Recent doctoral theses (ecology and environmental sciences) in Lithuania

Compiled by Virginija KALCIENĖ

REPRODUCTIVE ECOLOGY AND SUCCESS OF SEA TROUT *SALMO TRUTTA* L. IN A SMALL LOWLAND STREAM OF WESTERN LITHUANIA
ŠLAKIŲ *SALMO TRUTTA* L. REPRODUKCIJOS EKOLOGIJA IR EFEKTYVUMAS MAŽAME LYGUMŲ UPELYJE VAKARŲ LIETUVOJE

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Reproduction is a critical period of the salmonid fish life history. As early life stages are particularly sensitive to biotic and abiotic constraints, studying these stages is essential in salmonid population ecology, stocks management, conservation and restoration. No characterization of salmonid spawning habitats on a scientific basis has been made so far in the Eastern Baltic region, the rivers of which are important for salmonid reproduction and significantly contribute to the sea trout and salmon stocks in the Baltic.

The aim of this work was to assess sea trout spawning sites characteristics and to estimate their effects on reproductive success in a typical lowland salmonid stream, Blendžiava. The spawning site selection by sea trout females at different spatial scales was determined and spawning redds' sedimentary, hydraulic, and intragravel water physico-chemical characteristics were assessed. To test how the selected spawning sites influence sea trout reproductive success, *in situ* experiments on the survival of sea trout eggs and a study on fry emergence from natural redds and on dispersal of juveniles after emergence were accomplished. Additionally, a study on reproductive interaction between sympatric lampreys and salmonids was conducted.

The study results revealed that sea trout has specific spawning site preferences on a stream-, reach- and microhabitat scale, and is related with optimal conditions for egg survival. The vertical hydraulic gradient of hyporheic flow was found to be an essential factor which determines spawning site selection on a microhabitat scale and affects intragravel physico-chemical conditions. Upwelling groundwater significantly negatively affects egg incubation efficiency and fry emergence. A detailed sea trout fry emergence study revealed specific fry emergence patterns and a long overall period the end of which is critically important for emergent fish. The assessment of body condition status worsening of fish at the end of emergence was supported by analysis of muscle RNA : DNA ratio in emergent fry. Significant reproductive interaction in terms of sea trout redd superimposition by spring-spawning *Lampetra* sp. lampreys was described for the first time, suggesting the likely ecological effect on pre-emergent and emerging trout fry. The results of the present study supplement our understanding of a complex ecology of early life stages of salmonids and the functioning of ecosystems of salmonid rivers.

Key words: redd, egg survival, fry emergence, groundwater upwelling, superimposition

ESTIMATION OF EXPOSURE TO ROAD TRAFFIC NOISE AND ITS RELATION TO THE RISK OF HYPERTENSION IN WOMEN
AUTOMOBILIŲ TRANSPORTO KELIAMO TRIUKŠMO EKSPOZICIJOS ĮVERTINIMAS IR JOS RYŠYS SU MOTERŲ HIPERTENZIJOS RIZIKA

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The aim of this research is to estimate and evaluate the motor noise level in Kaunas city, and by controlling the influence of confounding factors to determine the residential noise impact on the risk of hypertension among women aged 20–45.

In this research, applying GIS and using Kaunas municipality noise measurement and modelling data, traffic flow and noise level maps were created and the influence of different truck type on prevailing environmental noise was evaluated for the first time. Individual residential exposition to 24-hour and night-time noise for hypertension risk was assessed for all study subjects. For the first time, by modelling traffic flow composition variations the noise level changes in the main streets of Kaunas were predicted. For the first time in Lithuania we used GIS for individual exposure estimation seeking to evaluate individual residential exposure to noise amongst reproductive aged women (20–45 years old) and controlling for confounding variables to assess association with hypertension risk.

