Book of Abstracts

4 – 7 September 2012

Escola Superior Agrária

Instituto Politécnico de Bragança

Bragança- PORTUGAL

INTERNATIONAL MEETING ON BIOLOGY AND CONSERVATION OF FRESHWATER BIVALVES

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4 – 7 September 2012

School of Agriculture

Polytechnic Institute of Bragança

Bragança, PORTUGAL

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Editors: Amílcar Teixeira, Manuel Lopes-Lima, Simone Varandas, Ronaldo Sousa, Elsa Froufe, Fernando Teiga

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International Meeting of Biology and Conservation of Freshwater Bivalves

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Edited by

Amílcar Teixeira

Manuel Lopes-Lima

Simone Varandas

Ronaldo Sousa

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Polytechnic Institute of Bragança, PORTUGAL

September, 2012

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Preface

Freshwater bivalves are a very important part of biodiversity, increasingly recognized as having key roles in the ecosystems they inhabit. Their global decline has been causing increasing concern. Although in recent decades there has been an increasing number of studies on the ecology and conservation of these animals, the integration of knowledge acquired by different research groups becomes urgent. This approach, in a comprehensive and integrative manner will also help policy makers to establish guidelines, which can then be applied in conservation management of these animals and their natural habitats.

It is under this perspective that this event was organized: to bring together international experts in biology and conservation of freshwater bivalves that through a cycle of conferences and debates, will be able to create a network of knowledge with the final goal of developing collaborative projects and eventually global directives for the protection and conservation of this important faunistic group.

The event was also initiated to bring scientists and students working in diverse topics in the research on biology and conservation of freshwater bivalves such as: general biology and ecology, conservation and threats to species and ecosystems, invasive species, phylogeny and phylogeography, systematics and taxonomy, physiology and reproduction and freshwater bivalves and ecosystem functioning. In addition, this is an opportunity to get together experts on distinct groups of freshwater bivalves from the tiny sphaeriid clams to the naiads passing through the major invasive threats of dreissenids and corbiculids.

In this context we would like to express our appreciation to our sponsors and organizing institutions and our gratitude to our keynote speakers, authors, session chairpersons and especially all attendees whose contributions have made the meeting a success.

The Organizing Committee

Amílcar Teixeira
Manuel Lopes-Lima
Simone Varandas
Ronaldo Sousa
Elsa Froufe
Fernando Teiga

Organization

- **Escola Superior Agrária do Instituto Politécnico de Bragança**
- **Universidade de Trás os Montes e Alto Douro**
- **CIMO- Centro de Investigação de Montanha**
- **CIIMAR-LA- Centro Interdisciplinar de Investigação Marinha e Ambiental**
- **CITAB- Centro de Investigação e de Tecnologias Agro-Ambientais e Biológicas**

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Chris Barnhart - Missouri State University, USA
David Aldridge - Cambridge University, United Kingdom
Rafael Araujo - Museo Nacional de Ciencias Naturales (CSIC), Spain
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Arthur Bogan - North Carolina Museum of Natural Sciences, USA
Mary Seddon- IUCN Freshwater Biodiversity Unit, Huntingdon Road, Cambridge, UK

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Christel Santos - School of Agriculture of Polytechnic Institute of Bragança, Portugal
Sandra Araújo - CIIMAR and ICBAS of Porto University, Portugal

Keynote speakers

Dr. Christopher Barnhart

Department of Biology, Missouri State University, Springfield, Missouri, USA

Dr. Barnhart research interests include the physiological ecology of animals, particularly in freshwater. Current projects focus on the conservation biology and captive propagation of freshwater bivalves, and the effects of hypoxia on aquatic organisms.

Dr. Mary Seddon

IUCN Freshwater Biodiversity Unit, Huntingdon Road, Cambridge, UK

Dr. Mary Seddon is currently the Chair of the SSC's Mollusc Specialist Group. She is also the head of Mollusca at Amgueddffa Cymru – National Museum Wales, based in Cardiff, UK. She's been working there on the taxonomy, biogeography and systematics of European and African landsnails since 1990. Since 1994 Mary has served as a member of the Mollusc Specialist Group and since 1995 has directed volunteer activity on Red Lists.

Dr. David L. Strayer

Cary Institute of Ecosystem Studies, Millbrook New York, USA

Dr. Strayer's research is focused on the distribution and roles of freshwater invertebrates. He is currently working on the ecology of the Hudson River and on understanding the controls on distribution and abundance of pearly mussels.

