. Estimating population dynamics and dispersal distances of owls from nationally coordinated ringing data in Finland. *Animal Biodiversity and Conservation*, 27 (1): 403–415
- Sergio, F., Newton, I., Marchesi, L. 2006. Ecologically justified charisma: preservation of top predators delivers biodiversity conservation. *Journal of Applied Ecology*, 43: 1049–1055, doi: 10.1111/j.1365-2664.2006.01218.x
- Zabala, J., Zuberogoitia, I., Martķnez-Climent, J.A., Martķnez, J.E., Azkona, A., Hidalgo, S., Iraeta, A. 2006. Occupancy and abundance of Little Owl *Athene noctua* in an intensively managed forest area in Biscay. *Ornis Fennica*, 83: 97–107.
- Zuberogoitia, I., Zabala, J., Martķnez, J.A., Hidalgo, S., Martķnez, J.E., Azkona, A., Castillo, I. 2007. Seasonal dynamics in social behaviour and spacing patterns of the Little Owl *Athene noctua*. *Ornis Fennica*, 84: 173–180.

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OBSERVATIONS ON SOME SCALE INSECTS (HEMIPTERA: COCCOIDEA) COLLECTED IN RIGA, WITH A REVISED CHECKLIST INCLUDING THREE SPECIES NEW FOR LATVIA

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Maluphy Ch., Ostrauskas H. 2008. Observations on some scale insects (Hemiptera: Coccoidea) collected in Riga, with a revised checklist including three species new for Latvia. *Acta Biol. Univ. Daugavp.*, 8(1): 107 - 113.

Collection data are provided for nine species of scale insect collected in Riga during July 2008. Three of these species are reported from Latvia for the first time: *Asterodiaspis variolosa* and *Parthenolecanium rufulum* on *Quercus robur* and *Physokermes hemicryphus* on *Picea abies*. A revised checklist of the Coccoidea of Latvia is presented and the total number of species recorded is 58. Forty-four species are native, or at least of European origin, and 14 are introduced species restricted to glasshouses and indoor plantings.

Key words: Coccoidea, Latvia, checklist, *Asterodiaspis variolosa*, *Parthenolecanium rufulum*, *Physokermes hemicryphus*.

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INTRODUCTION

The aim of this communication is to present data on some scale insects (Hemiptera, Coccoidea) collected in Riga during July 2008 and, secondly, to present a revised checklist of the Coccoidea of Latvia. National checklists are essential as baseline data from which faunistic changes, due to factors such as international trade and climate change, can be monitored and accurately assessed.

The scale insects of Latvia have been studied in great detail by Rasiņa (1955, 1959, 1960, 1966, 1971) and Velce & Rupais (1979). Rasiņa described eight new species of scale insect from Latvia, four of which have since become synonymised.

The four remaining valid species (*Atrococcus zirnitsi* (Rasiņa, 1966), *Pseudococcus pseudoperrisii* Rasiņa, 1971, *Trionymus latvicus* (Rasiņa, 1966) and *Trionymus paludicola* (Rasiņa, 1966)) are still only known from Latvia. Spuņģis & Kalniņš (2002) placed a checklist of Latvian Coccoidea on the Internet based primarily on the work of Rasiņa but the nomenclature and taxonomy is largely out of date. A revised checklist is presented here as an Appendix.

MATERIALS AND METHODS

Samples were collected by the first author on 20th and 29th-30th July in central Riga and at the airport. Adult females were slide-mounted

according to published methods (Malumphy 2002) and identified using the diagnostic keys provided by Kosztarab and Kozjir (1987). Full morphological descriptions of teneral adult females are provided by Kosztarab and Kozjir (1987). The nomenclature for the Coccoidea follows Ben-Dov, Miller and Gibson (2007). Slide-mounted specimens have been deposited at the following institutes: Central Science Laboratory (UK); Kaunas Tadas Ivanauskas Zoological Museum (Lithuania); and Latvian Nature Museum (Latvia).

RESULTS

Nine species of scale insect were collected in Riga, three of which are recorded from Latvia for the first time.

Pseudococcidae – mealybugs

Phenacoccus aceris (Signoret, 1875) – polyphagous tree mealybug

This is a common Holarctic species, broadly polyphagous on woody plants. Occasionally, it can be a pest when mass infestations occur on ornamental and fruit trees. It was recorded in Latvia by Rasiņa (1955, 1960)

Recent collection data: Riga District, Riga, Raiņa bulvāris, 29 July 2008, one ovisac, on *Tilia cordata*; Stabu Street, 29 July 2008, one ovisac, on *T. cordata*; Vermanes Garden, 29 July 2008, three ovisacs and dead females on *Crataegus* sp..

Coccidae – soft scales

Eulecanium tiliae (Linnaeus, 1758) – nut scale

This species is common and widespread in Europe. It is broadly polyphagous on woody plants and an occasional pest of ornamentals. It was recorded in Latvia by Rasiņa (1955).

Recent collection data: Riga District, Riga, Krišjāņa Barona Street, 29 July 2008, one parasitized female, abundant males, on *Crataegus*; Vermanes Garden, 29 July 2008, one parasitized female on *Acer platanoides*.

Parthenolecanium corni (Bouché, 1844) – brown scale, European fruit lecanium

This species occurs world-wide in temperate regions. It is broadly polyphagous, having a host plant list of more than 350 species, and is an important pest of orchard, ornamental and forestry trees. It was recorded in Latvia by Rasiņa (1960).

Recent collection data: Riga District, Riga, Pilsētas kanāls/Brīvības Street, 29 July 2008, one female on *Juglans regia*; Airport, 30 July 2008, one female on *J. regia*; 13 Janvāra Street, 20 July 2008, one female and male tests, on *Malus domestica*; Vecpilsētas Street, 29 July 2008, large infestation on *Rosa rugosa*.

Parthenolecanium rufulum (Cockerell, 1903) – oak soft scale

This is a common species found throughout Europe that feeds primarily on *Quercus*.

Recent collection data: Riga District, Riga, Smilšu Street, 29 July 2008, abundant on one branch on a single *Quercus robur*. This was one of a row of oak trees but the insect was not found on the neighbouring trees.

Physokermes hemicryphus (Dalman, 1826) – spruce-bud scale

This species occurs in central Europe and North America, feeding on *Picea*, and rarely *Abies*.

Recent collection data: Riga District, Riga, Vermanes Garden, 29 July 2008, post-reproductive females abundant and small numbers of first instars on *Picea abies*. Several trees were infested and some of the trees were in poor health due in part to being planted next to a busy road and suffering from the consequent pollution.

Asterolecaniidae – pit scales

Asterodiaspis variolosa (Ratzeburg, 1870) – golden oak scale

This is a common cosmopolitan species that feeds on *Quercus*. It is occasionally a pest causing shallow to deep pit galls on the bark.

Recent collection data: Riga District, Riga, Vermanes Garden, 29 July 2008, abundant adult

females with high levels of parasitism and low numbers of second instars, on *Quercus robur*.

Diaspididae – armoured scales

Chionaspis salicis (Linnaeus, 1758) – willow scale

This is a common trans-Palaeartic species that also occurs in North America. It is broadly polyphagous, and often a serious pest of forest and ornamental trees and of *Ribes*. It was recorded in Latvia by Rasiņa (1955, 1960).

Recent collection data: Riga District, Riga, Smilšu Street, 29 July 2008, huge population, branch killed, on *Tilia cordata*; Vecpilsētas Street, 29 July 2008, enormous population, on *T. cordata*.

Lepidosaphes ulmi (Linnaeus, 1758) – mussel scale

This is a very common, cosmopolitan, polyphagous species that is a serious pest of orchards, forest and ornamental trees. It was recorded in Latvia by Rasiņa (1955, 1960).

Recent collection data: Riga District, Riga International Airport, 30 July 2008, moderate infestation on *Sorbus aucuparia*; 13 Janvāra Street, 20 July 2008, abundant on *Malus domestica*; Vermanes Garden, 29 July 2008, low numbers of adults on *Crataegus monogyna*.

Leucaspis lowi (Colvée, 1882) – Löw's pine scale

This is a common Western Palaeartic species that feeds on *Pinus*. It was recorded in Latvia by Rasiņa (1955).

Recent collection data: Riga District, Riga International Airport, 30 July 2008, low numbers of adults, most were parasitised, on *Pinus sylvestris*.

DISCUSSION

Nine species of scale insect were collected in Riga during a brief visit in July 2008. Three species (*Asterodiaspis variolosa*, *Parthenolecanium rufulum* and *Physokermes hemicryphus*) are recorded from Latvia for the first time and each of these species was found in

large numbers on their host plants. The scale insect fauna of Latvia has been studied in detail by Rasiņa, so it was surprising to collect three species new for Latvia in such a brief period. It is possible that they are recent introductions although it is more likely that they have been previously overlooked.

A total of 58 species of coccoid are recorded in Latvia, belonging to seven families (see Appendix 1). Forty-four of these species are native, or at least European in origin, and 14 are exotic and restricted to glasshouses and indoor plantings.

Several coccoid species (for example, *C. salicis* on *Tilia*, *L. ulmi* on *Malus*, *P. corni* on *Rosa*, *P. rufulum* on *Quercus* and *P. hemicryphus* on *Picea*) were found to occur in large numbers on plants growing outdoors in the centre of Riga, sufficient to be damaging to their host plants. *Chionaspis salicis*, in particular, was present in enormous numbers and was found causing dieback to the lower branches of *T. cordata* trees grown in cramped conditions. The insects were largely hidden under a layer of black soot/pollution. The plants most susceptible to damage by scale insects are usually those already stressed by growing in urban environments.

REFERENCES

- Ben-Dov, Y., Miller, D. R. & Gibson, G. A. P. 2007. ScaleNet. 27 July 2006. <http://www.sel.barc.usda.gov/scalenet/scalenet.htm>
- Borchsenius, N.S. 1957. [Subtribe mealybugs and scales (Coccoidea). Soft scale insects Coccidae. Vol. IX.] (In Russian). Fauna SSSR. Zoologicheskii Institut Akademii Nauk SSSR. N.S. 66: 1-493.
- Borchsenius, N.S. & Danzig, E.M. 1966. [A new species of *Greenisca* Borchs. (Homoptera, Coccoidea, Ericoccidae) from the USSR *In* Bykhovskii, B.E., New Species of Insects of the Fauna of the USSR and Adjacent

- Countries.] (In Russian). Trudy Akademii Nauk SSR Zoologicheskogo Instituta 37: 41-44.
- Danzig, E.M. 1975c. Review of the cottony grass scales of the genus *Eriopeltis* Sign. (Homoptera, Coccoidea, Coccidae) of the Palaearctic. (In Russian). Entomologicheskoe Obozrenye 54: 808-813.
- Danzig, E.M. 1978. Scale insect fauna of South Sakhalin and Kunashir. (In Russian). Trudy Biologo-Pochvennogo, Akademii Nauk SSR, Vladivostok 50: 3-23.
- Danzig, E.M. 1980. Species of scale insects (Homoptera, Coccinea) new for Mongolia. (In Russian). Insects of Mongolia 7: 31-38.
- Danzig, E. & G. Watson, 2004. Hemiptera, Coccoidea. In Burkhardt, D.(ed.) 2004. Fauna Europaea. Version 1.1, <http://www.faunaeur.org>
- Kosztarab, M. & Kozjir, F.** 1987. Scale Insects of Central Europe. *Series Entomologica Series* 40: 1-400.
- Kozjir, F. 1998 (ed.). *Catalogue of Palaearctic Coccoidea*. Plant Protection Institute, Hungarian Academy of Sciences, Budapest, Hungary. 526 pp.
- Malumphy, C. 2002. *Parasaissetia nigra*. Diagnostic protocols for regulated pests. *OEPP/EPPO Bulletin* 32: 293-298.
- Spuņģis, V. & Kalniņš, M. 2002. Bruņutis – Coccoidea (subordo). <http://leb.daba.lv/Coccoidea.htm>
- Rasiņa, B.P. 1955. Material on the Coccoidea (Homoptera) fauna of the Latvian SSR. *Izvestiya Akademii Nauk Latviiskoi SSR* 5: 67-75.
- Rasiņa, B.P. 1959. Coccids (Homoptera Coccoidea) in different biotaxes of Latvian SSR. *Trudy Instituta Biologii, Akademii Nauk Latviiskoi SSR* 12: 107-119.
- Rasiņa, B. 1960. Coccid pests of ornamental trees and shrubs in Latvia, SSR. (In Latvian). *Latvijas Entomologs*. Riga 1: 9-16.
- Rasiņa, B.P. 1966. Neue Arten der Cocciden (Coccoidea, Pseudococcidae) aus der Lettischen SSR. [In Russian]. *Latvijas Entomologs*. Riga 11, 3-29.
- Rasiņa, B.P. 1971. A new species of mealybug *Pseudococcus pseudoperisii* Rasiņa (Coccoidea, Pseudococcidae) from the Latvian SSR. (In Russian). *Latvijas Entomologs*. Riga No. 13: 3-6.
- Velce, D. & Rupais, A. 1979. Records on the sucking pests of ornamental plants in Latvia. (In Latvian). *Latvijas Entomologs*. Riga 22: 50-56.

Appendix 1. A Checklist of Coccoidea (Hemiptera) of Latvia

The scale insects (Hemiptera, Coccoidea) of Latvia have been divided into two categories below: the first includes native species; the second non-native species found breeding under artificial conditions. Only the first reference recording the species in Latvia is listed. The identifications were not checked by the authors.

Native species

Forty-four species have been recorded from Latvia assigned to seven families.

Family Ortheziidae *Newsteadia* Green, 1902

Newsteadia floccosa (De Geer, 1778)
Rasiņa, 1955: 68.

Orthezia Bosc d'Antic, 1784
Orthezia urticae Linnaeus, 1758
Rasiņa, 1955: 68.

Family Pseudococcidae

***Atrococcus* Goux, 1941**

Atrococcus cracens Williams, 1962

Rasiņa, 1966: 7 (*Pseudococcus borchsenii*
Rasiņa, 1966).

Atrococcus paludinus (Green, 1921)

Rasiņa, 1966: 4 (*Pseudococcus alfredii*
Rasiņa, 1966).

Atrococcus zirnitsi (Rasiņa, 1966)

Rasiņa, 1966: 15 (*Pseudococcus zirnitsi*
Rasiņa, 1966).

***Coccura* Šulc, 1908**

Coccura comari (Künow, 1880)

Rasiņa, 1955: 69.

***Heterococcus* Ferris, 1918**

Heterococcus sp.

Rasiņa, 1955: 69.

***Peliococcus* Borchsenius, 1948**

Peliococcus calluneti (Lindinger, 1912)

Rasiņa, 1955: 68 (*Pseudococcus calluneti*
Lindinger, 1912).

***Phenacoccus* Cockerell, 1893**

Phenacoccus aceris (Signoret, 1875)

Rasiņa, 1955: 68 (*Phenacoccus aceris*
(Geoffroy), authorship incorrectly credited).

Phenacoccus piceae (Löw 1883)

Rasiņa, 1955: 69 (*Paroudablis piceae* (Low,
1883).

***Pseudococcus* Westwood, 1840**

Pseudococcus pseudoperrisii Rasiņa, 1971

Rasiņa, 1971: 3.

***Puto* Signoret, 1875**

Puto pilosellae (Šulc, 1898)

Rasiņa, 1955: 69 (*Cepeputo pilosellae* Šulc,
1898).

***Trionymus* Berg, 1899**

Trionymus latvicus (Rasiņa, 1966)

Rasiņa, 1966: 10 (*Pseudococcus latvicus*
Rasiņa, 1966).

Trionymus paludicola (Rasiņa, 1966)

Rasiņa, 1966: 12 (*Pseudococcus paludicola*
Rasiņa, 1966).

Family Coccidae

***Eriopeltis* Signoret, 1872**

Eriopeltis festucae (Boyer de Fonscolombe,
1834)

Rasiņa, 1955: 70 (*Eriopeltis Rasiņa e*
Borchsenius, 1956).

Eriopeltis lichtensteini Signoret, 1876

Rasiņa, 1955: 70.

***Eulecanium* Cockerell, 1893**

Eulecanium douglasi (Šulc, 1895)

Rasiņa, 1955: 71.

Eulecanium franconicum (Lindinger, 1912)

Rasiņa, 1955: 71.

Eulecanium tiliae (Linnaeus, 1758)

Rasiņa, 1955: 71 (*Eulecanium coryli*
(Linnaeus, 1758)).

***Luzulaspis* Cockerell, 1902**

Luzulaspis luzulae (Dufour, 1864).

Rasiņa, 1955: 70.

***Parafairmairia* Cockerell, 1899**

Parafairmairia bipartita (Signoret, 1872)

Rasiņa, 1955: 70 (*Parafairmairia delicata*
Borchsenius, 1952).

***Parthenolecanium* Šulc, 1908**

Parthenolecanium corni (Bouché, 1844)

Rasiņa, 1955: 70 (*Eulecanium corni*
(Bouché, 1844).

Parthenolecanium fletcheri (Cockerell, 1893)

Rasiņa, 1955: 71 (*Eulecanium arion*
(Lindinger, 1912)).

Parthenolecanium rufulum (Cockerell, 1903)

Recorded in 2008 by Malumphy and Ostrauskas (see above).

Phyllostroma Šulc 1942

Phyllostroma myrtilli (Kaltenbach, 1874)

Rasiņa, 1955: 71 (*Phyllostroma ericae* (Loew, 1883)).

Physokermes Targioni-Tozzetti, 1868

Physokermes hemicyrphus (Dalman, 1826)

Recorded in 2008 by Malumphy and Ostrauskas (see above).

Physokermes piceae (Schrank, 1801)

Rasiņa, 1955: 72.

Psilococcus Borchsenius, 1952

Psilococcus ruber Borchsenius, 1952

Borchsenius, 1957: 115 (*Psilococcus parvus* Borchsenius, 1957).

Pulvinaria Targioni-Tozzetti, 1866

Pulvinaria vitis (Linnaeus, 1758)

Rasiņa, 1955: 71 (*Pulvinaria betulae* (Linnaeus, 1758)).

Family Kermesidae

Kermes Boitard, 1828

Kermes quercus (Linnaeus, 1758)

Rasiņa, 1955: 70 (*Kermococcus quercus* (Linnaeus, 1758)).

Family Eriococcidae

Eriococcus Targioni-Tozzetti 1868

Eriococcus baldonensis (Rasiņa, 1966)

Rasiņa, 1966: 18 (*Acanthococcus baldonensis* Rasiņa, 1966).

Eriococcus brachypodii (Borchsenius & Danzig, 1966)

Borchsenius & Danzig, 1966: 43 (*Greenisca brachypodii* Borchsenius & Danzig, 1966).

Eriococcus glyceriae Green, 1921

Rasiņa, 1955: 69 (*Greenisca glyceriae* (Green, 1921), incorrectly placed in the Pseudococcidae), 1966: 21 (*Greenisca baltica* Rasiņa, 1966).

Eriococcus placidus Green, 1921

Rasiņa, 1955: 69 (*Greenisca placidus* (Green, 1921), incorrectly placed in the Pseudococcidae).

Eriococcus spurius (Modeer, 1778)

Rasiņa, 1955: 69 (*Gossyparia spuria* (Modeer, 1778), incorrectly placed in the Pseudococcidae).

Pseudochermes Nitsche, 1895

Pseudochermes fraxini (Kaltenbach, 1860)

Rasiņa, 1955: 69 (incorrectly placed in the Pseudococcidae).

Family Asterolecaniidae

Asterodiaspis Signoret, 1877

Asterodiaspis quercicola (Bouché, 1851)

Rasiņa, 1955: 70.