The data show that noise level depends on the average equivalent traffic flow. Heavy vehicles' input to noise level is higher when traffic intensity in the streets is low. The study shows that traffic noise can increase women hypertension risk. An exposure effect of road traffic noise was stronger in the ^{3}30 years age group. After full adjustment for potential confounding factors, a statistically significant increased hypertension risk of about 80% with exposure to high noise levels was revealed. Occupational noise and a noisy living place has a tendency to increase hypertension risk twice for women aged ≥30 (OR 2.03; 95% CI 0.87–4.74) and by 70% (OR 1.70; 95% CI 0.88–3.28) among women aged 20–45.

Key words: noise level, hypertension, traffic intensity

OXYGEN AND NUTRIENT EXCHANGE AT THE SEDIMENT-WATER INTERFACE IN THE EUTROPHIC BOREAL LAGOON (BALTIC SEA)
DEGUONIES IR MAISTO MEDŽIAGŲ APYKAITA TARP DUGNO NUOSĖDŲ IR PRIEDUGNINIO VANDENS EUTROFINĖJE BOREALINĖJE ĮLANKOJE (BALTIJOS JŪROJE)

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This study was performed to quantify the dynamics of the dissolved oxygen and nutrient (NH_4^+, NO_x^- and PO_4^{3-}) exchange at the sediment–water interface in the principal Curonian Lagoon environments. In this eutrophic estuarine system, the seasonal dynamics of chlorophyll *a* is tightly coupled with temperature and nutrient availability and is an important complex driving the oxygen and nutrient exchange process. Multivariate analysis results showed water chlorophyll *a* having a significant impact on oxygen uptake, which in turn played an important role in the reduction of the oxic layer thickness with a positive feedback to the release of soluble reactive phosphorus.

The results of this study indicate that bottom sediment has potential to remove, retain or release nutrients from / to the water column and consequently to influence eutrophication processes. Thus, this study supplies that benthic–pelagic coupling and its role in the ecosystem functioning at the Curonian Lagoon is important. Generally, the sediment role shifted from the source to sink along the depth gradient, being source in deep and sink in shallow sites.

Key words: Curonian Lagoon, eutrophication, sediment–water interface

ESTIMATION OF INDIVIDUAL EXPOSURE TO NITROGEN DIOXIDE AND ITS RELATION TO ADVERSE PREGNANCY OUTCOMES IN KAUNAS
INDIVIDUALIOS EKSPOZICIJOS AZOTO DIOKSIDU NUSTATYMAS IR RYŠIO SU NEPALANKIOMIS NĖŠTUMO BAIGTIMIS TYRIMAS KAUNO MIESTE

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There is now some epidemiological evidence concerning adverse effects of traffic-related air pollution on pregnancy outcomes and infant health. The evidence is suggestive of causality for the association of birth weight with air pollution, although for preterm birth and fetal growth the current evidence is insufficient to infer causal relationship and effects were not always consistent between studies.

Nitrogen dioxide (NO_2) is considered to be a marker for air pollution from traffic associated with health effects. In addition, a number of epidemiological studies have found various level relationships between exposures to traffic-related NO_2, suggesting that exposure to these air pollutants may increase women risk for adverse birth outcomes.

The objective of the study was to assess individual maternal exposure to NO_2 during pregnancy and to analyse the links between exposure and pregnancy outcomes.

As to scientific novelty and significance, for the first time in Lithuania we used GIS for individual exposure assessment seeking to improve the NO_2 exposure assessment for study population. Furthermore, we verified sensitivity of the Airviro dispersion modelling NO_2 in Kaunas by using Ogawa passive samplers. For the first time in Lithuania the effects of NO_2 exposure for adverse pregnancy outcomes were evaluated by using GIS for individual maternal exposure assessment and controlling for the influence of potential confounding variables.

The outcomes of interest are related to low birth weight (LBW), term low birth weight (TLBW), small for gestational age (SGA), and preterm birth (PB). Controlling confounding variables, the strongest relation between adverse pregnancy outcomes and NO_2 levels has increased with increasing ambient air NO_2 exposure.