Dr. David Aldridge

Department of Zoology, University of Cambridge, Cambridge, United Kingdom

Dr. Aldridge research focuses on the ecology of aquatic ecosystems, and in particular invasive species and the role of bivalve molluscs. Much of his work centres on using biology and ecology to answer questions which have wider practical applications. He is also the founder and Managing Director of BioBullets, a company that produces bivalve antifouling particles, since its inception in 2003.

Dr. Rafael Araujo Armero

Dept. de Biodiversidad y Biología Evolutiva, Museo Nacional de Ciencias Naturales (CSIC), Madrid, Spain

Dr. Araujo is an expert on Iberian naiads and its main research lines are on Biology, Taxonomy, Biogeography and Conservation of freshwater mussels. Currently is Research Curator of the malacological collection at the Museo Nacional de Ciencias Naturales (Madrid, Spain).

Dr. Jurgen Geist

Wildlife Biology & Wildlife Management Unit, Technische Universität München Wissenschaftszentrum Weihenstephan, Freising, Germany

Dr. Geist research is directed to the development of system biology models for chronological and spatial distribution of biodiversity in water ecosystems which integrate molecular biology and ecology approaches. Focus is placed on the quality of the aquatic habitat, genetic and demographic structures of fish and mussel populations, aquatic food webs and the development of stress biomarkers to indicate pollution in water bodies.

Dr. Arthur Bogan

North Carolina Museum of Natural Sciences, Raleigh, North Carolina, USA

Dr. Bogan's research is focused on developing a phylogeny of the freshwater bivalves of the world. Other research interests lie in developing a handbook on freshwater gastropods of North Carolina. He is also part of a collaboration team that's been formed to produce a photographic catalog of the nearly 1,000 named taxa in the North American freshwater gastropod family Pleuroceridae.

Field Trips

There will be two simultaneous field trips in the conference: **1) Côa Valley Archaeological Park** or **2) Visit to freshwater mussels by the rivers Tuela and Tua (Douro basin).**

Buses will leave from the main gate of the IPB Campus at 7:00 on Friday, September 7, and will return at 19:00. Previous registration is required.

Venues

The conference will take place at the Auditorium Paulo Quintela (R. Abílio Beça, September 4), located near the centre of Bragança (see map below) and at the Auditorium Dionísio Gonçalves in the Campus Santa Apolónia- School of Agriculture of the Polytechnic Institute of Bragança (September 5 and 6).

Internet and computer access

Wireless internet will be available. Please ask for access codes at the Information Desk. IPB is part of the Eduroam European network.
A computer room will also be available to participants of the conference.

Transportation

The organization will provide a bus from and to hotels recommended (Hotel S. Lázaro, Hotel Ibis and Pousada da Juventde). Check for schedules at your hotel and at Information Desk. Alternatively, taxi service is available upon request:

- Praça de Táxis, Av. João da Cruz, Phone: 273 322 138
- Praça de Táxis, Estação Rodoviária, Phone: 273 322 007