Asterodiaspis variolosa (Ratzeburg, 1870)

Recorded in 2008 by Malumphy and Ostrauskas (see above).

Family Diaspididae

Aulacaspis Cockerell, 1893

Aulacaspis rosae (Bouché, 1833)

Rasiņa, 1955: 73.

Chionaspis Signoret, 1869

Chionaspis salicis (Linnaeus, 1758)

Rasiņa, 1955: 73.

Dynaspidiotus Thiem & Gerneck, 1934

Dynaspidiotus abietis (Schrank, 1776)

Rasiņa 1955: 73 (*Nuculaspis abietis* (Schrank 1776)).

Dynaspidiotus britannicus (Newstead, 1898)

Rasiņa, 1955: 74.

Lepidosaphes Shimer, 1868

Lepidosaphes ulmi (Linnaeus, 1758)

Rasiņa, 1955: 72.

Leucaspis Signoret, 1869

Leucaspis lowi (Colvče, 1882)

Rasiņa 1955: 72 (*Anamaspis loewi* (Colvče, 1882)).

Introduced species established on indoor plantings

Fourteen species have been only recorded breeding on plants grown in glasshouses and buildings, but some of these may be able to survive outdoors during the summer, for example *Coccus hesperidum* Linnaeus. Most of these species may occur only as transient populations, surviving as long as their host plants do.

Family Ortheziidae

Insignorthezia Kozir, 2004

Insignorthezia insignis (Browne, 1887)
Rasiņa, 1955: 68 (*Orthezia insignis* Douglas, authorship incorrectly credited).

Family Pseudococcidae

Pseudococcus Westwood 1840

Pseudococcus longispinus (Targioni-Tozzetti, 1867)
Rasiņa, 1955: 68 (*Pseudococcus adoninum* (Geoffroy)).

Family Coccidae

Coccus Linnaeus, 1758

Coccus hesperidum Linnaeus, 1758
Rasiņa, 1955: 70.

Coccus pseudoheperidum (Cockerell, 1895)

Rasiņa, 1955: 70.

Pulvinaria Targioni-Tozzetti, 1866

Pulvinaria floccifera (Westwood, 1870)

Rasiņa, 1955: 71 (*Chloropulvinaria floccifera* (Westwood, 1870)).

Saissetia Deplanche, 1859

Saissetia coffeae (Walker, 1852)

Rasiņa, 1955: 71 (*Saissetia hemisphaerica* (Targioni Tozzetti, 1867)).

Family Diaspididae

Abgrallaspis Balachowsky, 1948

Abgrallaspis cyanophylli (Signoret, 1869)
Rasiņa, 1955: 74 (*Hemiberlesia cyanophylli* (Signoret, 1869)).

Aonidia Targioni Tozzetti, 1868

Aonidia lauri (Bouché, 1833)
Rasiņa, 1955: 74.

Aspidiotus Bouché, 1833

Aspidiotus nerii Bouché, 1833
Rasiņa 1955: 73 (*Aspidiotus hederæ* (Vallot, 1829), authorship incorrectly credited).

Diaspis Costa, 1835

Diaspis boisduvalii Signoret, 1869
Rasiņa, 1955: 73.

Hemiberlesia Cockerell, 1897

Hemiberlesia lataniae (Signoret, 1869)
Rasiņa, 1955: 74.
Hemiberlesia palmae (Cockerell, 1893)
Rasiņa, 1955: 74 (*Hemiberlesia palmae* (Morgan, 1893)).

Lepidosaphes Shimer, 1868

Lepidosaphes pinnaeformis (Bouché, 1851)
Rasiņa, 1955: 73 (*Lepidosaphes machili* (Maskell, 1898)).

Pinnaspis Cockerell, 1892

Pinnaspis aspidistrae (Signoret, 1869)
Rasiņa, 1955: 73.

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TERRESTRIAL SNAIL FAUNA OF EURO-SIBERIAN ALDER-WOODS (CL. *ALNETEA GLUTINOSAE*) IN LATVIA

Digna Pilāte

Pilāte D. 2008. Terrestrial snail fauna of Euro-Siberian alder-woods (Cl. *Alnetea glutinosae*) in Latvia. *Acta Biol. Univ. Daugavp.*, 8(1): 115 - 126.

Studies of the snail fauna in Euro-Siberian alder-woods (Cl. *Alnetea glutinosae*) were carried out in Latvia during the period 1995-2005, by examining samples from 15 forest districts located in different parts of the country. In total, 43 species (belonging to 15 genera) of terrestrial snails were found. That is half of all terrestrial snail species ever recorded in Latvia. The average number of species per sampling plot was 16 (range 6-28). Of nationally protected and endangered snail species, 11 were found in the alder-woods – *Acicula polita* (Hartmann, 1840), *Aegopinella nitidula* (Draparnaud, 1805), *Bulgarica cana* (Held, 1836), *Clausilia bidentata* (Ström, 1765), *C. dubia* (Draparnaud, 1805), *C. cruciata* (Studer, 1820), *C. pumila* (C. Pfeiffer, 1828), *Cochlicopa nitens* (Gallenstein, 1848), *Limax cinereoniger* (Wolf, 1803), *Macrogastra latestriata* (A. Schmidt, 1857), *Ruthenica filograna* (Rossmässler, 1836). Of the four species included in Annex II of the EU Habitats & Species Directive, one was found – *Vertigo moulinsiana* (Dupuy, 1849).

Key words: terrestrial snails, alder-woods, fauna, Latvia.

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INTRODUCTION

Alder-woods are included as endangered habitats in Annex I of the EU Habitats and Species Directive (European Communities 1992). The main threat is land reclamation. Such woods mainly occur in places of groundwater outflow, in vicinities of bogs and mires, and in flood-planes of rivers and lakes (Priedītis 1999). In Latvia, they are found all over the country, but especially in its northern and western parts (Kabucis 2000).

Different opinions about the richness of terrestrial snails in wetland forests exist. A. Shileiko (Učėėėži

1978) characterized them as being scanty in number of terrestrial snail species. Other studies, however, show that wetland forests, including wet coniferous forests, are rich habitats in this respect (Ehnström, Waldén 1986, Niemelä 1997, Pilāte 2000, 2001, Waldén 2001). Maintenance of molluscs' diversity is helped by such woods.

In Latvia, the first studies about terrestrial snail fauna in deciduous wetland forests were realized in 1995 (Suško 1998), and in 1997 (Pilāte 2000). Altogether, 42 terrestrial snail species were found in deciduous wetland forests. However, the snail fauna of alder-woods was not described

separately. During these studies, *Vertigo moulinsiana*, a species included in Annex II of the EU Habitats and Species Directive, was found in Latvia for the first time (Pilāte 2004). Up to now, this species has only been found in alder-woods (Pilāte 2007).

During 2004 and 2005, assessment of factors having impact on the diversity of snail species in alder-woods, and a continuation of the studies of malaco fauna as well, was carried out within the framework of the following two projects: „The development and approbation of the natural forest biotopes management monitoring methodology” financed by the State Stock Company „Latvia’s State Forests” and „The development of management models for non-clear cutting forests” financed by Forests Development Fund.

MATERIAL AND METHODS

Fieldwork was carried out in the forest districts of Aizkraukle, Aloja, Benkava, Ērberģe, Kaive, Liepupe, Mežole, Palsmane, Rudbārži, Slītere, Talsi, Taurkalne, Vārme, Viesīte and Žīguri during the months May-October, in the years 1995-2005 (Fig. 1).

Three methods were used to collect the snails: the volume-sampling method, the area-sampling method and gathering by hand (Valovirta 1996, Dunger, Fiedler 1997).

The volume-sampling method was used in 1995, 2004 and 2005. In each homogenous habitat, one sampling plot with an area of 10 x 20 m was marked. While walking in a zigzag pattern, litter was taken by hand after every second step, and sifted into a litter sieve (10 mm) separating coarse litter – leaves, branches, stems and cones. In total, 40 litter samples, one in each sampling plot and each of them having the volume of 3-5 l, were collected. Samples were air-dried and then

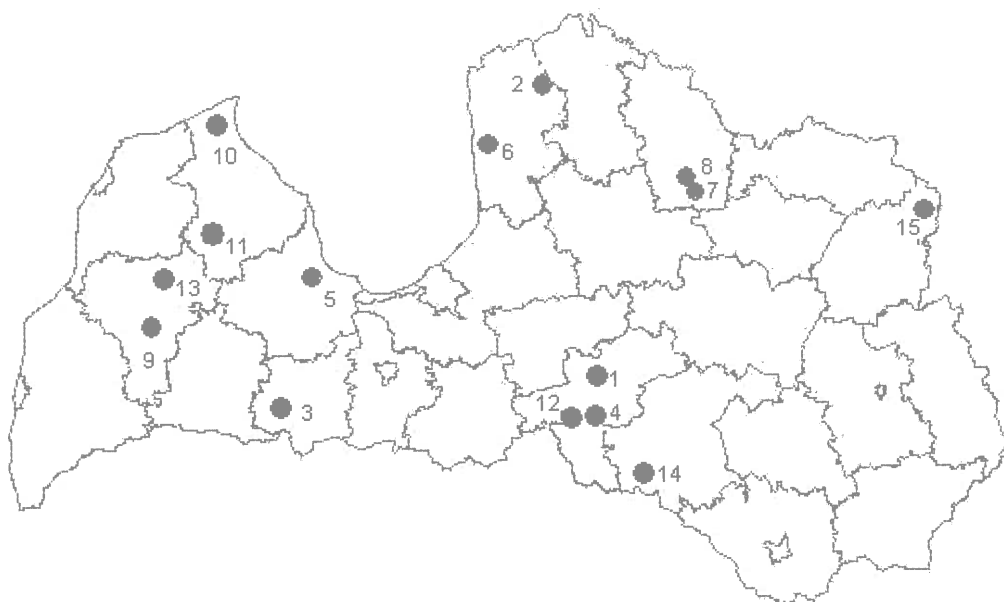


Fig. 1. Location of study sites. Explanations: 1 – Aizkraukle, 2 – Aloja, 3 – Benkava, 4 – Ērberģe, 5 – Kaive, 6 – Liepupe, 7 – Mežole, 8 – Palsmane, 9 – Rudbārži, 10 – Slītere, 11 – Talsi, 12 – Taurkalne, 13 – Vārme, 14 – Viesīte, 15 – Žīguri.

sifted through soil sieves (5 mm, 3 mm, 2.5 mm, 2 mm and 1 mm). Snail shells were picked out with tweezers, while looking through a magnifying glass.

In 1997, the area-sampling method was used in Aizkraukle, Mežole and Slītere. In each homogenous habitat, one plot was chosen, where sampling was done along a 25 m transect line. One litter sample was taken every meter along each transect with a biocenometer (20 x 20 cm). In total, 150 samples were collected in six sampling plots. Each sample was sifted through a litter sieve. Samples were air-dried and then separately sifted through soil sieves. Snail shells were picked out with tweezers, while looking through a magnifying glass.

Snails were gathered by hand, from both tree trunks and decomposing wood, within the boundaries of each sampling plot. This method was used to determine the species composition, because certain species are rarely found in the litter.

Species were identified and classified according to Kerney et al. (1983). To identify species of the families *Clausiliidae* and *Vertiginidae*, also the publications of I. M. Liharev (Ēčōāšāā 1962) and B. M. Pokryszko (Pokryszko 1990) were used. Kerney et al. (1983) and Pflieger (1984) were used to determine the ecological groups of the snail species.

The domination structure was drawn up according to Schwerdtfeger (Schwerdtfeger 1975). The occurrence classes of species were estimated according to Schwerdtfeger (Schwerdtfeger 1975) ($F = 100 \cdot b/a$). The occurrence classes were divided according to Tischler (Tischler 1979).

The gathered material was stored, partly at the Natural History Museum of Latvia and partly at the Daugavpils University Institute of Systematic Biology.

RESULTS AND DISCUSSION

Terrestrial snail species in alder-woods

Family Aciculidae

1. *Acicula polita* (Hartmann, 1840)

Silvicolous species. I. cl. Material: 29.07.1997, Aizkraukle distr., Aizkraukle, 2 ind.; 11.07.1995, 01.07.1997, Valka distr., Mežole, 55 ind.; 30.09.2004, Limbaži distr., Liepupe, 25 ind.; 17.09.2005, 46 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 1 ind.

Family Ellobiidae

2. *Carychium minimum* (O.F.Müller, 1774)

Silvicolous species. V. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 83 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 242 ind.; 11.07.1995, 01.07.1997, Valka distr., Mežole, 131 ind.; 30.09.2004, Limbaži distr., Aloja, 260 ind.; 23.09.2004, Tukums distr., Kaive, 118 ind.; 29.09.2004, Kuldīga distr., Vārme, 1 ind.; Rudbārži, 107 ind.; 23.09.2004, Talsi distr., Talsi, 202 ind.; 17.09.2005, Limbaži distr., Liepupe, 132 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 17 ind.; Ērberģe, 40 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 37 ind.; 08.10.2005, Balvi distr., Žiguri, 155 ind.; 11.09.2005, Valka distr., Palsmane, 110 ind.; Mežole, 126 ind.; 09.09.2005, Dobeles distr., Benkava, 71 ind.

3. *Carychium tridentatum* (Risso, 1826)

Wetland species. III. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 118 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 109 ind.; 11.07.1995, 01.07.1997, Valka distr., Mežole, 395 ind.; 30.09.2004, Limbaži distr., Aloja, 12 ind.; 23.09.2004, Tukums distr., Kaive, 99 ind.; 29.09.2004, Kuldīga distr., Vārme, 3 ind.; Rudbārži, 77 ind.; 23.09.2004, Talsi distr., Talsi, 25 ind.; 13.09.2005, Aizkraukle distr., Ērberģe, 46 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 57 ind.; 08.10.2005, Balvi distr., Žiguri, 11 ind.; 11.09.2005, Valka distr., Palsmane, 20 ind.; Mežole, 16 ind.

Family Succineidae

4. *Succinea oblonga* (Draparnaud, 1801)

Eiribiont species. I. cl. Material: 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 67 ind.; 09.09.2005, Dobeles distr., Benkava, 1 ind.

5. *Succinea putris* (Linnaeus, 1758)

Wetland species. II. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 1 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 15 ind.; 30.09.2004, Limbaži distr., Liepupe, 1 ind.; 08.10.2005, Balvi distr., Žīguri, 6 ind.; 11.09.2005, Valka distr., Palsmane, 6 ind.; Mežole, 11 ind.; 09.09.2005, Dobeles distr., Benkava, 20 ind.

Family Cochlicopidae**6. *Cochlicopa lubrica* (O.F.Müller, 1774)**

Eiribiont species. V. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 37 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 113 ind.; 11.07.1995, 01.07.1997, Valka distr., Mežole, 76 ind.; 30.09.2004, Limbaži distr., Aloja, 60 ind.; 23.09.2004, Tukums distr., Kaive, 79 ind.; 29.09.2004, Kuldīga distr., Vārme, 3 ind.; Rudbārži, 31 ind.; 23.09.2004, Talsi distr., Talsi, 34 ind.; 17.09.2005, Limbaži distr., Liepupe, 28 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 50 ind.; Ērberģe, 17 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 24 ind.; 08.10.2005, Balvi distr., Žīguri, 44 ind.; 11.09.2005, Valka distr., Palsmane, 20 ind.; Mežole, 28 ind.; 09.09.2005, Dobeles distr., Benkava, 3 ind.

7. *Cochlicopa nitens* (Gallenstein, 1848)

Wetland species. I. cl. Material: 11.07.1995, Valka distr., Mežole, 9 ind.;

Family Vertiginidae**8. *Columella edentula* (Draparnaud, 1805)**

Wetland species. III. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 40 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 6 ind.; 11.07.1995, 01.07.1997, Valka distr., Mežole, 24 ind.; 23.09.2004, Tukums distr., Kaive, 5 ind.; 29.09.2004, Kuldīga distr., Vārme, 9 ind.; Rudbārži, 3 ind.; 17.09.2005, Limbaži distr., Liepupe, 2 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 22 ind.; Ērberģe, 2 ind.; 15.09.2005, Jēkabpils distr., Viesīte,

13 ind.; 08.10.2005, Balvi distr., Žīguri, 12 ind.; 11.09.2005, Valka distr., Palsmane, 5 ind.; Mežole, 2 ind.; 09.09.2005, Dobeles distr., Benkava, 71 ind.; 17.09.2005, Limbaži distr., Aloja, 2 ind.

9. *Columella aspera* (Walden, 1966)

Silvicolous species. IV. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 10 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 12 ind.; 11.07.1995, 01.07.1997, Valka distr., Mežole, 25 ind.; 30.09.2004, Limbaži distr., Aloja, 8 ind.; 23.09.2004, Tukums distr., Kaive, 4 ind.; 29.09.2004, Kuldīga distr., Vārme, 12 ind.; 23.09.2004, Talsi distr., Talsi, 6 ind.; 17.09.2005, Limbaži distr., Liepupe, 15 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 13 ind.; Ērberģe, 11 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 8 ind.; 08.10.2005, Balvi distr., Žīguri, 9 ind.; 11.09.2005, Valka distr., Palsmane, 1 ind.; Mežole, 5 ind.

10. *Vertigo pusilla* (O.F. Müller, 1774)

Silvicolous species. III. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 4 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 2 ind.; 11.07.1995, Valka distr., Mežole, 1 ind.; 23.09.2004, Aizkraukle distr., Ērberģe, 26 ind.; 29.09.2004, Kuldīga distr., Vārme, 19 ind.; 17.09.2005, Limbaži distr., Liepupe, 6 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 21 ind.; 08.10.2005, Balvi distr., Žīguri, 3 ind.; 11.09.2005, Valka distr., Mežole, 1 ind.

11. *Vertigo antivertigo* (Draparnaud, 1801)

Wetland species. II. cl. Material: 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 20 ind.; 30.09.2004, Limbaži distr., Aloja, 28 ind.; 23.09.2004, Tukums distr., Kaive, 2 ind.; 29.09.2004, Kuldīga distr., Rudbārži, 6 ind.; 23.09.2004, Talsi distr., Talsi, 5 ind.; 08.10.2005, Balvi distr., Žīguri, 1 ind.; 11.09.2005, Valka distr., Mežole, 4 ind.; 09.09.2005, Dobeles distr., Benkava, 20 ind.

12. *Vertigo substriata* (Jeffreys, 1833)

Wetland species. V. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 37 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 150 ind.; 11.07.1995, Valka distr., Mežole, 83 ind.; 30.09.2004, Limbaži distr., Aloja, 182 ind.; 23.09.2004, Tukums distr., Kaive, 103 ind.;

29.09.2004, Kuldīga distr., Vārme, 37 ind.; Rudbārži, 58 ind.; 23.09.2004, Talsi distr., Talsi, 95 ind.; 17.09.2005, Limbaži distr., Liepupe, 5 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 35 ind.; Ērberģe, 33 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 11 ind.; 08.10.2005, Balvi distr., Žīguri, 26 ind.; 11.09.2005, Valka distr., Palsmane, 20 ind.; Mežole, 12 ind.; 09.09.2005, Dobeles distr., Benkava, 1 ind.

13. *Vertigo moulinsiana* (Dupuy, 1849)

Wetland species. I. cl. Material: 29.07.1997 Aizkraukle distr., Aizkraukle, 56 ind.; 11.09.2005, Valka distr., Mežole, 2 ind.

14. *Vertigo lilljeborgi* (Westerlund, 1871)

Wetland species. I. cl. Material: 30.09.2004, Limbaži distr., Aloja, 11 ind.; 11.09.2005, Valka distr., Mežole, 8 ind.; 08.10.2005, Balvi distr., Žīguri, 1 ind.