Key words: nitrogen dioxide, adverse pregnancy outcomes, geographic information systems

INTEGRATED ASSESSMENT OF POLLUTION AND BIOMARKER RESPONSES IN THE BALTIC SEA
INTEGRUOTAS APLINKOS TARŠOS BEI BIOŽYMENŲ ATSAKO VERTINIMAS BALTIJOS JŪROJE

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The aim of the study is an integrated assessment of the spread of contaminants and their biological effects in the Lithuanian zone of the Baltic Sea. The long-term monitoring data on contaminants in water, sediments and biota were summarized; the peculiarities of distribution of contaminants in the Klaipėda harbour, Būtingė oil terminal, dredged sediments dumping site, adjacent area to the Russian D-6 oil platform and chemical munitions dumpsite were described; biomarker responses in marine organisms from the different areas of the south-eastern Baltic Sea and the Curonian Lagoon were evaluated and the impact of contaminants on biomarker responses in mussels was assessed.

The thesis reflects the overall goals of the hazardous substances segment of the HELCOM Baltic Sea Action Plan – to achieve the Baltic Sea with life undisturbed by hazardous substances, and of the EU Marine Strategy Framework Directive – concentrations of contaminants are at levels not giving rise to pollution effects. The ongoing activities of the HELCOM and EU are aimed at the integrated holistic assessments of the environmental state of the Baltic Sea. The combination of contaminant concentrations with the biological effects were used in the HELCOM Chemical Status Assessment Tool CHASE, which has also been applied to Lithuanian waters. Whereas more scientific evidence appears, the biological effects become an important issue of the environmental research. This study also reflects the importance of integration of biological effects to the Baltic Sea environmental monitoring programme.

Key words: Baltic Sea, monitoring, pollution, biomarkers

DIVERSITY AND ECOLOGY OF *SARCOCYSTIS* IN LITHUANIAN GAME FAUNA
LIETUVOS MEDŽIOJAMOSIOS FAUNOS SARKOSPORIDIJŲ (*SARCOCYSTIS*) ĮVAIROVĖ IR EKOLOGIJA

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Up till now the ecology and biodiversity of *Sarcocystis* species in the game fauna in Lithuania have been investigated using traditional morphological methods. In the period of 2005–2011, muscle samples of 384 birds and 177 mammals were examined for Sarcocystis sarcocysts. The cysts of *Sarcocystis* spp. were investigated using light microscopy, transmission electron microscopy and DNA analysis (18S rDNA, 28S rDNA, ITS–1 region). Statistically significant higher *Sarcocystis* infection prevalence and intensity rates ($p < 0.05$) were determined in mammals as compared to the birds. Macrocysts were detected only in the Mallard, they were identified as S. rileyi and this is the first evidence of *S. rileyi* infection in Europe. Based on the results of cyst wall ultrastructure and DNA analysis, four new bird *Sarcocystis* species were described: *S. albifronsi, S. wobeseri, S. anasi, S. cornixi*. Eight *Sarcocystis* species were identified in the examined mammals using morphological and DNA analysis: *S. miescheriana* from wild boar; *S. gracilis, S. capreolicanis, S. oviformis, S. silva* and *S. hofmanni*-like from roe deer; *S. hjorti, S. hofmanni*-like and *Sarcocystis* sp. ex *Cervus elaphus* from red deer; *S. hjorti* from moose. *S. columbae, S. oviformis, S. hjorti* and *S. silva* were found in Lithuania for the first time. Using molecular investigation it was proved that some analysed *Sarcocystis* species (*S. wobeseri, S. hjorti, S. silva* and *S. hofmanni*-like) are not rigidly specific to the intermediate host. *Sarcocystis* species in the phylogenetic trees of 18S rDNA and 28S rDNA were grouped according to the similarity of the morphological characteristics and relatedness of intermediate and definitive hosts.