Family Valloniidae

15. *Vallonia costata* (O.F. Müller, 1774)

Steppe species. I. cl. Material: 30.09.2004, Limbaži distr., Liepupe, 1 ind.; 08.10.2005, Balvi distr., Žīguri, 13 ind.

16. *Acanthinula aculeata* (O.F. Müller, 1774)

Silvicolous species. II. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 40 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 4 ind.; 11.07.1995, Valka distr., Mežole, 15 ind.; 23.09.2004, Tukums distr., Kaive, 9 ind.; 29.09.2004, Kuldīga distr., Vārme, 33 ind.; Rudbārži, 2 ind.; 17.09.2005, Limbaži distr., Liepupe, 49 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 3 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 15 ind.; 11.09.2005, Valka distr., Palsmane, 3 ind.

Family Endodontidae

17. *Punctum pygmaeum* (Draparnaud, 1801)

Eiribiont species. V. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 38 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 469 ind.; 11.07.1995, 01.07.1997, Valka distr., Mežole, 174 ind.; 30.09.2004, Limbaži distr., Aloja, 125 ind.,

23.09.2004, Tukums distr., Kaive, 108 ind.; 29.09.2004, Kuldīga distr., Vārme, 66 ind.; Rudbārži, 42 ind.; 23.09.2004, Talsi distr., Talsi, 60 ind.; 17.09.2005, Limbaži distr., Liepupe, 29 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 36 ind.; Ērberģe, 27 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 44 ind.; 08.10.2005, Balvi distr., Žīguri, 103 ind.; 11.09.2005, Valka distr., Palsmane, 27 ind.; Mežole, 51 ind.; 09.09.2005, Dobeles distr., Benkava, 2 ind.

18. *Discus ruderatus* (Ferussac, 1821)

Silvicolous species. IV. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 32 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 13 ind.; 11.07.1995, 01.07.1997, Valka distr., Mežole, 20 ind.; 30.09.2004, Limbaži distr., Aloja, 42 ind., 23.09.2004, Tukums distr., Kaive, 11 ind.; 29.09.2004, Kuldīga distr., Vārme, 22 ind.; Rudbārži, 3 ind.; 23.09.2004, Talsi distr., Talsi, 16 ind.; 30.09.2004, Limbaži distr., Liepupe, 2 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 50 ind.; Ērberģe, 1 ind.; 08.10.2005, Balvi distr., Žīguri, 3 ind.; 11.09.2005, Valka distr., Palsmane, 8 ind.; Mežole, 9 ind.

Family Arionidae

19. *Arion subfuscus* (Draparnaud, 1805)

Silvicolous species. I. cl. Material: 27.06.1995, Talsi distr., Slītere, 1 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 2 ind.; 11.07.1995, Valka distr., Mežole, 1 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 4 ind.; Ērberģe, 4 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 1 ind.

Family Vitrinidae

20. *Vitrina pellucida* (O.F. Müller, 1774)

Eiribiont species. I. cl. Material: 19.07.1997, Talsi distr., Slītere, 6 ind.; 29.09.2004, Kuldīga distr., Vārme, 4 ind.; 17.09.2005, Limbaži distr., Liepupe, 3 ind.

Family Zonitidae

21. *Vitrea crystallina* (O.F. Müller, 1774)

Silvicolous species. V. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 30 ind.; 25.05.1995,

29.07.1997, Aizkraukle distr., Aizkraukle, 29 ind.; 11.07.1995, 01.07.1997, Valka distr., Mežole, 92 ind.; 30.09.2004, Limbaži distr., Aloja, 38 ind.; 23.09.2004, Tukums distr., Kaive, 5 ind.; 29.09.2004, Kuldīga distr., Vārme, 16 ind.; Rudbārži, 2 ind.; 23.09.2004, Talsi distr., Talsi, 3 ind.; 17.09.2005, Limbaži distr., Liepupe, 22 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 16 ind.; Ērberģe, 26 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 63 ind.; 08.10.2005, Balvi distr., Žīguri, 11 ind.; 11.09.2005, Valka distr., Palsmane, 21 ind.; Mežole, 27 ind.

22. *Aegopinella pura* (Alder, 1830)

Silvicolous species. II. cl. Material: 19.07.1997, Talsi distr., Slītere, 37 ind.; 25.05.1995, Aizkraukle distr., Aizkraukle, 10 ind.; 11.07.1995, 01.07.1997, Valka distr., Mežole, 20 ind.; 29.09.2004, Kuldīga distr., Vārme, 14 ind.; 17.09.2005, Limbaži distr., Liepupe, 54 ind.; 13.09.2005, Aizkraukle distr., Ērberģe, 2 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 20 ind.; 08.10.2005, Balvi distr., Žīguri, 1 ind.; 11.09.2005, Valka distr., Palsmane, 2 ind.

23. *Aegopinella nitidula* (Draparnaud, 1805)

Silvicolous species. I. cl. Material: 25.05.1995, Aizkraukle distr., Aizkraukle, 4 ind.

24. *Nesovitrea hammonis* (Ström, 1765)

Eiribiont species. V. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 96 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 164 ind.; 11.07.1995, 01.07.1997, Valka distr., Mežole, 112 ind.; 30.09.2004, Limbaži distr., Aloja, 131 ind.; 23.09.2004, Tukums distr., Kaive, 82 ind.; 29.09.2004, Kuldīga distr., Vārme, 24 ind.; Rudbārži, 43 ind.; 23.09.2004, Talsi distr., Talsi, 206 ind.; 17.09.2005, Limbaži distr., Liepupe, 9 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 33 ind.; Ērberģe, 38 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 11 ind.; 08.10.2005, Balvi distr., Žīguri, 24 ind.; 11.09.2005, Valka distr., Palsmane, 14 ind.; Mežole, 32 ind.

25. *Nesovitrea petronella* (L.Pfeiffer, 1853)

Wetland species. V. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 126 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 151 ind.; 11.07.1995, 01.07.1997, Valka distr., Mežole, 109

ind.; 30.09.2004, Limbaži distr., Aloja, 6 ind.; 23.09.2004, Tukums distr., Kaive, 98 ind.; 29.09.2004, Kuldīga distr., Vārme, 33 ind.; Rudbārži, 23 ind.; 23.09.2004, Talsi distr., Talsi, 29 ind.; 17.09.2005, Limbaži distr., Liepupe, 61 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 82 ind.; Ērberģe, 46 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 33 ind.; 08.10.2005, Balvi distr., Žīguri, 5 ind.; 11.09.2005, Valka distr., Palsmane, 45 ind.; Mežole, 24 ind.

26. *Oxychilus alliarius* (Miller, 1822)

Silvicolous species. I. cl. Material: 19.07.1997, Talsi distr., Slītere, 4 ind.; 29.09.2004, Kuldīga distr., Vārme, 1 ind.

27. *Zonitoides nitidus* (O.F.Müller, 1774)

Wetland species. IV. cl. Material: 19.07.1997, Talsi distr., Slītere, 1 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 47 ind.; 30.09.2004, Limbaži distr., Aloja, 58 ind.; 23.09.2004, Tukums distr., Kaive, 137 ind.; 29.09.2004, Kuldīga distr., Rudbārži, 38 ind.; 23.09.2004, Talsi distr., Talsi, 11 ind.; 17.09.2005, Limbaži distr., Liepupe, 3 ind.; 13.09.2005, Aizkraukle distr., Ērberģe, 1 ind.; 08.10.2005, Balvi distr., Žīguri, 11 ind.; 11.09.2005, Valka distr., Palsmane, 28 ind.; Mežole, 9 ind.; 09.09.2005, Dobeles distr., Benkava, 63 ind.

Family Limacidae

28. *Limax cinereoniger* (Wolf, 1803)

Silvicolous species. I. cl. Material: 25.05.1995, Aizkraukle distr., Aizkraukle, 1 ind.

29. *Malacolimax tenellus* (O.F.Müller, 1774)

Silvicolous species. I. cl. Material: 15.09.2005, Jēkabpils distr., Viesīte, 1 ind.

Family Euconulidae

30. *Euconulus fulvus* (O.F.Müller, 1774)

Eiribiont species. V. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 38 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 214 ind.; 11.07.1995, 01.07.1997, Valka distr., Mežole, 119 ind.; 30.09.2004, Limbaži distr., Aloja, 117 ind.; 23.09.2004, Tukums distr., Kaive, 135 ind.; 29.09.2004, Kuldīga distr., Vārme, 50 ind.;

Rudbārži, 47 ind.; 23.09.2004, Talsi distr., Talsi, 46 ind.; 17.09.2005, Limbaži distr., Liepupe, 10 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 18 ind.; Ērberģe, 11 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 8 ind.; 08.10.2005, Balvi distr., Žīguri, 32 ind.; 11.09.2005, Valka distr., Palsmane, 11 ind.; Mežole, 28 ind.; 09.09.2005, Dobeles distr., Benkava, 6 ind.

Family Clausiliidae

31. *Cochlodina laminata* (Montagu, 1803)

Silvicolous species. III. cl. Material: 19.07.1997, Talsi distr., Slītere, 2 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 6 ind.; 11.07.1995, 01.07.1997, Valka distr., Mežole, 10 ind.; 23.09.2004, Tukums distr., Kaive, 4 ind.; 29.09.2004, Kuldīga distr., Vārme, 2 ind.; 17.09.2005, Limbaži distr., Liepupe, 9 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 8 ind.; Ērberģe, 4 ind.

32. *Ruthenica filograna* (Rossmässler, 1836)

Silvicolous species. I. cl. Material: 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 12 ind.; 30.09.2004, 17.09.2005, Limbaži distr., Liepupe, 55 ind.; 11.09.2005, Valka distr., Mežole, 3 ind.

33. *Macrogastera ventricosa* (Draparnaud, 1801)

Silvicolous species. II. cl. Material: 19.07.1997, Talsi distr., Slītere, 1 ind.; 11.07.1995, 01.07.1997, Valka distr., Mežole, 3 ind.; 23.09.2004, Tukums distr., Kaive, 8 ind.; 29.09.2004, Kuldīga distr., Vārme, 1 ind.; 17.09.2005, Limbaži distr., Liepupe, 4 ind.; 08.10.2005, Balvi distr., Žīguri, 5 ind.; 11.09.2005, Valka distr., Mežole, 6 ind.

34. *Macrogastera plicatula* (Draparnaud, 1801)

Silvicolous species. I. cl. Material: 25.05.1995, Aizkraukle distr., Aizkraukle, 7 ind.; 11.07.1995, Valka distr., Mežole, 8 ind.; 29.09.2004, Kuldīga distr., Vārme, 1 ind.; 23.09.2004, Talsi distr., Talsi, 8 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 1 ind.; Ērberģe, 20 ind.

35. *Macrogastera latestriata* (A.Schmidt, 1857)

Silvicolous species. I. cl. Material: 29.09.2004, Kuldīga distr., Vārme, 1 ind.

36. *Clausilia bidentata* (Ström, 1765)

Silvicolous species. I. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 3 ind.; 23.09.2004, Tukums distr., Kaive, 1 ind.; 29.09.2004, Kuldīga distr., Vārme, 15 ind.

37. *Clausilia dubia* (Draparnaud, 1805)

Silvicolous species. I. cl. Material: 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 2 ind.; 17.09.2005, Limbaži distr., Liepupe, 4 ind.

38. *Clausilia cruciata* (Studer, 1820)

Silvicolous species. II. cl. Material: 11.07.1995, Valka distr., Mežole, 11 ind.; 23.09.2004, 13.09.2005, Aizkraukle distr., Ērberģe, 7 ind., 7 ind.; 30.09.2004, 17.09.2005, Limbaži distr., Liepupe, 2 ind., 9 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 5 ind.; 08.10.2005, Balvi distr., Žīguri, 2 ind.

39. *Clausilia pumila* (C.Pfeiffer, 1828)

Silvicolous species. I. cl. Material: 25.05.1995, Aizkraukle distr., Aizkraukle, 4 ind.; 02.10.2004, Aizkraukle distr., Taurkalne, 7 ind.; 30.09.2004, 17.09.2005, Limbaži distr., Liepupe, 6 ind., 3 ind.; 13.09.2005, Aizkraukle distr., Ērberģe, 15 ind.

40. *Bulgarica cana* (Held, 1836)

Silvicolous species. I. cl. Material: 01.07.1997, Valka distr., Mežole, 1 ind.; 30.09.2004, 17.09.2005, Limbaži distr., Liepupe, 4 ind., 2 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 4 ind.

Family Bradybaenidae

41. *Bradybaena fruticum* (O.F.Müller, 1774)

Silvicolous species. II. cl. Material: 11.07.1995, Valka distr., Mežole, 4 ind.; 30.09.2004, Limbaži distr., Liepupe, 2 ind.; 13.09.2005, Aizkraukle distr., Taurkalne, 5 ind.; 15.09.2005, Jēkabpils distr., Viesīte, 2 ind.; 11.09.2005, Valka distr., Palsmane, 1 ind.; Mežole, 2 ind.

Family Helicidae

42. *Perforatella bidentata* (Gmelin, 1788)

Silvicolous species. V. cl. Material: 27.06.1995, 19.07.1997, Talsi distr., Slītere, 7 ind.; 25.05.1995, 29.07.1997, Aizkraukle distr., Aizkraukle, 21 ind.; 01.07.1997, Valka distr., Mežole, 13 ind.;

30.09.2004, Limbaži distr., Aloja, 36 ind.;
23.09.2004, Tukums distr., Kaive, 36 ind.;
29.09.2004, Kuldīga distr., Vārme, 7 ind.; Rudbārži,
3 ind.; 23.09.2004, Talsi distr., Talsi, 13 ind.;
17.09.2005, Limbaži distr., Liepupe, 8 ind.;
13.09.2005, Aizkraukle distr., Taurkalne, 15 ind.;
Ērberģe, 5 ind.; 15.09.2005, Jēkabpils distr., Viesīte,
7 ind.; 08.10.2005, Balvi distr., Žīguri, 14 ind.;
11.09.2005, Valka distr., Palsmane, 4 ind.; Mežole,
1 ind.

43. *Cepaea hortensis* (O.F.Müller, 1774)

Silvicolous species. I. cl. Material: 25.05.1995,
Aizkraukle distr., Aizkraukle, 2 ind.; 29.09.2004,
Kuldīga distr., Vārme, 1 ind.; 30.09.2004, Limbaži
distr., Liepupe, 1 ind.; 13.09.2005, Aizkraukle distr.,
Taurkalne, 2 ind.

Characteristics of the snail fauna

In total, 13 650 terrestrial snails were collected in
the alder-woods, representing 43 species of 15
genera. The average number of species per
sampling plot was 16 (range 6-28). Of the 86
terrestrial snail species recorded in Latvia up to
2000, more than 60 were found in forests (Pilāte
2007). As the studies in alder-woods revealed
that half of the total number of Latvian terrestrial
snail species can be found there, these forests
can be regarded as having a very rich snail fauna.

Opinions about diversity of malaco fauna in
wetland forests differ widely. As terrestrial snails
cannot stay in water for a long time, such forests
have been characterized as being poor with
reference to the number of snail species (Učēdēzi
1978). Other studies have shown, however, that
wetland forests are rich in snail species
(Ehnström, Waldén 1986, Niemelä 1997, Pilāte 2000,
Waldén 2001). For instance, studies in wetland
forests and marshes in South and Central Sweden
revealed more than 40 species (Waldén 2001).

Regarding the total number of snail species
found, Latvian alder-woods are comparable to
deciduous forests in an early stage of succession
and of broad-leaved forests (Pilāte 2000).
Sometimes, as few as six species were found in
an alder-wood (this study). Such low numbers of

species could be caused by a lack of saturation
of water in the substratum. Similar results have
been obtained in alder-wood studies in Sweden
(Proschwitz 2006). The same applies to the
indicators of species diversity, which were found
in the lowest numbers in sampling plots
continuously saturated with water.

Characteristics of contents of species

Four ecological groups were represented among
the snail species found in this alder-wood study
- 26 were forest species, 10 wetland species, six
euribiont species and one a steppe species
Vallonia costata. The highest proportions of all
snails found were made up of the forest species
Carychium minimum (15%) and the two euribiont
species *Punctum pygmaeum* (12%) and
Nesovitrea hammonis (10%) (Fig. 2). All three
frequently occurred in the alder-woods. Almost
as abundant as the afore-mentioned were the
three wetland species *Carychium tridentatum*
(8%), *Nesovitrea petronella* (8%) and *Vertigo*
substriata (8%) and the two euribiont species
Euconulus fulvus (8%) and *Cochlicopa lubrica*
(6%). Also the four last-mentioned species
occurred quite often in the alder-woods, but
Carychium tridentatum less frequently.

Nearly half of the species found in alder-woods
in this study (*Arion subfuscus*, *Bradybaena*
fruticum, *Carychium minimum*, *C. tridentatum*,
Cepaea hortensis, *Cochlicopa lubrica*,
Cochlodina laminata, *Euconulus fulvus*,
Nesovitrea hammonis, *Perforatella bidentata*,
Punctum pygmaeum, *Succinea oblonga*, *S.*
putris, *Vallonia coctata*, *Vertigo substriata*,
Vitrea crystallina, *Vitrea pellucida*, *Zonitoides*
nitidus) are found often or quite often in the whole
territory of Latvia, and in various forest habitats
(Rudzīte 1999, Pilāte 2000, 2001, 2003a,b, Pilate,
Greke 2002). In this study, *Carychium minimum*,
Cochlicopa lubrica, *Euconulus fulvus*,
Nesovitrea hammonis, *Perforatella bidentata*,
Punctum pygmaeum, *Vertigo substriata* and
Vitrea crystallina were characterized as being of
occurrence class V, and *Zonitoides nitidus* of
class IV. Other species (*Arion subfuscus*,
Bradybaena fruticum, *Carychium tridentatum*,

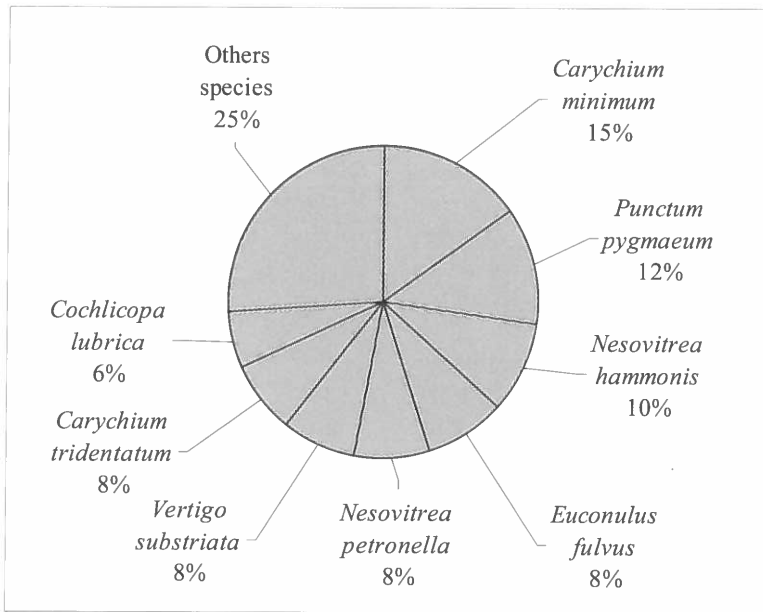


Fig. 2. Community structure of snail species in black alder forests in Latvia. Proportions of terrestrial snail species found in the collected samples (see Material and Methods).

Cepaea hortensis, *Cochlodina laminata*, *Succinea oblonga*, *S. putris*, *Vallonia coctata*, *Vitrina pellucida*) were found more rarely and in lower numbers (occurrence class I-III). *Nesovitrea petronella* is regarded as occasional in Latvia (Rudzīte 1999). In this study, however, this species was of occurrence class V, and it was found in almost every sampled area. Frequent occurrence of this species, as well as of other species mentioned above, in wetland deciduous forests and also in other types of forest habitats has been pointed out earlier (Pilāte 2000, 2001, Waldén 2001, Proschwitz 2006).

Of other species found in alder-woods, *Acicula polita*, *Aegopinella nitidula*, *Bulgarica cana*, *Clausilia bidentata*, *C. cruciata*, *C. dubia*, *C. pumila*, *Cochlicopa nitens*, *Macrogastra latestriata*, *Malacolimax tenellus*, *Oxychilus alliarius* and *Ruthenica filigrana* are rare in Latvia, while *Acanthinula aculeata*, *Aegopinella pura*, *Columella aspera*, *Discus ruderatus*, *Macrogastra ventricosa*, *M. plicatula*, *Limax cinereoniger*, *Vertigo antivertigo* and *V. pusilla*

are occasional (Spuris 1998, Rudzīte 1999). Of these species, *Columella aspera* and *Discus ruderatus* were of occurrence class IV, *Vertigo pusilla* of class III, while all the others were of class I-II in the alder-woods (this study). The three species being of an occurrence class higher than I-II are often found in other Latvian forest habitats as well (Pilāte 2000, 2001, 2003a,b, Pilāte, Greke 2002).

Up to 1998, there was only one record in Latvia, by then more than 50 years old, of the species *Vertigo lilljeborge* (Rudzīte 1999). In 1999, the species was found in Salaspils (Stalažs 2000). During the studies in alder-woods the species was found in five places (Pilāte 2007).

Protected and endangered terrestrial snail species

Out of 21 terrestrial snail species protected in Latvia, 10 were recorded in this study (*Acicula polita*, *Bulgarica cana*, *Clausilia bidentata*, *Clausilia dubia*, *Clausilia cruciata*, *Clausilia*

pumila, *Cochlicopa nitens*, *Limax cinereoniger*, *Macrogastrea latestriata*, *Ruthenica filograna*). For two of these, *Clausilia cruciata* and *Macrogastrea latestriata*, micro-reserves have to be created (Latvijas Republikas Ministru kabinets, 1999, 2000, 2004). One of four species included in Annex II of the EU Habitats and Species Directive was found. For this species, *Vertigo moulinsiana*, a protected area should be set up. The very first time this species was found in a Latvian alder-wood was in 1997 (Pilāte 2004). Occurrence in Latvia of this species had already been considered possible however (Rudzīte 1999). For the time being, another three records of this species exist, all of them made in alder-woods (Pilāte 2007). It is a species of wetland habitats and more characteristic to fens (Kerney et al. 1983), often found at banks of water bodies, in stands of *Glyceria maxima* and *Phragmites australis*, and more rarely in wetlands forests, including alder quagmires (Pokryszko 1990, Killeen 2003).

Out of 20 terrestrial snail species included in the Latvian Red Data Book (Spuris 1998), 10 were found (*Acicula polita*, *Aegopinella nitidula*, *Bulgarica cana*, *Clausilia bidentata*, *Clausilia dubia*, *Clausilia cruciata*, *Clausilia pumila*, *Cochlicopa nitens*, *Cochlodina orthostoma*, *Ruthenica filograna*).

All protected and endangered snail species recorded in this study, most frequently occur in moderately wet deciduous forests and in mixed spruce forests in Latvia (Rudzīte 1999; Pilāte 2004, 2007, Pilāte, Rudzīte 2007). *Cochlicopa nitens* is an exception, as it can also be found in wetland forests, most often in alder-woods (Pilāte 2007).

CONCLUSIONS

In this alder-wood study, 43 terrestrial snail species were found, which makes up a half of all known terrestrial snail species in Latvia. Therefore, in respect of snail fauna, these forests can be regarded as very rich. Alder-woods are of that reason crucial for the maintenance of the diversity of snail fauna in forests in general.

Typical alder-wood species, the most frequently found snail species in these woods, were *Carychium minimum*, *Cochlicopa lubrica*, *Columella aspera*, *Discus ruderatus*, *Euconulus fulvus*, *Nesovitrea hammonis*, *N. petronella*, *Perforatella bidentata*, *Punctum pygmaeum*, *Vertigo substriata*, *Vitrea crystallina* and *Zonitoides nitidus*).

Alder-woods are also important as they house half of all snail species that are protected and endangered in Latvia. They are of great importance for *Vertigo moulinsiana*, a species that is very rare in Latvia, and which is listed in Annex II of the EU Habitats and Species Directive. In Latvia, this species has hitherto only been recorded in alder-woods.

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REFERENCES

- Dunger W., Fiedler H.I. (Hrsg). 1997. Methoden der Bodenbiologie. 2., neubearbeitete Auflage. G. Fischer, Jena, Stuttgart, Lübeck, Ulm: ss. 430-433.
- Ehnström B., Waldén W. H. 1986. Faunavård i skogsbruket. - Del 2. Den lägre faunan. Skogsstyrelsen, Jönköping: 352 p.
- European Communities. 1992. Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora. – Official

- Journal of the European Communities L 206: 750p.
- Kabucis I. (red.) 2000. Biotopu rokasgrāmata. Eiropas Savienības aizsargājami biotopi Latvijā. Rīga: 160 lpp. (In Latvian)
- Kerney M. P., Cameron R. A. D., Jungbluth J. H. 1983. Die Landschnecken Nord- und Mitteleuropas. Hamburg, Berlin, Paul Parey: 384S.
- Killeen I.J. 2003. Ecology of Desmoulin's Whorl Snail. Conserving Natura 2000 Rivers Ecology Series No.6. English Nature, Peterborough: pp. 1-23.
- Latvijas Republikas Ministru kabinets. 2000. Noteikumi par īpaši aizsargājamo sugu un ierobežoti izmantojamo sugu sarakstu (2000. gada 14. novembra noteikumi Nr. 396, I. pielikums ar 20.11.2004. grozījumiem) (Regulations issued by the Cabinet of Ministers, Republic of Latvia 2000, 2004).
- Latvijas Republikas Ministru kabinets. 1999. Noteikumi par dabas liegumiem (1999. gada 15. jūnija noteikumi Nr. 212. ar 20.11.2004. grozījumiem) (Regulations issued by the Cabinet of Ministers, Republic of Latvia 1999, 2004).
- Niemelä J. 1997. Invertebrates and Boreal Forest Management. – Conservation Biology, vol. 11 (3): pp. 601-610.
- Pfleger V. 1984. Weichtiere. Prag: Artia, 192 S.
- Pilāte D. 2000. Sauszemes gliemežu ekoloģijas pētījumi Latvijas mežos (Ecological research of terrestrial snails in forests of Latvia). Research of nature, 1, (1): pp. 9-18. (In Latvian; abstract in English)
- Pilāte D. 2001. Fauna of terrestrial molluscs in coniferous forests of Latvia. – Acta Biol. Univ. Daugavp., 1, (1): pp. 34-37.
- Pilāte D. 2003a. Sauszemes gliemežu fauna Slīteres nacionālā parka meža biotopos (Fauna of terrestrial molluscs in forests of Slītere National Park). – Daba un Muzejs, 8: pp. 75-81. (In Latvian; abstract in English)
- Pilāte D. 2003b. Fauna of terrestrial molluscs in the forests of Gauja National Park. – Acta Biol. Univ. Daugavp., 3, (1): pp. 15-20.
- Pilāte D. 2004. *Vertigo moulinsiana* (Dupuy, 1849) (Gastropoda: Pulmonata) in Latvia. – Acta Universitatis Latviensis, Biology, 2004, Vol.676: pp. 127-129.
- Pilāte D. 2007. New Data of Protected, Endangered and Rare Terrestrial Snail Species in Latvia. Cross-Border Cooperation in Researches of Biological Diversity (Barševskis A. & Šaulienē I. ed.), Acta Biol. Univ. Daugavp., Suppl. 1: pp. 75-80.
- Pilāte D., Greke C. 2002. Die Mollusken des Slītere-Nationalparks und angrenzender Gebiete (Nordwest-Lettland). – Malak. Abh. Mus. Tierkde. Dresden 20, Nr. 30.: Ss. 283-293.
- Pilāte D., Rudzīte M. 2007. Gliemji (Molluscs). – Biodiversity in Gauja National Park (V. Pilāts ed.). Sigulda, Gauja National Park Administration: pp. 184-188. (In Latvian; abstract in English)
- Pokryszko B.M. 1990. The Vertiginidae of Poland (Gastropoda: Pulmonata: Pupilloidea) – a systematic monograph. – Annales Zoologici, Tom 43, Nr 8: pp. 134-255.
- Priedītis N. 1999. Latvian forest: nature and diversity. Rīga: WWF: p. 209.
- Proschwitz T. 2006. Land- och sötvattenslevande mollusker i alkärren vid Överjärva (Solna kommun) och Bergendal (Sollentuna kommun) (Stockholms län) 2004 (Land and freshwater molluscs in the alder swamps at "Överjärva" (municipality Solna) and

- “Bergendal” (municipality Sollentuna) – province of Stockholms län, E.Swededen). – Medden landen från Göteborgs Naturhistoriska Museum: Nr 18: pp.1-17. (In Swedish; abstract in English)
- Rudzīte M. 1999. Latvijas zemesgliemeži. Rīga: Gandrs: 147 lpp.
- Schwerdtfeger F. 1975. Synökologie. Hamburg, Parey: 451 S.
- Spuris Z. (ed.) 1998. Red data book of Latvia – rare and treated species of plants and animals, Vol. 4, Rīga: 388 lpp.
- Stalažs A. 2000. Jaunas reto gliemju sugu atradnes Latvijā (New data of rare mollusc species in Latvia). – Research of nature, 1, (1): pp. 21. (In Latvian; abstract in English)
- Suško U. 1998. Natural forests of Latvia. A study on biodiversity structures, dependent species and forest history. – Rīga, WWF: 186p.
- Tischler W. 1979. Einführung in die Ökologie. Stuttgart, G. Fischer, 2. Aufl.: 306 S.
- Valovirta, I. 1996. Land mollusc monitoring scheme: a handbook for field and laboratory methods. Finnish Environmental Institute/ Nordic Council of Ministers, Helsinki.
- Waldén H. W. 2001. Landmolluskfaunans ekologi i sump- och myrskogar i mellersta Norrland, med jämförelser beträffande förhållandena i södra Sverige (Studies on the ecology of terrestrial molluscs in swampy woods and mires in Sweden, with special reference on soil chemistry and preservation value of the habitats). – Rapport Nr 1/01, Jönköping: p 47. (In Swedish; abstract in English)
- Ёихарев И. М. 1962. Клаузилииды (Clausiliidae). Фауна СССР. Моллюски. Т. III, вып. 4. Москва, Ленинград: Академия наук СССР: 317 стр.
- Шилейко А. А. 1978. Наземные моллюски надсемейства Helicoidea. Фауна СССР. Моллюски. Т. III, вып. 6., Ленинград: Наука: 384 стр.

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GENUS *ACER* L. IN LATVIA

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Evarts-Bunders P., Svilāns A., Bice M. 2008. Genus *Acer* L. in Latvia. *Acta Biol. Univ. Daugavp.*, 8 (1): 127 - 132.

In the researches of genus *Acer* data about distribution of cultivated taxa of genus *Acer* in Latvia, as well as analysis of winter hardiness and evaluation of species invasivity have been collected. During the researches in the territory of Latvia 112 taxa of genus *Acer* were identified: 42 species, 8 subspecies, 9 varieties, 3 hybridogenous species, 1 forma and 49 cultivars.

Keywords: *Acer*, arboreal taxa, invasive species, winter hardiness, Latvia

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INTRODUCTION

Acer holds significant place among the largest and most important arboreal genera. Its significance in both ornamental and economic uses is matched by its taxonomical complexity. Genus *Acer* includes 124 species, as well as more than 100 intraspecific taxa – subspecies, varieties and forms (Gelderen e.o.1994).

In Latvia, only Norway maple (*Acer platanoides* L.) is growing naturally, whose number was the highest about 5000 years ago at the end of the Atlantic climatic period. During the last 1500 years area of distribution is noticeably decreased due to the development of agriculture and deforestation.

Today, Norway maple is a minority tree species growing naturally on well – drained rich soils together with ash (*Fraxinus excelsior*), wych-elm (*Ulmus glabra*) and small-leaver lime (*Tilia*

cordata). In such broad-leaved forests Norway maple can form till 20 % from all tree layer structure.

Norway maple is often planted in old Latvian parks, gardens and artificial dendrological plantations. Parameter for monumental tree status for Norway maple in Latvia is circumference of 3,5 m. Largest maple-tree in Latvia is known from Trikāta municipality in Valka district with trunk perimeter of 5,82 m.

First data about maple introduction recorded since 1805 (Friebe 1905). At this time first landscape parks were planted widely in Latvia, and Norway maple was often planted there. So, during plantation of Vērmanes Park at 1816, the main role was given to maples.

Aceraceae family is a not popular research object till nowadays, there are only few information sources on the introduction of foreign species

of maple in Latvia. First introduced experience was carried out by plant nursery owner J. Cigra (Cigra 1803). Already in 1803 he was offered 6 different maple taxa (5 of them are introduced), but some years later, in plant catalogue from 1817, 1819 and 1820 – 11 taxa was offered: *A. campestre*, *A. campestre* f. *variegata* hort (?), *A. monspessulanum*, *A. negundo*, *A. platanoides* f. *variegatis* hort. (?), *A. platanoides* 'Laciniatum', *A. pseudoplatanus*, *A. saccharinum*, *A. tataricum*, *A. pennsylvanicum* and *A. opulifolium*. By the data of J. Klinge (Klinge 1883), 35 taxa of maples (19 species and 16 cultivated forms) grew in territory of Latvia in the 19th century: *Acer campestre* L., *A. campestre* 'Pulverlentum' *A. colchicum* Booth ex Gordon, *A. ginnala*, *A. lobelii* Tenore, *A. macrophyllum*, *A. mono*, *A. monspessulanum*, *A. negundo*, *A. negundo* 'Variegatum', *A. opalus*, *A. pennsylvanicum*, *A. pictum*, *A. platanoides*, *A. platanoides* 'Cucullatum', *A. platanoides* 'Dissectum' *A. platanoides* 'Globosum', *A. platanoides* 'Laciniatum', *A. platanoides* 'Lorbergi' *A. platanoides* 'Purpureum', *A. platanoides* 'Reitenbachii', *A. platanoides* 'Schwedleri', *A. pseudoplatanus*, *A. pseudoplatanus* 'Laciniatum' *A. pseudoplatanus* 'Leopoldii', *A. pseudoplatanus* 'Purpurascens', *A. pseudoplatanus* f. *variegatum* (Weston) Rehder, *A. pseudoplatanus* 'Worley', *A. rubrum*, *A. saccharinum*, *A. saccharum*, *A. spicatum*, *A. tataricum* and *A. tementosum*.

The last comprehensive work in this field was carried out by L. Zariņš (Zariņš 1959). According to this investigation, 15 species and 18 cultivars were growing in the territory of Latvia at this time. The decrease of number of species can be explained by several extremely cold winters – in years 1939/40, 1940/41, 1955/56, as well as by ravage caused by two World Wars in the territory of the state. At that time various taxa of genus *Acer* can be traced in the western part of Latvia. The objects rich in maple species – parks and arboretums in Kazdanga, Skrīveri, Liepāja, Aizvīķi, Ķemeri, Tērvete and Krāslava, as well as the Botanical Garden of the University of Latvia in Riga. At that time 4 foreign maple species are considered to be conventional – *A.*

pseudoplatanus, *A. tataricum*, *A. negundo* and *A. saccharinum*.

In 1956 a botanical garden was founded in Salaspils (At present - National Botanical garden). During the fifty years of existence there have been done attempts to introduce more than 50 foreign maple species as well as number of intraspecific taxa. Many taxa of genus *Acer* still grow only in the arboretum of National Botanical garden.

Similar researches have been done also in Estonia. During period of 1961 – 1996, the dendroflora of 1300 parks and gardens all over Estonia were studied (in the 1960's and the 1980's), resulting in the identification of 56 taxa. (Elliku, Tamm 1997).

MATERIAL AND METHODS

The present paper is the analysis of systematic diversity, plant invasivity and winter hardiness of genus *Acer* in Latvia. Investigation has been made mainly on the basis of the live plant collection analysis in the National Botanical garden in Salaspils and the Kalsnava arboretum as well as data base of introduced dendroflora, which was collected by dendrologists of National Botanical garden in 1974–1999. During that time, the dendroflora of more than 4000 parks, gardens, dendrological plantations and other objects all over Latvia were carefully studied.

Winter hardiness of arboreal taxa was estimated during last 5 years by the modified scale of S. Y. Sokolov (Cinovskis 1987):

- I. Plants are winter-hardy, no damages.
- II. Branches are damaged.
 - II₁ Tips of the last year branches or only buds are damaged.
 - II₂ The last year branches are damaged in full length.
 - II₃ Twigs of the last two years are damaged.
 - II₄ Twigs of the last three years are damaged.

III Trunks are damaged or plants are destroyed by frost.

III₁ Trunks are damaged down to the snow level.

III₂ Trunks are damaged till the root collar, but plants recreate successfully by sprouting.

III₃ Plants are destroyed.

I-II_{3 - first} number (I) shows winter hardiness in western regions of Latvia, other (II₃) – winter hardiness in eastern regions of Latvia.

Analysis and classification of peregrine taxa according to their invasion abilities developed by A. Svilāns (Svilāns 2003) was used for the classification of the invasive species.

1st level: **Naturalized peregrine taxa** – taxa, whose distribution (invasion) has subsided (become stable) in the territory of Latvia; as well as taxa, which are to be exterminated, consumption of resources is needed for this reason and the negative consequences of the extermination are incommensurable wider than the damages done by these taxa to the environment. This group includes both archeophytes and neophytes.

2nd level: **Aggressive peregrine taxa** – taxa, whose distribution (invasion) speed or amount (in country, any region or habitat type) creates direct and obvious danger to environment. The interference is needed for the prevention of the invasion.

3rd level: **Temperate invasive peregrine taxa** – taxa, which have caused clear tendencies of distribution (invasion), but the dormant danger to the environment is unknown. Constant monitoring is needed.

4th level: **Little invasive peregrine taxa** – taxa, which do not distribute or distribute very rarely. Periodic monitoring is needed.

RESULTS

During the researches in Latvia 112 taxa of genus *Acer* were identified: 42 species, 8 subspecies, 9 varieties, 3 hybridogenous species, 1 forma and 49 cultivars. In the given list of defined cultivated maple taxa number of deposits in the state (for very rare taxa concrete location is given as well), winter hardiness as well as level of invasivity is indicated. In recent years many decorative species have been widely planted in private household lots and collections; however survey of such private collections has not been done due to various grounded reasons.

It must be noted that in National Botanical garden separate most valuable and less winter hardy decorative maple species are being covered in winter, especially it is observed with *Acer palmatum* species. In this case winter hardiness for this taxa is weaker that indicated in the list.

LIST OF CULTIVATED TAXA OF GENUS ACER IN LATVIA

1. *Acer barbinerve* Maxim. Species was found in 9 localities. I-II₃, 4th level of invasion.
2. *Acer campestre* L. 70. I-II₃, 4th level of invasion.
3. *Acer campestre* L. f. *suberosum* (Dumort.) Cin. 3. I-II₃, 4th level of invasion.
4. *Acer campestre* L. subsp. *leiocarpon* (Wallr.) Pax HBN III₃, 4th level of invasion.
5. *Acer campestre* 'Postelense' HBN (Hortus Botanicus Nationalis or National Botanical garden, Salaspils), Private collections. No data about winter resistance, 4th level of invasion.
6. *Acer campestre*. 'Nanum' Jčkabpils. No data about winter resistance. 4th level of invasion.
7. *Acer capillipes* Maxim. HBN. III₃, 4th level of invasion.
8. *Acer cappadocicum* Gled. HBN, Lâèupe. II₁, 4th level of invasion.