Key words: *Sarcocystis*, game fauna, molecular markers, microscopy

DNA POLYMORPHISM OF COMMON ASH (*FRAXINUS EXCELSIOR* L.) AND THE INFLUENCE OF ECOLOGICAL CONDITIONS *IN VITRO* ON MORPHOGENESIS IN ISOLATED EMBRYO CULTURE
PAPRASTOJO UOSIO (*FRAXINUS EXCELSIOR* L.) DNR POLIMORFIZMAS IR EKOLOGINIŲ SĄLYGŲ POVEIKIS GEMALŲ MORFOGENEZEI *IN VITRO*

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Currently, the massive dieback of the common ash (*Fraxinus excelsior* L.) is observed in many European countries. Starting in 1996, a large-scale dieback of ash stands has been increasingly observed in Lithuania. The aim of the research was to estimate genetic diversity of common ash and to evaluate the influence of environmental conditions on embryo morphogenesis *in vitro*. The random amplified polymorphic DNA (RAPD) method was used for the evaluation of genetic diversity of common ash. The microsatellite method was used for the estimation of genetic similarity of common ash maternal trees and offspring. The genetic similarity of offspring to maternal trees varied from 42.1 to 64.9%. This showed the parental alleles difference from maternal alleles as well as high level of DNA polymorphism in common ash families. According to RAPD polymorphism results, genetic variations within and among populations of common ash were determined.

One of the techniques currently widely used for the preservation of genetic diversity of endangered plant species is the propagation *in vitro*. Embryo culture is a convenient method for studying organogenesis of common ash *in vitro*. The *in vitro* propagation of common ash has not been analysed in Lithuania as yet. Following identification of the best medium for common ash embryo development, the influence on common ash morphogenesis *in vitro* of pH rate (acidity) and light spectrum was investigated. The selection of the best (by morphogenetic potential) plantlets, the *in vitro* technique, was adapted for the adventitious shoot multiplication in the isolated embryo culture. This method can be applied for the massive propagation of the selected genotypes of common ash.

Key words: common ash, genetic diversity, morphogenesis *in vitro*, RAPD, microsatellite

EFFECTS OF EXPOSURES TO DRINKING WATER TRIHALOMETHANES AND TOBACCO SMOKE ON ADVERSE PREGNANCY OUTCOMES IN RELATION TO GLUTATHIONE S-TRANSFERASE T1 AND M1 GENE POLYMORPHISM
TRIHALOMETANŲ GERIAMAJAME VANDENYJE IR TABAKO DŪMŲ POVEIKIS NEPALANKIOMS NĖŠTUMO BAIGTIMS ESANT GLUTATIONO S-TRANSFERAZĖS T1 IR M1 GENETINIAM POLIMORFIZMUI

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Adverse pregnancy outcomes cause a large public health burden because of its high prevalence, and environmental hazards are considered to be potential risk factors. The main causes of many adverse pregnancy outcomes are not known, but there is increasing evidence that the greatest impact may have the environment. Fetal development most likely depends on a number of interacting factors, including genetic, epigenetic, and environmental risk factors. Given different environmental exposures and individual genetic variations of pregnant women, the study may reveal women groups susceptible to environmental hazards and explain the differences in risk of adverse pregnancy outcomes among individuals exposed to a particular environmental toxicant. Furthermore, an enhanced understanding of pathologic mechanisms may allow the development of interventions that can be used to prevent adverse pregnancy outcomes.

The present study suggests the prevalence of GSTT1–0 and GSTM1–0 genotypes in Lithuanian population. For the first time in Lithuania the effects of drinking water THM exposure and tobacco smoking for adverse pregnancy outcomes in relation to Glutathione S-transferase T1 and M1 gene polymorphism were evaluated. Furthermore, we found an association between exposure to high THM internal dose during pregnancy and the presence of the GSTM1 null and GSTT1 null genotypes for the risk of low birth weight, providing evidence that both genetic and environmental factors determine complex traits such as adverse pregnancy outcomes. The genes involved in metabolic detoxification processes such as GSTM1 and GSTT1 should be treated as candidate risk factors for low birth weight.

The results of this study stress the need for appropriate policy and programs aimed at cessation of tobacco smoking and chlorinated drinking water use during pregnancy. The improved understanding of etiological mechanisms of adverse pregnancy outcomes should allow clinicians to design appropriate interventions so that the incidence of low birth weight and related fetal and neonatal morbidity and mortality will be reduced.

Key words: adverse pregnancy outcomes, GSTT1-0, GSTM1-0, trihalomethanes, tobacco smoke