9. *Acer circinatum* Pursh 9. II₃-III₁, 4th level of invasion.
10. *Acer cissifolium* (Siebold & Zucc.) K.Koch HBN, Kalsnava, Jaunbrēdīi. I-II₂, 4th level of invasion.
11. *Acer x coriaceum* Bosc ex Tausch (*A. monspessulanum* x *A. opalus*) HBN. III₁, 4th level of invasion.
12. *Acer diabolicum* Blume ex K.Koch HBN. No data about winter resistance, 4th level of invasion.
13. *Acer divergens* Pax HBN. I, 4th level of invasion.
14. *Acer ginnala* Maxim. Often planted (244). I, 3th - 4th level of invasion.
15. *Acer ginnala* Maxim. var. *aidzuense* (Franch.) Pax HBN, Katlakalns. I, 4th level of invasion.
16. *Acer ginnala* x *A. tataricum* Widely cultivated. I, 3th - 4th level of invasion.
17. *Acer glabrum* Torr. 6. I-II₁, 4th level of invasion
18. *Acer glabrum* Torr. var. *douglasii* (Hook.) Dippel HBN. I, 4th level of invasion
19. *Acer griseum* (Franch.) Pax HBN. III₃, 4th level of invasion
20. *Acer henryi* Pax HBN, Kalsnava, Dobele. II₃-III₃, 4th level of invasion
21. *Acer japonicum* Thunb. ex A. Murray HBN. II₃-III₂, 4th level of invasion
22. *Acer japonicum* 'Aconitifolium' HBN. III₁, 4th level of invasion
23. *Acer japonicum* 'Vitifolium' HBN. III₁, 4th level of invasion
24. *Acer lobelii* Ten. HBN, Ādapi. II₂, 4th level of invasion
25. *Acer longipes* Franch. ex Rehder subsp. *amplum* (Rehder) De Jong HBN. No data about winter resistance, 4th level of invasion
26. *Acer macrophyllum* Pursh HBN, HBU (Hortus Botanicus Universitatis Latviensis, Riga). II₂, 4th level of invasion
27. *Acer mandshuricum* Maxim. 6. I, 4th level of invasion
28. *Acer maximowiczianum* Miq. HBN. No data, 4th level of invasion
29. *Acer miyabei* Maxim. HBN, Kalsnava. I, 4th level of invasion
30. *Acer mono* Maxim. 12. I-II₁, 4th level of invasion
31. *Acer mono* Maxim. var. *marmoratum* (Nicholson) Kitam. HBN. No data, 4th level of invasion
32. *Acer mono* Maxim. var. *mayrii* (Schwerin) Nakai 5. I, 4th level of invasion
33. *Acer monspessulanum* L. HBN, Katlakalns, Lçdurga. II₂-II₃, 4th level of invasion
34. *Acer monspessulanum* L. subsp. *ibericum* (M.Bieb.) Yaltirik HBN. II₃-III₁, 4th level of invasion
35. *Acer negundo* L. Widely cultivated. I-II₃, 1th - 2th level of invasion
36. *Acer negundo* L. subsp. *californicum* (Torr. & A.Gray) Wesm. HBN, Aizupe, Lâeupe. I, 4th level of invasion
37. *Acer negundo* L. var. *interius* (Britton) Sarg. HBN, Lçdurga, Kazdanga. I, 4th level of invasion.
38. *Acer negundo* L. var. *pseudo-californicum* Schwer. 6. I, 4th level of invasion
39. *Acer negundo* L. var. *violaceum* (Kirchn.) Jaeger Bauska, Kalsnava. I-II₂, 1th - 2th level of invasion
40. *Acer negundo*. 'Auratum' Kalsnava, Lçdurga, Private collections. No data about winter resistance, 4th level of invasion
41. *Acer negundo*. 'Aureo-marginatum' Private collections. No data about winter resistance, 4th level of invasion
42. *Acer negundo*. 'Elegans' Private collections. No data about winter resistance.
43. *Acer negundo*. 'Fastigiatum' Kalsnava. No data about winter resistance. 4th level of invasion.
44. *Acer negundo*. 'Flamingo' Kalsnava, Private collections No data about winter resistance. 4th level of invasion
45. *Acer negundo*. 'Odessanum' Private collections. II₃, 4th level of invasion
46. *Acer negundo*. 'Salaspils' HBN, Kalsnava. I- II₂, 4th level of invasion
47. *Acer negundo*. 'Variegatum' HBN, Kalsnava, Private collections. II₁-II₃, 4th level of invasion

48. *Acer negundo* x *A. platanoides* HBN. I, 4th level of invasion.
49. *Acer opalus* Mill. HBN, Lçdurga. III₁, 4th level of invasion.
50. *Acer opalus* Mill. subsp. *obtusatum* (Willd.) Gams. Lçdurga. III₁, 4th level of invasion
51. *Acer palmatum* Thunb. ex A. Murray 5. II₁-III₁, 4th level of invasion
52. *Acer palmatum* 'Atropurpureum' HBN, Private collections. 4th level of invasion
53. *Acer palmatum* 'Dissectum' HBN, Katlakalns, Private collections. 4th level of invasion.
54. *Acer palmatum* 'Elegans' Private collections. 4th level of invasion.
55. *Acer palmatum* 'Satsuki-beni' HBN, 4th level of invasion.
56. *Acer palmatum* Thunb. ex A. Murray var. *amoenum* (Carriere) Hara HBN. II₁, 4th level of invasion.
57. *Acer pensylvanicum* L. HBN, Kalsnava, Baltezers, Salacgrîva. II₁, 4th level of invasion.
58. *Acer pensylvanicum*. 'Erythrocladum' Kalsnava. II₂, 4th level of invasion.
59. *Acer platanoides* L. Common I
60. *Acer platanoides*. 'Crimson King' 10. I, No data about genetic erosion risk of local *Acer* population.
61. *Acer platanoides*. 'Cucullatum' HBN. Kalsnava, Liepâja. II₁, No data about genetical erosion risk of local *Acer* population.
62. *Acer platanoides*. 'Deborah' HBN. Private collections. No data about genetic erosion risk of local *Acer* population.
63. *Acer platanoides*. 'Dissectum' 3. I, No data about genetic erosion risk of local *Acer* population.
64. *Acer platanoides*. 'Drummondii' 7. I-II₂, No data about genetic erosion risk of local *Acer* population.
65. *Acer platanoides*. 'Faassen's Black' Private collections. No data about genetical erosion risk of local *Acer* population.
66. *Acer platanoides*. 'Globosum' 5. I-II₂, No data about genetic erosion risk of local *Acer* population.
67. *Acer platanoides*. 'Golden Globe' Private collections. No data about genetic erosion risk of local *Acer* population.
68. *Acer platanoides*. 'Laciniatum' Kalsnava. II₃, No data about genetic erosion risk of local *Acer* population.
69. *Acer platanoides*. 'Nizetti' Private collections. No data about genetic erosion risk of local *Acer* population.
70. *Acer platanoides* 'Paldiskii' HBN. I.
71. *Acer platanoides*. 'Palmitifidum' 5 I-II₁, No data about genetic erosion risk of local *Acer* population.
72. *Acer platanoides*. 'Pictum' Private collections. I, No data about genetic erosion risk of local *Acer* population.
73. *Acer platanoides*. 'Reitenbachii' HBN, Kalsnava. I, No data about genetic erosion risk of local *Acer* population.
74. *Acer platanoides*. 'Royal Red' HBN, Kalsnava, Private collections. I, No data about genetical erosion risk of local *Acer* population.
75. *Acer platanoides*. 'Rubrum' 35. I-II₁, No data about genetic erosion risk of local *Acer* population.
76. *Acer platanoides*. 'Schwedleri' 144. I, 3th level of invasion.
77. *Acer platanoides*. 'Stollii' 7. I, No data about genetic erosion risk of local *Acer* population.
78. *Acer platanoides*. 'Tharandtensis' HBN, Kalsnava. I, No data about genetic erosion risk of local *Acer* population.
79. *Acer platanoides*. 'Undulatum' Liepâja. I, No data about genetic erosion risk of local *Acer* population.
80. *Acer platanoides* 'Waldereeii' HBN, Kalsnava. II₃, No data about genetic erosion risk of local *Acer* population.
81. *Acer pseudoplatanus* L. 208. I-II₁₋₃, 2th-3th level of invasion.
82. *Acer pseudoplatanus*. 'Brilliantissimum', Private collections. No data about winter resistance. 4th level of invasion.
83. *Acer pseudoplatanus*. 'Leopoldii' HBU. 4th level of invasion.
84. *Acer pseudoplatanus*. 'Purpurascens' 97. I-III₁, 2th-3th level of invasion.

85. *Acer pseudoplatanus*. 'Trilobatum' 4, 4th level of invasion.
86. *Acer pseudoplatanus*. 'Variegatum' 26. I-III₁, 4th level of invasion.
87. *Acer pseudoplatanus*. 'Worley' HBN, Jaunbrēdīi. II₃, 4th level of invasion.
88. *Acer pseudosieboldianum* (Pax) Kom. 15. I-II₂, 3th - 4th level of invasion.
89. *Acer regelii* Pax HBN, Baltezers. III₄, 4th level of invasion.
90. *Acer rubrum* L. 19. I-II₂, 4th level of invasion.
91. *Acer rufinerve* Siebold & Zucc. HBU. I-II₁, 4th level of invasion.
92. *Acer saccharinum* L. 63 I, 4th level of invasion.
93. *Acer saccharinum*. 'Lutescens' HBN, Kalsnava. I, 4th level of invasion.
94. *Acer saccharinum*. 'Nana' Kalsnava. 4th level of invasion.
95. *Acer saccharinum*. 'Pyramidalis' HBN, Kalsnava. I, 4th level of invasion.
96. *Acer saccharinum*. 'Tripartitum' Lčdurga. I, 4th level of invasion.
97. *Acer saccharinum*. 'Wieri' 17. I, 4th level of invasion.
98. *Acer saccharum* Marshall 9. I, 4th level of invasion.
99. *Acer shirasawanum* Koidz. var. *tenuifolium* Koidz. HBN III₁, 4th level of invasion.
100. *Acer sieboldianum* Miq. HBN. No data about winter resistance, 4th level of invasion.
101. *Acer spicatum* Lam. 9. I, 4th level of invasion.
102. *Acer stachyophyllum* Hiern subsp. *betulifolium* (Maxim.) P.C.DeJong HBN. II₃-III₁, 4th level of invasion.
103. *Acer tataricum* L. 147. I, 4th level of invasion.
104. *Acer tataricum* L subsp. *semenovii* (Reg. & Herd.) E. Murray 4. I-II₂, 4th level of invasion.
105. *Acer tegmentosum* Maxim. 12. I-II₃, 3th - 4th level of invasion.
106. *Acer trautvetteri* Medw. 5. II₂, 4th level of invasion.
107. *Acer triflorum* Komar. HBN. II₃, 4th level of invasion.
108. *Acer truncatum* Bunge Lâeupe. II₄, 4th level of invasion.
109. *Acer tschonoskii* Maxim. HBN, Dimzas, Lâeupe. I, 4th level of invasion.
110. *Acer tschonoskii* Maxim. subsp. *komarovii* (Pojark). Urossov & Naduluzhko HBN, Kalsnava. II₂, 4th level of invasion.
111. *Acer ukurunduense* Trautv. & C.A.Mey. HBN, Lâeupe, Private collections. II₂-II₃, 4th level of invasion.
112. *Acer velutinum* Boiss. HBN. II₃, 4th level of invasion.

REFERENCES

- Cigra J. E. 1803. Tas Āboludārznieks. – Rīga.
- Cinovskis R. 1987. Botaničeskije sady Pribaltiki. Zimostoikost' derevjev i kustarnikov v 1978/79. g. – Rīga: 248 p.
- Elliku J., Tamm H. 1997. Genus *Acer* in Estonia. – In: Baltic botanic gardens in 1996. Estonia, Latvia, Lithuania. – Rīga: 2: 39 – 46.
- Friebe W. 1805. Flora für Liefland, Ehistland und Kurland. – Rīga: Hartmann Buchhandlung, s. 26 – 32, 335.
- Gelderens D. M., Jong P. C., Oterdoom H. J. 1994. Maples of the World – Portland: Timberpress.
- Klinge J. 1883. Holzgewächse von Est-, Liv- und Curland. – Dorpat: Verlag von C. Mattiesen, 290 s.
- Svilāns A. 2003. Invazīvie citzemju taksoni Latvijā. – In: Latvijas veģetācija. 7: 95 – 104.
- Zariņš L. 1959. Latvijas PSR sastopamo kļavu sugu izplatība un piemērotība vietējiem apstākļiem. – In: Daiļdārzniecība 1: 119 – 134.

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PHENOLOGY OF HERBACEOUS VEGETATION IN DECIDUOUS FOREST OF KAMSA BOTANICAL – ZOOLOGICAL RESERVE, LITHUANIA

Jolita Abraitienė, Vitas Marozas

Abraitienė J., Marozas V. 2007. Phenology of herbaceous vegetation in deciduous forest of Kamsa botanical-zoological reserve, Lithuania. *Acta Biol. Univ. Daugavp.*, 8(1): 133 - 138.

The development of plants depends on dynamic of temperature, moisture and the length of the day during the year. This phenomenon is very clear in the deciduous forests. The aim of this work was to determine seasonal dynamic of herbaceous vegetation in the deciduous forests of Kamsa botanical - zoological reserve in 2006 year. Investigations were done during vegetation period of 2006 year. The dates of phenological appearance and projection cover were recorded. The spectra of vegetation and flowering were made. Data on temperature and precipitation were analyzed with the purpose to determinate the influence of microclimatic conditions on plants growth and development. It was determined, that projection cover of the plants changed during the vegetation period. The highest projection cover of the ephemeroids *Anemone ranunculoides*, *Anemone nemorosa*, *Corydalis solida*, *Ficaria verna* was in spring. *Mercurialis perennis*, *Polygonatum multiflorum*, *Aegopodium podagraria*, *Pulmonaria obscura*, *Stachys sylvatica* had the highest projection cover in summer. The April of 2006 was cold, so plant species began flowering a week later than usually. The flowering of the herbaceous species in the forest depended on a tree foliation. The most plant species flowered in spring, when trees were still without leaves. Only in this period ephemeroids were flowering in the deciduous forest. The time and length of plant flowering and vegetation depended on the sum of active temperatures. In 2006 the sum of active temperatures in vegetation period (from the end of April till the middle of October) was higher than average, consequently, the development of plant species was faster and phenological phases were shorter.

Keywords: ephemeroids, deciduous forest, herbaceous vegetation, seasonal dynamics.

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INTRODUCTION

Seasonal variety of vegetation is one of the most important ecological adaptations, which is

common in the middle latitude vegetation. This phenomenon is particularly clear in board-leaved forests. Spring ephemeroids (short time vegetation plants) flowering in the period starting

from snow melting till leaves on trees foliate, when lot of light reach the ground. During summer time efemeroids are replaced by species which like warm conditions, are heliophobic, have long vegetation. During majority of vegetation season such plants dominate in forest herbaceous cover.

Plants adopt to live in certain environment conditions. Plants are dependent on seasonal environment conditions: temperature, moisture and the length of the day variation. Variation of climatic conditions (light, temperature, moisture) thought the year influence the growth of plans and development periodicity. All plant species individually adapt to climate periodical variation and develop their own optimal time of a year.

Phenology of broad-leaved forest has been studied in Russia, Poland, Germany, USA (Gorishina, 1969; Falinska, 1986; Ellenberg, 1979; Fred&Taylor, 1974). The biggest focus of vegetation scientists in Lithuania has been turned to studies of seasonal dynamic of meadow plants community (Natkevicaite-Ivanauskiene, 1983). Broad-leaved forests seasonal vegetation dynamic has been studied little. Purvinas and other (Purvinas et al., 1991, 1996) studied ecological factors and seasonal dynamics of *Corydalis cava* L. in Kamša reserve.

The aim of this work was to determine seasonal dynamic of herbaceous vegetation in the deciduous forests in Kamsa botanical - zoological reserve in the 2006 year.

MATERIALS AND METHODS

The object of the work was broad-leaved forest in Kamša zoological-botanical reserve. Kamša reserve is located in North-east part of the middle Europe. Reserve fell in the mixed forests zone and belongs to the East Europe plain west side part (Basalykas, 1965).

Climate conditions are suboceanic. It is common mild winters and chilly summers, variable weather, long year seasons alternation periods, warmer autumn then spring weather. Average annual

temperature is 6.2°C, average annual precipitation is 612mm. The majority of precipitation is during warm year period.

In Kamsa reserve broad-leaved trees dominate: lime, hornbeam, maple, oak. Spruce grow alone or in a small groups (Navasaitis, Rudzeviciene, 1993). According data of Venckus and Lekavičius during 1973 - 1975 years in reserve 432 plant species were present: 18 species of trees, 30 species of shrubs and 384 species of herbs (Venckus, Lekavičius, 1976).

The investigations were performed in the 90 years old forest which is typical for Kamsa reserve. The trees of *Tilia cordata* Mill., *Acer platanoides* L., *Fraxinus excelsior* L., *Ulmus glabra* Huds., *Quercus robur* L. and shrubs of *Lonicera xylosteum* L., *Padus avium* Mill., *Euonymus verrucosus* Scop., *Corylus avellana* L. dominated in the site.

Investigations were done during vegetation period of 2006 year. The dates of phenological appearance (tree and shrub foliation, flowering of herbaceous plants) and projection cover of herbaceous vegetation were recorded. Phenological changes were registered each week. The spectra of vegetation and flowering were made. Data on temperature and precipitation were analysed with the purpose to determinate the influence of microclimatic conditions on plants growth and development. We used data on temperature and precipitation form Kaunas meteorological station, which is situated near the study location (about 2 km).

RESULTS AND DISCUSSION

The changes of plant species projection cover during vegetation period of 2006 year is presented in figure 1. At the beginning of April winter-green plants - *Hepatica nobilis* Mill. and *Asarum europaeum* L. started to vegetate. Vegetation of efemeroids such as *Anemone nemorosa* L., *Anemone ranunculoides* L., *Corydalis solida* (L.) Clairv. and *Ficaria verna* Huds also started. The

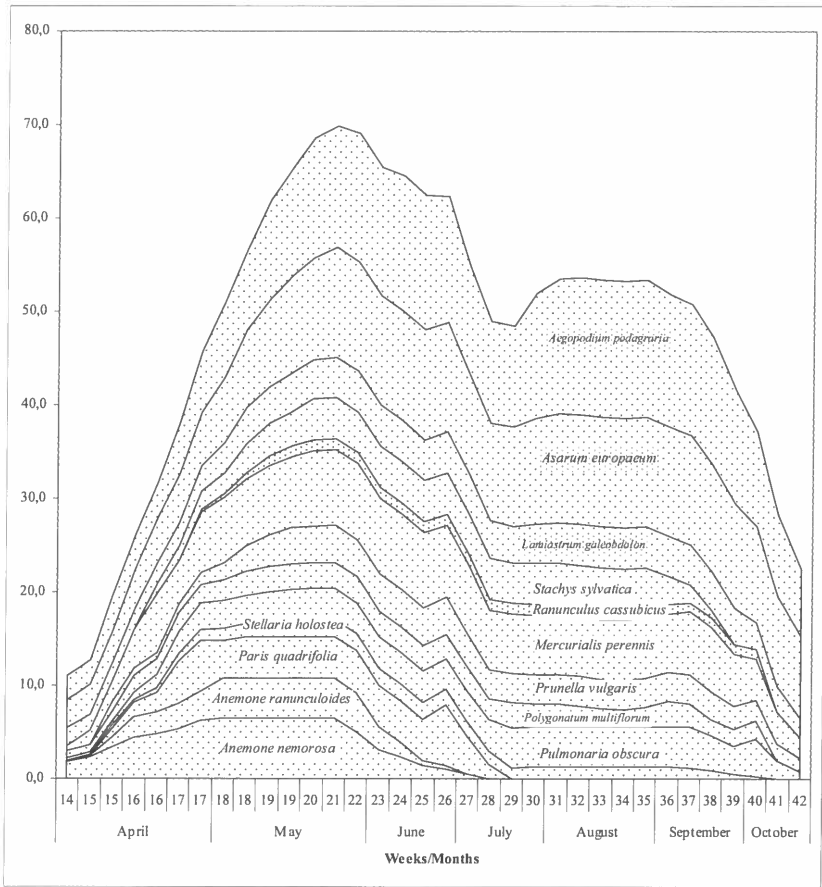


Fig. 1. Changes of projection cover during vegetation period in 2006

highest projection cover of efemeroids was at the beginning of May.

In the middle of May summer-green herbs - *Mercurialis perennis* L. *Polygonatum multiflorum* (L.) All., *Aegopodium podagraria* L., *Pulmonaria obscura* Dumort., *Stachys sylvatica* L. prevailed. The highest projection cover was of these plants: *Aegopodium podagraria* L., *Asarum europaeum* L., *Mercurialis perennis* L. The lowest projection cover was of *Corydalis solida* (L.) Clairv., *Viola reichenbachiana* Jord. ex Boreau.

Vegetation period of plants differs. For example leaves of *Asarum europaeum* L. stay alive longer then one year. Leaves of *Hepatica nobilis* Mill., *Oxalis acetosella* L. survive during the winter. Vegetation period of efemeroids (*Anemone nemorosa* L., *Anemone ranunculoides* L.,

Corydalis solida (L.) Clairv, *Ficaria verna* Huds) is short. It lasts about 6-14 weeks.

Flowering of herbs is shown in the figure 2. *Asarum europaeum* L., *Hepatica nobilis* Mill., *Corydalis solida* (L.) Clairv started to flower first. At the beginning of April *Pulmonaria obscura* Dumort., *Viola reichenbachiana* Jord. ex Boreau., *Anemone nemorosa* L. started to flower; *Anemone ranunculoides* L., *Mercurialis perennis* L., *Ficaria verna* Huds. - slightly later. *Stellaria holostea* L., *Polygonatum multiflorum* (L.) All., *Ranunculus cassubicus* L., *Lamiastrum galeobdolon* (L.), *Paris quadrifolia* L.; started to flower at the end of April and at the beginning of May; *Asperula odorata* L., *Phyteuma spicatum* L. -at the beginning of June; *Stachys sylvatica* L., *Aegopodium podagraria* L. - at the middle of June; *Prunella vulgaris* L. - at the beginning of July. Spring herbs flowered shorter

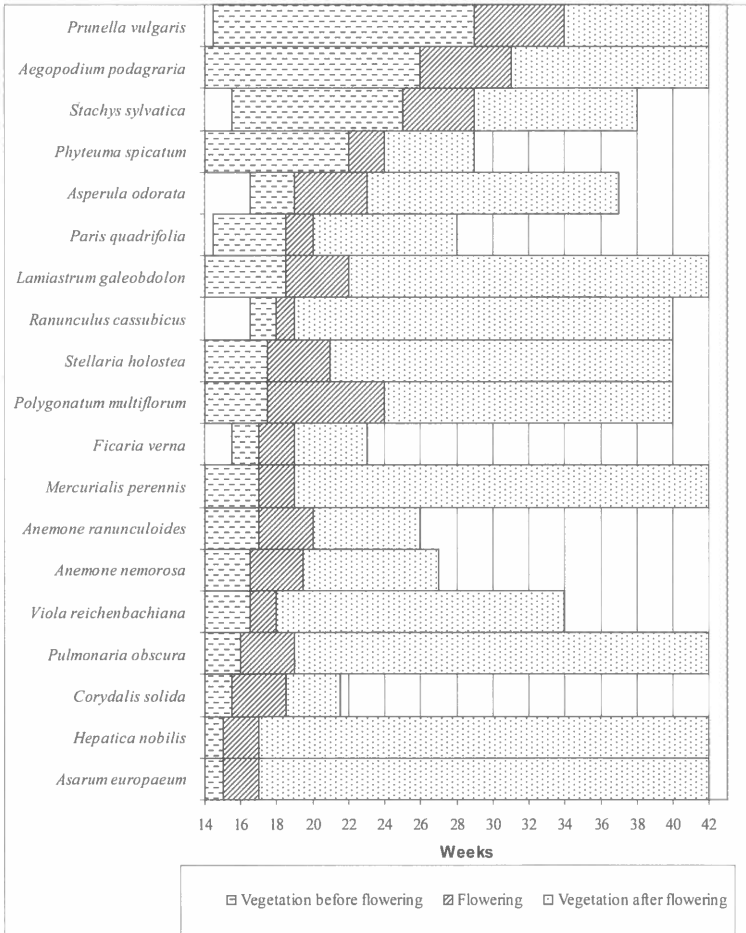


Fig. 2. Phenological spectrum of herbs in 2006 (2-4 weeks) then summer herbs (6-8 weeks). The majority of plants flowered during the April- May. At the end of May the number of flowering plant species decreased.

Flowering of herbaceous vegetation in deciduous forest depends on the foliage of trees in the stand. The majority of plants flowered in the spring when trees were without leaves and light conditions were good. In 2006 the majority of plants flowered when trees and shrubs were without leaves. *Padus avium* Mill. started to foliate first; a little later - *Ulmus glabra* Huds., *Corylus avellana* L., *Acer platanoides* L.; *Tilia cordata* Mill., *Quercus robur* L., *Fraxinus excelsior* L. started to foliate latest (3 fig.).

Phenology of plants depends on the temperature and precipitation of the year. The temperature has a influence to anatomical, morphological, physiological processes of plants also to growth and development of plants. The influence of temperature is many-sided and connected not only with certain temperature but also with its variation during the year or the day.

The vegetation and flowering of the plants depends on active temperature sums. In 2006 active temperature sum (starting from the end of April till the middle of October) was higher then average. The average temperature sum is 2200°C. In 2006 average temperature sum was 2690°C. In 2006 April was cold (4 fig.) therefore plants started to flower one week later then in normal year. At the beginning of May it became very warm that was why spring plants flowered intensively.

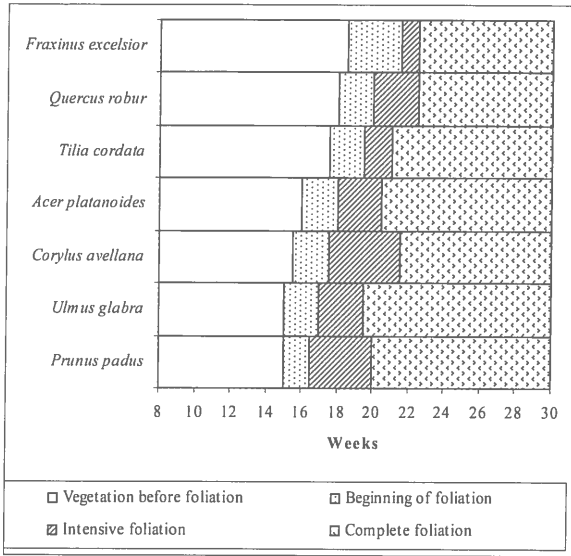


Fig. 3. Foliation of trees and shrubs in 2006

Equal precipitation distribution during the vegetation period is important for the plants development. In 2006 year during April and May precipitation was 119 mm, but it was not equally distributed. The highest amount of precipitation was in the 22 week – 46.3 mm. The dry period was from the beginning of June till the beginning of August. Precipitation was only 83.3 mm, the highest amount of precipitation was in week 28 – 63.9 mm (4 fig.). In August precipitation amount was 182.2 mm. The plants cover depended on the precipitation amount. In 2006 during dry period in July the projection cover of herbs decreased (especially *Aegopodium podagraria* L.). Later during the August projection cover increased again.

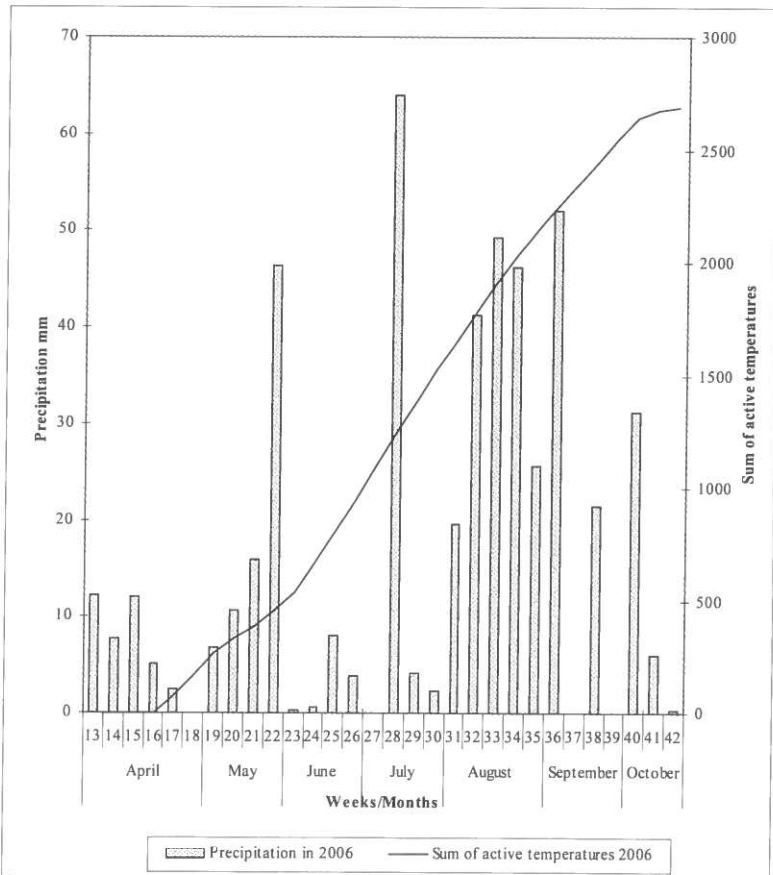


Fig. 4. Sum of temperatures and precipitation in 2006

CONCLUSIONS

The largest projection cover of the ephemeroïds *Anemone ranunculoides*, *Anemone nemorosa*, *Corydalis solida*, *Ficaria verna* was in spring. *Mercurialis perennis*, *Polygonatum multiflorum*, *Aegopodium podagraria*, *Pulmonaria obscura*, *Stachys sylvatica* had the highest projection cover in summer.

The April of 2006 was cold, so plant species began to flower a week later than usually. The flowering of the herbaceous species in the forest depended on the tree foliation. The most plant species flowered in spring, when trees were still without leaves. Only in this period efemeroids were flowering in the deciduous forests.

The time and length of plant flowering and vegetation depended on the sum of active temperatures. In 2006 the sum of active temperatures in vegetation period (from the end of April till the middle of October) was higher than average, consequently, the development of plant species was faster and phenological phases were shorter.

REFERENCES

- Gorishina T.K. 1969. Sping efemeroids in oak steppe forest. Leningrad.
- Falinska K. 1986. Seasonal dynamics of forest communities. Vegetation Dynamics in Temperate Lowland Primeval Forest. Ecological Studies in Bialowieza Forest (red. Falinski J., B). In: Geobotany 8, DR W. Junk Publishers, pp. 165-305.
- Ellenberg H. 1979. Zeigerwerte der Gefasspflanzen Mitteleuropas. -2. Aufl.-Gottingen.
- Fred G., Taylor J. 1974. Phenodynamics of Production in a Mesic Desiduous Forest. In: Phenology and Seasonality Modeling (ed. Lieth H.). New York, pp. 237-254.
- Natkevičaitė-Ivanauskienė, M. 1983. Botaninė geografija ir fitocenologijos pagrindai (Botanical Geography with Backgrounds of Phytocenology). Vilnius. (In Lithuanian).
- Purvinas E., Navasaitis M., Odinas G. 1991. Kamšos draustinio šlaitų retųjų augalų augimvietės ir jų ekologiniai ypatumai (Ecological characteristics of sites of rare plants in the slopes of Kamsa reserve). Agriculture: proceedings of LAA, T.37, pp. 15-23. (In Lithuanian).
- Purvinas E., Navasaitis M., Marozas V. 1996. Lapuočių medynų augimviečių su tuščiaviduriu rūteniu rūšinė struktūra ir bioekologiniai santykiai Kamšos botaninio draustinio Nemuno raguose (Species composition and bioecological relations of deciduous forest with *Corydalis cava* in Kamsa botanical – zoological reserve). Forestry: proceedings, LMIT.37. p. 73-88. (In Lithuanian).
- Basalykas A. 1965. Lietuvos TSR teritorijos fizinio geografinio rajonavimo sutikslinimas. (Physical-geographical zonation of Lithuania). Physical geography of Lithuania. Vilnius, T. 2, pp. 24-32. (In Lithuanian).
- Navasaitis A., Rudzevičienė D. 1993. Kauno rajono draustinių ekologinis įvertinimas (Ecological evaluation of reserves of Kaunas district). Agriculture: proceedings of LAA, T.42, pp. 55-60. (In Lithuanian).
- Venckus Z., Lekavičius A. 1976. Kamšos botaninio - zoologinio draustinio augalija ir retos bendrijos (Vegetation and rare communities in Kamsa botanical-zoological reserve). Agriculture: proceedings of LAA, T.2, pp. 138-140.

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EDGE EFFECT ON GROUND VEGETATION OF THE BIRCH FOREST

Vitas Marozas

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The objective of this study was to estimate the edge effect on species richness in agriculturally maintained forest-grassland boundaries of birch dominated forest and to determine how species respond to forest edge. The study area was selected in Southwest Lithuania. The impact of edge effect on overall herbaceous species composition of birch dominated forest was evaluated by means of Canonical Correspondence Analysis. Species richness of herbs and mosses in birch-dominated forest was the lowest one in the forest edge and increased up to the distance 5 m. The cover of herbs and mosses did not differed highly. The cover of herb layer slightly increased up to 10 m. CCA biplot showed a good correlation of overall species composition and distance from the forest edge. At the edge mean Ellenberg light and nitrogen values was slightly higher and decreased to forest interior.

Key words: canonical correspondence analysis, forest edge effect, forest fragmentation, species diversity.

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INTRODUCTION

Fragmentation changes the spatial nature of the landscape, increases the amount of edge habitat and induces changes in both the abiotic and biotic environment. Fragmentation and habitat loss are among the most important causes of world-wide species decline (Haila 1999; Murcia 1995). In many parts of mixed European forest zone, logging has transformed the forest landscape into patches of forest islands of various sizes that are isolated from one another by open fields. One of fragmentation and related habitat loss consequences is decreasing proportion of interior habitat and increasing

proportion of edge (Murcia 1995; Haila 1999, Matlack & Litvaitis 1999).

Forest fragmentation necessarily leads to the increase in the amount of forest edge. Changes of abiotic and biotic conditions in the edges compared with the intact habitat are called edge effect. These numerous effects include changes in wind, humidity, radiation, predation, parasitism, and species interactions (Saunders et al. 1991; Chen et al. 1995; Murcia 1995; Risser 1995; Donovan et al. 1997; Voller 1998). Compared with forest interiors, forest edges typically have different plant species composition and community structure. Edges influence both the

ecosystem structure and function through their roles of sites of exchange of energy, materials, and organisms between patches (Hansen et al. 1988; Chen et al. 1996).

Changes in structure, composition and function of edges primarily result from alteration of microclimate, following the structural modification of the landscape. Microclimate, including solar radiation, moisture, wind, and temperature is a primary driver of ecosystem and landscape-level processes such as photosynthesis, regeneration, plant growth, nutrient cycling, and decomposition (Perry 1994). At forest edges microclimatic variables (light intensity and duration, relative humidity, air temperature) and soil factors (pH, organic carbon, total nitrogen, available phosphorus, soil moisture and temperature) change fast over short distances.

In response to these conditions, vegetation structure and composition at the edge are different as compared to the one in the forest interior. To counteract the negative effects of edges it is important to understand how species respond to the conditions at the habitat edges (Haila 1999). Forest edges are preferred habitat of many species. Edges of forest fragments are easily invaded by species from surrounding ecosystems and some species may continue invading through the edge into the forest interior. Edge habitat is unsuitable for species requiring interior habitat and consequently such species may be lost if fragments become too small (Haila 1999).

The extent of the edge effects penetration into the forest is important. Knowledge of edge width is critical for management focusing on the preservation of the natural characteristics of forests (Brothers 1993) and for setting priorities for conservation. Edge effects are the most significant consequences of fragmentation resulting from natural and human-caused disturbances. The area influenced by edges is an important measurement for ecological studies and natural resource management.

The objective of this study was to estimate the edge effect on species richness in agriculturally maintained forest-grassland boundaries of birch dominated forest and to determine how species respond to forest edge.

MATERIAL AND METHODS

The study area was located in South-western Lithuania (54° 21' – 54° 55' N, 23° 29' – 23° 41' E). The study area falls in the transitional deciduous coniferous mixed forest zone of Europe (Ahti et al. 1968). Plain landscape and leached moraine podsol soils prevail. Annual mean temperature ranges from +6.3 to +6,7° C and temperatures of the warmest and coldest months (July and January) are from +16.5 to +17.5 and from –5.0 to –4.7° C, respectively. The annual mean precipitation is between 650 and 750 mm. Period with snow continues from 75 to 90 days (Bukantis 1994).

Ten transects were established in well-developed agricultural grassland and forest edges. Sites were chosen to minimise slope, canopy heterogeneity, human interference and local variation in other factors, which might affect species composition. Transects began at the bases of trees that formed the edges and extended perpendicularly in the forest. The length of transects was 30 m. At the each transect square form (1x1) plots were set up at distances of 0 m, 5 m, 10 m, 15 m, 20 m, 25 m and 30 m from the forest edge.

Vegetation sampling was conducted during July and August. All herbaceous species and mosses were recorded and percentage cover of each species was estimated in each plot. Overall herbs and mosses cover was also estimated. Plant species nomenclature is according Jankeviciene (1998).

The impact of edge effect on overall herbaceous species composition in lime dominated forest was evaluated by means of Canonical Correspondence Analysis (CCA) (Jongman et al.

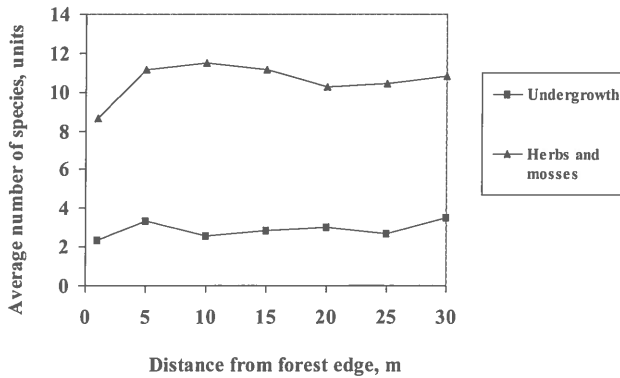


Fig. 1. Dependence of average number of species of undergrowth, herbs and mosses from distance to forest edge

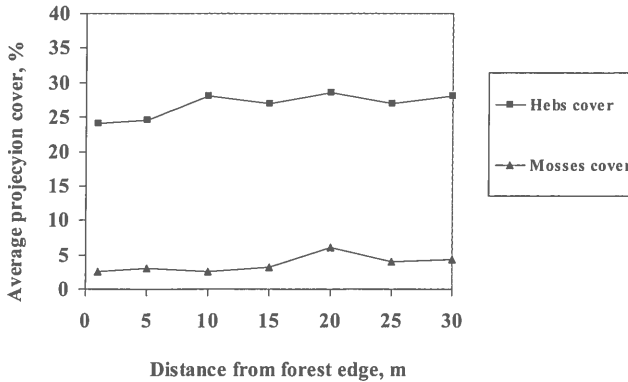


Fig. 2. Dependence of herbs and mosses average projection cover from distance to forest edge

1987) using the program CANOCO for Windows (ter Braak & Šmilauer 1998). Transect identifiers were used as covariables to analyse only the response to the distance from the forest edge. Significance was tested by the distribution-free Monte Carlo test (499 permutations).

In order to estimate environmental conditions Ellenberg indicator values for light, moisture, reaction and nitrogen were calculated (Ellenberg et al. 1991). Indifferent species were disregarded from the analyses. The value of an environmental variable at a site (plot) was estimated by weighted average method. Indicator values of all species present at the site were averaged in proportion to species percentage cover.

RESULTS AND DISCUSSION

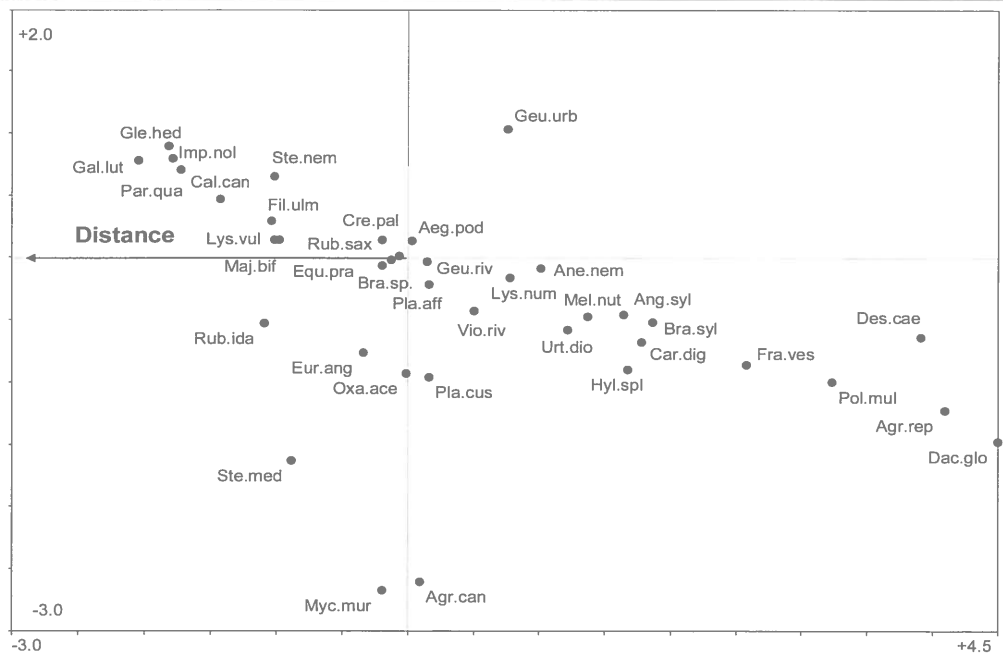
Species richness of herbs and mosses in birch-dominated forest was the lowest one in the forest edge and increased up to the distance 5 m. Then species number become stable towards the forest interior (Fig. 1).

In some cases edge effect increases plant species richness (Brothers and Springarn 1992; Matlack 1994; Burke & Nol 1998). Low densities or complete absence of some forest plant species may occur at the edge, but other species may be more common at restricted to edge habitats (Chen et al. 1992; Matlack 1994; Fraver 1994; Burke & Nol 1998, Marozas, 2003). In other cases species richness may be lower because of environmental variation (van der Maarel, 1990).

The cover of herbs and mosses did not differed highly. The cover of herb layer slightly increased up to 10 m. than become stable towards the forest interior (Fig. 2).

The relationship of overall species composition in the birch-dominated forest to the distance from the forest edge shows CCA biplot (Fig. 3). Correlation of overall species composition and distance from the forest edge is 0.821, Monte Carlo test - $p=0.002$.

Species of *Agropyron repens*, *Angelica sylvetris*, *Anemone nemorosa*, *Brachypodium sylvaticum*, *Carex digitata*, *Dactylis glomerata*, *Deschampsia caespitosa*, *Fragaria vesca*, *Geum urbanum*, *Hylocomnium splendens*, *Lysimachia nummularia*, *Melica nutans*, *Polygonatum multiflorum*, *Urtica dioica*, *Viola riviniana* showed tendency to grow in forest edge.



Aeg.pod - *Aegopodium podagraria*, Agr.can - *Agropyron caninum*, Agr.rep - *Agropyron repens*, Ane.nem - *Anemone nemorosa*, Ang.syl - *Angelica sylvestris*, Bra.sp. - *Brachythecium* sp., Bra.syl - *Brachypodium sylvaticum*, Cal.can - *Calamagrostis canescens*, Car.dig - *Carex digitata*, Cre.pal - *Crepis paludosa*, Dac.glo - *Dactylis glomerata*, Des.cae - *Deschampsia caespitosa*, Equ.pra - *Equisetum pretense*, Eur.ang - *Eurhynchium angustirete*, Fil.ulm. - *Filipendula ulmaria*, Fra.ves - *Fragaria vesca*, Gal.lut - *Galeobdolon luteum*, Geu.riv - *Geum rivale*, Geu.urb - *Geum urbanum*, Gle.hed - *Glehoma hederacea*, Hyl.spl. - *Hylocomnium splendens*, Imp.nob. - *Impatiens noli-tangere*, Lys.vul - *Lysimachia vulgaris*, Lys.num - *Lysimachia nummularia*, Maj.bif - *Majanthemum bifolium*, Myc.mur - *Mycelis muralis*, Mel.nut - *Melica nutans*, Oxa.ace - *Oxalis acetosella*, Pla.aff - *Plagiomnium affine*, Pla.cus - *Plagiomnium culpidatum*, Pol.mul - *Polygonatum multiflorum*, Par.qua - *Paris quadrifolia*, Rub.ida - *Rubus idaeus*, Rub.sax - *Rubus saxatilis*, Ste.med - *Stellaria media*, Ste.nem - *Stellaria nemorum*, Urt.dio - *Urtica dioica*, Vio.riv - *Viola riviniana*

Fig. 3. Dependence of herbs and mosses species from distance to forest edge

Species of *Calamagrostis canescens*, *Crepis paludosa*, *Filipendula ulmaria*, *Galeobdolon luteum*, *Geum rivale*, *Glehoma hederacea*, *Impatiens noli-tangere*, *Lysimachia vulgaris*, *Majanthemum bifolium*, *Mycelis muralis*, *Paris quadrifolia*, *Rubus idaeus*, *Rubus saxatilis*, *Stellaria nemorum* showed tendency to grow in forest interior.

Distribution of the species along the edge forest interior gradient depends on the species response

on the different ecological factors. Figure 4 shows mean Ellenberg values along forest edge interior gradient in birch dominated forests. At the edge mean light and nitrogen values was slightly higher and decreased to forest interior. We can see slightly higher values of moisture, reaction at the edge too, but its started to increase from the 15 m from the edge.

Species of broad ecological diapason, usually intolerant to light shading have been determined

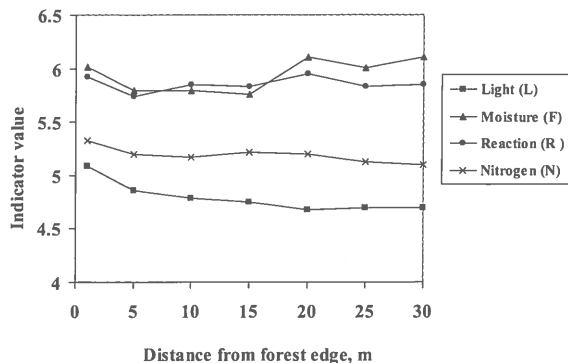


Fig. 4. Dependence of Ellenberg indicator values from distance to forest edge

to occur at the forest edge. In the forest interior species are frequently found to be tolerant to the light shading, characteristic to a forest species. Investigations in birch dominated forest grassland edges and previous studies have shown that edges are characterised by the species that are shade intolerant, have good vegetative reproduction, and are most often associated with early stages of secondary succession (Wales 1972; Whitney & Runkle 1981).

CONCLUSIONS

Species richness of herbs and mosses in birch-dominated forest was the lowest one in the forest edge and increased up to the distance 5 m. The cover of herbs and mosses did not differ highly. The cover of herb layer slightly increased up to 10 m.

CCA biplots showed a good correlation of overall species composition and distance from the forest edge.

At the edge mean Ellenberg light and nitrogen values was slightly higher and decreased to forest interior.

REFERENCES

- Ahti, T., Hämet-Ahti L. & Jalas J., 1968. Vegetation zones and their sections in northwestern Europe. *Ann. Bot. Fenn.*, 5: 169-211.
- Brothers, T.S. & Springarn, A. 1992. Forest fragmentation and alien plant invasion of central Indiana old-growth forest. *Conserv. Biol.* 6: 91-100.
- Brothers, T.S. 1993. Fragmentation and edge effects in central Indiana old growth forest. *Nat. Areas J.* 13: 268-275.
- Bukantis, A. 1994. Lietuvos klimatas. [Climate of Lithuania.] Vilnius Universiteto leidykla, Vilnius. (In Lithuanian.)
- Burke, D.M. & Nol, E. 1998. Edge and fragmented size effects on the vegetation of deciduous forest in Ontario, Canada. *Nat. Areas J.* 18: 45-53.
- Chen, J., Franklin, J.E. & Lowe, J.S. 1996. Comparison of abiotic and structurally defined patch patterns in a hypothetical forest landscape. *Conserv. Biol.* 10: 854-862.
- Chen, J., Franklin, J.F. & Spies, T.A. 1992. Vegetation responses to edge environments in old-growth Douglas-fir forest. *Ecol. Appl.* 2: 387-396.
- Chen, J., Franklin, J.F. & Spies, T.A. 1995. Growing-season microclimatic gradients from clearcut edges into old-growth Douglas-fir forest. *Ecol. Appl.* 5: 74-86.
- Donovan, T.M., Jones, P.W., Annand, E.M. & Thompson III F.R. 1997. Variation in local-scale edge effects: mechanisms and landscape context. *Ecology* 78: 2064-2075.
- Ellenberg, H., Weber, H.E., Wirth, V., Werner, W. & Paulien, D. 1992. *Zeigerwerte von Pflanzen*

- in Mitteleuropa. Verlag Erich Goltze KG, Göttingen.
- Fraver, S. 1994. Vegetation responses along edge-to-interior gradients in the mixed hardwood forest of the Roanoke river basin, North Carolina. *Conserv. Biol.* 8: 822-832.
- Haila, Y. 1999. Islands and fragments. In: Hunter M.L. (eds.) *Maintaining biodiversity in forest ecosystems*, pp.234-264. Cambridge University Press, Cambridge, United Kingdom.
- Hansen, A.J., di Castri, F. & Naiman, R.J. 1988. Ecotones: what and why? *Biol. Int.* 17: 9-46.
- Jankevičienė, R. (eds.) 1998. *Dictionary of Plant Names*. Institute of Botany Publishers, Vilnius.
- Jongman, R. H., Braak, C. J. F. ter & Tongeren, O. F. R. van. 1987. *Data Analysis in Community and Landscape Ecology*. Pudoc, Wageningen.
- Marozas V. Effect of the Lime Forest - Grassland Edge on Ground Vegetation. *Acta Biol. Univ. Daugavp.* 4: 47-52.
- Matlack, G.R. & Litvaitis, J.A. 1999. Forest edges. In: Hunter, M.L. (eds.) *Maintaining biodiversity in forest ecosystems*, pp.210-233. Cambridge University Press, Cambridge, United Kingdom.
- Matlack, G.R. 1994. Vegetation dynamics of the forest edge – trends in space and successional time. *J. Ecol.* 82: 113-123.
- Murcia, C. 1995. Edge effects in fragmented forest: implications for conservation. *Trends Ecol. Evol.* 10: 58-62.
- Perry, D.A. 1994. *Forest Ecosystems*. Johns Hopkins University Press, Baltimore, Md.
- Risser, P.G. 1995. The status of the science of examining ecotones. *Bioscience* 45: 318-325.
- Saunders, D.A., Hobbs, R.J. & Margules, C.R. 1991. Biological consequences of ecosystem fragmentation: a review. *Conserv. Biol.* 5: 18-32.
- ter Braak, C.J.F. & Šmilauer, P. 1998. *CANOCO Release 4. Reference manual and user's guide to Canoco for Windows: Software for Canonical Community ordination*. Microcomputer Power, Ithaca, New York.
- Van der Maarel, E. 1990. Ecotones and ecoclines are different. *J. Veg. Sci.* 1: 135-138.
- Voller, J. 1998. Managing for edge effects. In: Voller, J. & Harrison, S. (eds.) *Conservation biology principles for forested landscapes*, pp. 215-233. University of British Columbia Press, Vancouver, Canada.
- Wales, B. 1972. Vegetation analysis of northern and southern edges in a mature oak-hickory forest. *Ecol. Monogr.* 42: 451-471.
- Whitney, G.G. & Runkle J.R. 1981. Edge versus age effects in the development of a beech-maple forest. *Oikos* 37: 377-381.

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THE STATUS OF LITHUANIAN NATURAL AND SEMI-NATURAL MEADOW COMMUNITIES AND THEIR PRESERVATION POSSIBILITIES

Jūratė Sendžikaitė, Romas Pakalnis, Dalia Avižienė

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The aboveground dry weight of phytomass and economic value of meadow communities included into 4 systematic classes were ascertained: *Molinio-Arrhenatheretea elatiori* (240–1140 g/m²; 1.7–8.7 points; large variation of phytomass and economic value is conditioned by habitat and taxonomic diversity of communities), *Festuco-Brometalia erecti* (270–620 g/m²; 3.6–7.1 points), *Trifolio-Geranietea sanguinei* (700 g/m²; 5.1 points), *Nardetea strictae* (560–1240 g/m²; 2.0–3.5 points). Management and traditional usage of natural meadows is insufficient to maintain favourable conservation status of biological diversity.

Key words: aboveground phytomass, economic value, meadow communities

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INTRODUCTION

Meadows in a forest zone are mostly synanthropic because of human impact upon the primary landscape, of course, with the exception of natural wetlands and flood meadows (Erings 1964, Green 1990, Muller et al. 1998). Geographical situation, great amount of precipitation in growth season, favourable wintering conditions, dense hydrographic net (1 km² – 1 km) and human activity have predetermined the prevalence of meadows on Lithuanian landscape

(Rašomavičius 1998). Under temperate climatic conditions meadow ecosystems have formed as a result of centuries-long traditions of land use, which facilitated the formation of meadow communities characterized by high diversity of vascular plant species.

Transformation of natural meadows into farmlands has resulted in almost total destruction of continental meadows in the 20th century not only in Lithuania, but also in all Europe. Meadows and natural pastures cover 7.6% of the Lithuanian

territory (Statistical... 2005). Only flood meadows near rivers and lakes and small fragments between arable fields are considered as natural ones. These grasslands vary in their structure, floristic composition and productivity according to the prevailing ecological conditions and the intensity of management. The Lithuanian meadow communities are ascribed to 35 associations included into 5 classes: *Asteretea tripolii* Westhoff et Beeftink in Westhoff et al. 1962, *Molinio-Arrhenatheretea elatioris* R. Tx. 1937, *Festuco-Brometea erecti* Br.-Dl. Et R. Tx. 1943, *Trifolio-Geranietea sanguinei* Th. Müller 1961 and *Nardetea strictae* Rivas Goday et Borja Carbonell 1961 (Rašomavičius 1998).

Economic activity retards succession in the grassland by impeding the prevalence of species of the following stages (forbs, shrubs, and forests). Management and traditional usage of natural meadows seem to be insufficient in order to maintain favourable conservation status of biological diversity (Muller 1992; Prach 1993). In Lithuania, 8 types of meadow habitats are listed in Annex I of the EU Habitats Directive (92/43/EEC): 6120 Xeric sand calcareous grasslands, 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia erecti*), 6230 Species-rich *Nardus* grasslands on siliceous substrates, 6410 *Molinia* meadows on calcareous peaty or clayey-silt-laden soils (*Molinion caeruleae*), 6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels, 6450 Northern boreal alluvial meadows, Lowland hay meadows, 6510 lowland hay meadows, and 6530 Fennoscandian wooded meadows (Rašomavičius 2001). Therefore, investigations on different systematic categories of natural and semi-natural meadow communities have become relevant not only theoretically and economically, but also from the point of view of preservation of biological diversity.

At the end of the 20th century, after restoration of private land property rights in Lithuania, the economic value of meadows declined, which had an ecological effect on landscape stability and allowed botanical diversity restoration to

increase. Changes in land-use and farming traditions have stimulated naturalization of abandoned agricultural lands allowing increase in their biodiversity, and also caused rapid degradation of abandoned natural meadows. After Lithuania's integration into EU, new possibilities to preserve biodiversity in the remaining natural and restoring semi-natural meadows have emerged. The financial assistance that is now available to farmers encourages them to maintain meadows and prevent succession to scrubland or woodland.

MATERIAL AND METHODS

Natural conditions. Lithuania lies on the western fringe of the East European Plain, in the middle and lower basin of the river Nemunas. The relief is a meridian-oriented alteration of lowland plains and hilly uplands. The climate falls into the zone of temperate climate, lying in the transition region between West European maritime and East European continental (Basalykas 1958). Main climatic parameters influencing plant growth conditions and the development of communities in Lithuania: total Solar radiation (per year) – 3600 MJ/m² (85 kcal/cm²); mean annual air temperature – +6,2°C; sum of active temperatures ($\sum T > 10^{\circ}\text{C}$) – 1900–2300 °C; annual precipitation – 675 mm; hydrothermal coefficient (HTC) – 1,3–1,9 (Bukantis 2001).

Methods. Investigations on productivity of different systematic categories of natural and semi-natural meadow communities were carried out in 2000–2005 on different regions of Lithuania (Fig. 1). The classification of plant communities was presented following J. Braun-Blanquet school principles (Braun-Blanquet 1964, Pott 1995, Dierßen 1996, Rašomavičius 1998). Nomenclature of plant species was applied following Z. Gudžinskas (1999).

Aboveground phytomass (TAP – total aboveground phytomass, VPP – vascular plant phytomass) of meadow communities was ascertained according to N. Lapinskienė (1986). Flora composition of the communities and

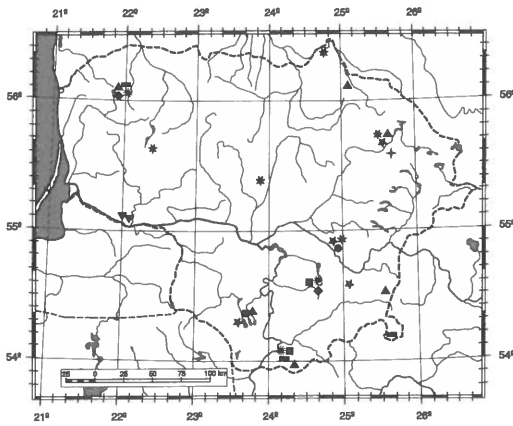


Fig. 1. Systematic categories (I–X) and study sites of natural and semi-natural meadow communities in Lithuania:

- I – $\frac{3}{4}$ Ass. *Cirsietum rivularis*; II – \square Ass. *Deschampsietum cespitosae*;
 III – $-$ Ass. *Alopecuretum pratensis*; IV – Ass. *Molinietum caeruleae*;
 V – \hat{g} Ass. *Festucetum pratensis*; VI – \dagger Ass. *Anthoxantho-Agrostietum tenuis*;
 VII – \bar{e} Ass. *Festuco-Cynosuretum cristati*; VIII – \acute{z} All. *Mesobromion erecti*;
 IX – \hat{A} Ass. *Trifolio-Agrimonetum eupatoriae*;
 X – $-$ Ass. *Polygalo-Nardetum strictae*

aboveground phytomass (dry weight, g/m²) were registered in June (1st harvest). At every study site, the aboveground phytomass and number of vascular plants species were observed on three trial plots of 1 m² in size (Fig. 2, 3). The aboveground part, mown down to the soil level, was divided into vascular plants (arranged into species), bryophytes and dead parts of plants. The sorted out sample was dried up and weighted, i.e. the specific weight of every species of grass was indicated. Economic value of the communities was indicated following the methods of A. Petkevičius and A. Stancevičius (1982).

RESULTS AND DISCUSSION

Investigations on the status of 30 natural and semi-natural meadow communities were carried out on different geographical regions of

Lithuania. Mostly the communities (22) of *Molinio-Arrhenatheretea elatioris* R. Tx. 1937 class, found in both continental and flood meadows, were investigated, as far as to this class belong the most common in Lithuania communities occupying the largest areas. The following syntaxonomic subordination of the all investigated communities was ascertained:

Cl. *Molinio-Arrhenatheretea elatioris* R. Tx. 1937

O. *Molinieta caeruleae* W. Koch 1926
 All. *Calthion palustris* R. Tx. 1937 em. Lebrun et al. 1949

Ass. *Cirsietum rivularis* Noviński 1927
 Ass. *Deschampsietum cespitosae* Horvatić 1930
 All. *Alopecurion pratensis* Passarge 1964
 Ass. *Alopecuretum pratensis* Regel 1925
 All. *Molinion caeruleae* W. Koch 1926
 Ass. *Molinietum caeruleae* W. Koch 1926
 O. *Arrhenatheretalia elatioris* Pawłowski 1928
 All. *Arrhenatherion elatioris* (Br.-Bl. 1925) W. Koch 1926

Ass. *Festucetum pratensis* Soõ 1938
 All. *Cynosurion cristati* R. Tx. 1947
 Ass. *Anthoxantho-Agrostietum tenuis* Sillinger 1933

Ass. *Festuco-Cynosuretum cristati* R. Tx. in Bükler 1942

Cl. *Festuco-Brometalia erecti* Br.-Bl. Et R. Tx. 1943

O. *Brometalia erecti* Br.-Bl. 1936
 All. *Mesobromion erecti* Br.-Bl. Et Moor 1938
 Cl. *Trifolio-Geranietea sanguinei* Th. Müller 1961

O. *Origanetalia vulgaris* Th. Müller 1961
 All. *Trifolion medii* Th. Müller 1961

Ass. *Trifolio-Agrimonetum eupatoriae* Th. Müller 1961

Cl. *Nardetea strictae* Rivas Goday et Borja Carbonell 1961

All. *Violion caninae* Schwickerath 1944
 Ass. *Polygalo-Nardetum strictae* Oberdorfer 1957

I. *Cirsietum rivularis* Noviński 1927 communities. Floristically rich meadows (18–25 vascular plant species/m²; *Deschampsia cespitosa* (L.) P. Beauv., *Alopecurus pratensis* L., *Festuca pratensis* Huds., *F. rubra* L., *Cirsium rivulare*

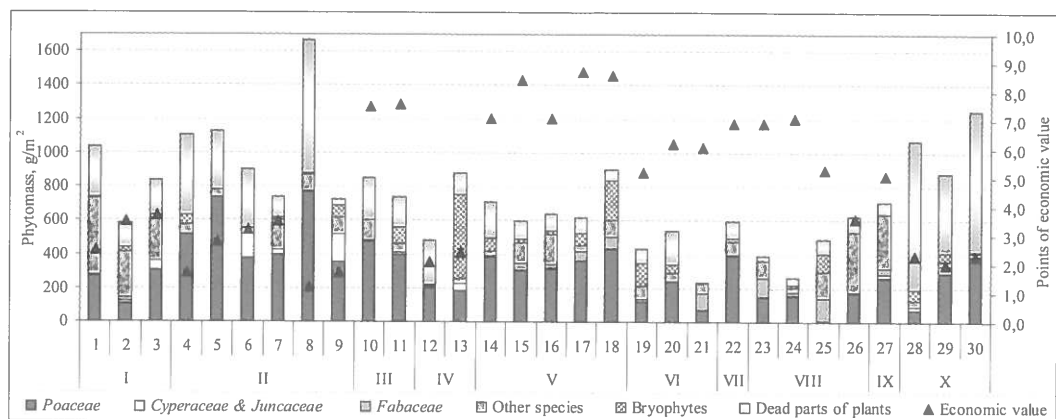


Fig. 2. Aboveground phytomass (dry weight, g/m^2) and economic value (points) of different systematic categories (I–X) of natural and semi-natural meadow communities (1–30) in Lithuania

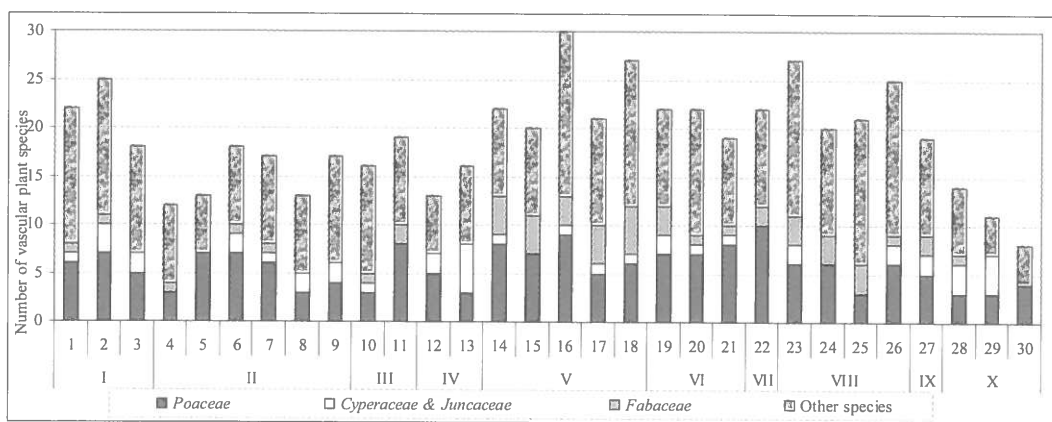


Fig. 3. Number of vascular plant species (in 1 m^2 trial plots) in different systematic categories (I–X) of natural and semi-natural meadow communities (1–30) in Lithuania

(Jacq.) All., *Carex nigra* (L.) Reichard, *Filipendula ulmaria* (L.) Maxim., *Geum rivale* L., *Equisetum fluviatile* L., etc.) of the *Cirsietum rivularis* communities occupy fertile and wet habitats (Fig. 1, 3). Economically low value (2.5–3.7 points) meadows produce $580\text{--}1040 \text{ g}/\text{m}^2$ of the TAP (however, dead parts of plants make up 25–30 %) (Fig 2). These meadow communities are not suitable for fodder stocking, because in the grassland prevail forbs of low economic value (*Cirsium rivulare* – up to 41 %, *Equisetum fluviatile* – 13 %, *Filipendula ulmaria* – 10 % of VPP). As far as in Lithuania *Cirsietum rivularis* communities reach their northern distribution boundary, they are interesting from the

phytogeographical point of view and, therefore, must be preserved.

II. *Deschampsietum cespitosae* communities prevail on river valleys and interhill depressions, where high ground water level and poor soil aeration is characteristic. Aboveground phytomass of vascular plants consists of 12–18 species (*Deschampsia cespitosa*, *Festuca pratensis*, *Phleum pratense* L., *Poa pratensis* L., *Equisetum palustre* L., *Filipendula ulmaria*, *Galium uliginosum* L., *Lychnis flos-cuculi*, *Bistorta major* Gray, *Carex nigra* (L.) Reichard and etc.) (Fig. 3). Although *Deschampsietum cespitosae* communities may produce rather large amount of TAP ($725\text{--}1665 \text{ g}/\text{m}^2$), dead parts of

plants also make up big quantity (16–43 %). Abundance of low value fodder plants (*Deschampsia cespitosa* can produce about 30–85 % of VPP, *Carex nigra* – 5–24 %, *Galium uliginosum*, *Lychnis flos-cuculi*, *Peucedanum palustre* (L.) Moench, *Bistorta major*, *Stelaria palustris* Retz. and other plant species – 1–15 % each) predetermines low economic value of the grassland (1.2–3.5 points) (Fig. 2).

III. *Alopecuretum pratensis* communities establish on naturally drained alluvial soils and are moderately rich in species (16–19 species) (Fig 3). *Alopecurus pratensis*, *Arrhenatherum elatius* (L.) P. Beauv. ex J. Presl et C. Presl, *Bromopsis inermis* (Leys.) Holub, *Elytrigia repens* (L.) Nevski, *Dactylis glomerata* L., *Festuca pratensis*, *Poa pratensis*, etc. occur. Economically, the communities are rather productive – 730–850 g/m² of TAP, whereas dead parts of plants make up 24–30 % and bryophytes – up to 14 % (Fig. 2). High economic value of the grassland (7.5–7.6 points) depends upon the abundance of the *Poaceae* (R. Br.) Bernhart species (in single trial plots *Arrhenatherum elatius* may produce up to 55 %, *Alopecurus pratensis* – up to 45 %, *Bromopsis inermis* – up to 30 %, *Poa pratensis* – up to 5 %, *Dactylis glomerata* – up to 3 % of the VPP).

IV. Moderately rich in vascular plant species (13–16) the *Molinietum caeruleae* communities are found on calcareous, peaty or clayey-silt-laden soils (Fig. 1). *Molinia caerulea* (L.) Moench, *Galium boreale* L., *G. uliginosum*, *Equisetum palustre*, *Carex panacea*, etc. form the grassland. Although the communities produce about 480–880 g/m² of TAP, vascular plants make up only 30–45 % of the harvest (Fig. 2). Abundance of low value fodder plants (*Molinia caerulea* produces about 67–90 %, *Carex panicea* – up to 6 % of VPP) show low economic value of the grassland (2.1–2.4 points).

V. Mesophillous *Festucetum pratense* communities of the *Arrhenatherion elatioris* association are found in flood and continental meadows. From 20 to 30 vascular plant species were registered in the trial plots. *Dactylis*

glomerata, *Festuca pratensis*, *F. rubra*, *Phleum pratense*, *Poa pratensis*, *Lathyrus pratense*, *Ranunculus acris*, *Galium mollugo* L., *Achillea millefolium* L., etc. form the grassland. Economically, these meadow communities are the most valuable: rather productive (620–900 g/m² of TAP) and of high economic value (7.1–8.4 points). Economic value of the grassland depends on large amount of valuable fodder plants of the *Poaceae* and *Fabaceae* Lindl. species in VPP (60–93 % and 2–12 %, respectively).

VI. *Anthoxantho-Agrostietum tenuis* establish on mineral soils undergoing the process of meadow formation or degrading of sown meadows. 19–22 vascular plant species were registered in the trial plots (Fig. 3). *Agrostis capillaris* L., *Anthoxanthum odoratum* L., *Briza media* L., *Festuca pratensis*, *Poa pratensis*, *Pilosella officinarum* F. W. Schultz et Sch. Bip., etc. occur in the grassland. The communities were not productive (240–540 g/m² of TAP), the grassland showed average economic value (5.2–6.1 points) (Fig. 2). Bryophytes and dead parts of plants made up rather large amount of the TAP (up to 32 and 37 %, correspondingly). The largest amount of the VPP is produced by *Agrostis capillaris* (up to 53 %), *Pilosella officinarum* (up to 25 %), *Festuca rubra* (up to 20 %) and *Anthoxanthum odoratum* (up to 18 %).

VII. *Festuco-Cynosuretum cristati* communities were investigated on the slopes of hills in Eastern Lithuania (Sendžikaitė 2001). The grassland consists of *Festuca pratensis*, *F. rubra*, *Agrostis capillaris*, *Anthoxanthum odoratum*, *Phleum pratense*, *Poa trivialis* L., *Briza media*, *Cynosurus cristatus* L., *Pimpinella saxifraga* L., etc. In the trial plots, 22 vascular plant species were inventoried (Fig. 3). The community shows average productivity (600 g/m² of TAP) and good economic value of the grassland (6.9 points) (Fig. 2). Bryophytes and dead parts of plants make up about 20 % of the TAP. The phytomass of vascular plants is produced mainly by *Festuca rubra* (up to 48 %), other *Poaceae* species add much poor amount (*Briza media* – 8 %, *Poa pratensis* – 7 %, *Agrostis capillaris* and *Festuca*

pratensis – 5 %, *Anthoxanthum odoratum* – 4 %).

VIII. Communities of the *Mesobromion erecti* association grow on floodplains, the shorelines of water bodies and slopes of hills. These mesophilous species-rich communities (21–27 species) produce low TAP – 270–620 g/m², vascular plants make up about 60–94 %. (Fig. 2, 3). Relatively large content of dead parts of plants (6–18 %) shows insufficient management of meadows. Economically, the evaluation of grasslands varied: from low (3.6 points) to high (7.1 points) economic value (Fig 2). The value of grassland depends upon the content of valuable *Poaceae* (*Festuca pratensis*, *F. rubra*, *Dactylis glomerata*, *Poa angustifolia* L., *P. compressa* L., etc.) and *Fabaceae* (*Trifolium repens* L., *Medicago falcata* L., *M. lupulina* L., *Vicia cracca* L., *Onobrychis viciifolia* Scop., etc.) plants, in low economic value grasslands it makes up about 33 %, whereas in high economic value grasslands it comes to 41–88 % of VPP.

IX. *Trifolio-Agrimonetum eupatoriae* communities are characteristic to forest edges and slopes of hills. *Trifolium medium* L., *Agrimonia eupatoria* L., *Galium album* Mill., *Senecio jacobaea* L., *Briza media* and *Festuca rubra* prevail in the grasslands. Average number of vascular plants in single trial plots comes to 19 species (Fig. 3). Economically, average fodder value meadows (5.1 points) produce about 700 g/m² of TAP, 40 % of which is obtained from the *Poaceae* (*Festuca rubra*, *Dactylis glomerata*, *Poa pratensis*, *Briza media*, etc.) and 5 % of the *Fabaceae* (*Trifolium medium*, *Medicago falcata*, *Vicia cracca*, etc.) species (Fig. 2). Average value of the grassland depends on the abundance of low economic value plants (*Agrimonia eupatoria*, *Centaurea scabiosa* L., *Fragaria viridis* Duchesne, *Hypericum perforatum* L., *Pimpinella saxifraga*, *Thymus pulegioides* L., etc.) in the VPP (even 53 %).

X. *Polygalo-Nardetum strictae* communities most often are found on the terraces of river valleys at the foot of hills and on the edges of bogs. In the grassland prevailed *Nardus stricta*

L., *Agrostis capillaris*, *Danthonia decumbens* (L.) DC., *Carex pilulifera* L., *Polygala vulgaris* L., *Potentilla erecta* (L.) Raeuschel, etc. Floristically, the investigated communities are poor (8–14 species) (Fig. 3). Economic value of such grassland is low (2.0–2.3 points). Although TAP of the communities was rather high (880–1250 g/m²), however, dead parts of plants made up even 53–82 %, bryophytes – up to 6 % (Fig. 2), besides that, *Nardus stricta* made about 40–90 % of VPP.

A complex of growth conditions and management of grasslands in separate study sites determined quite large diversity of meadow productivity (especially of the communities of *Molinio-Arrhenatheretea elatioris* class): from 240 g/m² (Ass. *Anthoxantho-Agrostietum tenuis*) to 1660 g/m² (Ass. *Deschampsietum cespitosae*) of dry weight aboveground phytomass (Fig. 2). A fodder demand in Lithuania has currently decreased, therefore, a threat of extinction of natural and semi-natural meadow communities has occurred. Instead of abandoned meadows, areas overgrown with shrubs or trees can gradually form. Meadow communities (Ass. *Alopecuretum pratensis*, Ass. *Festucetum pratensis*) with rather productive and economically valuable grassland (6.1–10.0 points) have more chances to survive. Nevertheless, to preserve biological diversity, meadows producing small amount of vascular plant phytomass (Ass. *Molinietum caeruleae*, Ass. *Anthoxantho-Agrostietum tenuis*, All. *Mesobromion erecti*, Ass. *Polygalo-Nardetum strictae*) or those of low economic value (up to 6.0 points; Ass. *Cirsietum rivularis*, Ass. *Deschampsietum cespitosae*, Ass. *Molinietum caeruleae*, Ass. *Trifolio-Agrimonetum eupatoriae*, Ass. *Polygalo-Nardetum strictae*) are also important. Therefore, it is necessary to observe and evaluate natural meadow status, leave the areas for preservation of biological diversity as well as select a proper way of their management.

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REFERENCES

- Basalykas A. (ed.). 1958. Lietuvos TSR fizinė geografija, 1. Vilnius (In Lithuanian, summary in Russian).
- Bukantis A. (ed.). 2001. Klimatas. In: Liekis A. (ed.), Lietuvos dirvožemiai, Vilnius. Pp. 120 – 131. (In Lithuanian, summary in English).
- Eringis, K. 1964. Dolgolietnie kul'turnyje pastbisča Litvy. Vilnius (in Russian, summary in Lithuanian and Germany).
- Dierßen, K. 1996. Vegetation Nordeuropas. Stuttgart (in Germany).
- Green, B.H. 1990. Agricultural intensification and the loss of habitat, species and amenity in British grasslands: a review of historical change and assessment of future prospects. Grass and Forage Science, 45: 365 – 372.
- Gudžinskas Z. 1999. Vascular plants of Lithuania. Vilnius (in Lithuanian).
- Lapinskienė N. 1986. Podzemnaja čast' travjanistykh rastenij i fitocenzov v Litovskoj SSR. Vilnius (in Russian, summary in English).
- Muller S., Dutoit T., Alard D., Gréville F. 1998. Restoration and rehabilitation of species-rich grassland ecosystems in France: a review. Restoration Ecology, 6: 94 – 101.
- Petkevičius A., Stancevičius A. 1982. Pašariniai pievų ir ganyklų augalai. Vilnius (in Lithuanian).
- Pott R. 1995. Die Pflanzengesellschaften Deutschlands. Stuttgart (in Germany).
- Prach K. 1993. Vegetation changes in a wet meadow complex, South Bohemia, Czech Republic. Folia Geobotanica Phytotaxonomica, 28: 1 – 13.
- Rašomavičius V. (ed.). 1988. Vegetation of Lithuania, 1. Meadows. Kaunas–Vilnius (in Lithuanian, summary in English).
- Rašomavičius V. (ed.). 2001. Habitats of European Importance in Lithuania. Vilnius (in Lithuanian).
- Sendžikaitė, J. 2001: Structure and phytomass of meadow communities on the slope of Lake Davilas. Botanica Lithuanica, 7(3): 245 – 262.
- Statistical Yearbook of Lithuania. 2005. Statistics Lithuania, Vilnius.

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