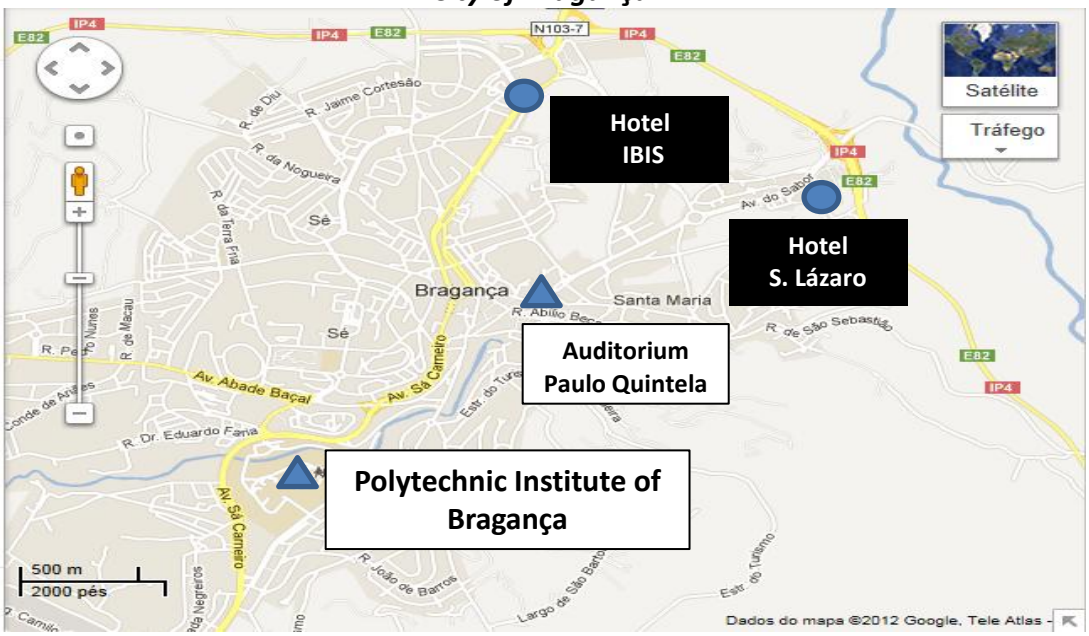
Food and Refreshments

A welcome Ice Breaker cocktail will be served at the Centro de Arte Contemporânea Graça Morais (R. Abílio Beça 105, near the center of Bragança) in the first day of the International Meeting. Lunches in the remaining days of the conference (except the day of field trips- 7th September) will be served at the IPB Canteen (Cantina Alternativa do IPB), located at the Campus de Santa Apolónia (see the map below).

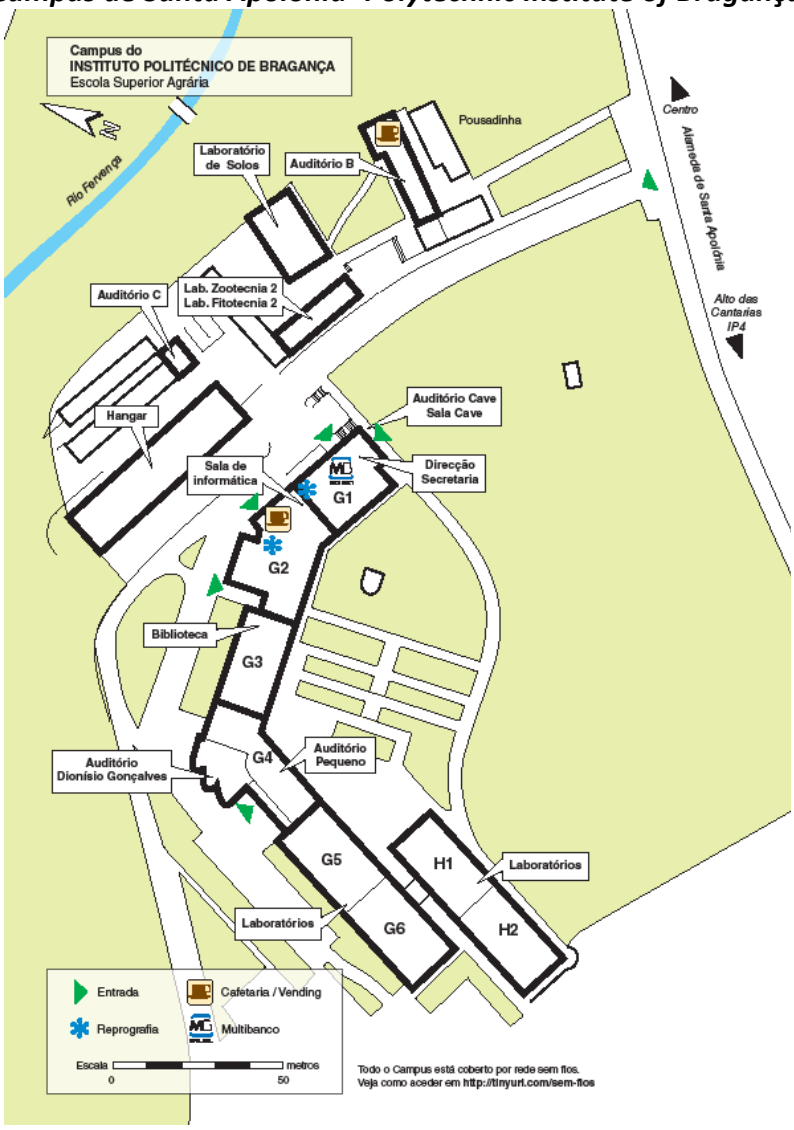
Morning and afternoon coffee breaks will be available outside of Auditório Paulo Quintela (R. Abílio Beça, September 4) and Auditório Dionísio Gonçalves (G4 in the map) at the School of Agriculture of the Polytechnic Institute of Bragança (September 5 and 6).

Maps

City of Bragança



Campus de Santa Apolónia- Polytechnic Institute of Bragança



Schedule overview

	Aud. Paulo Quintela Bragança- R. Abílio Beça	Aud. Dionísio Gonçalves IPB- Campus Sta Apolónia	Aud. Dionísio Gonçalves IPB- Campus Sta Apolónia	Field Trips
Time	**Tuesday 04/07**	**Wednesday 05/07**	**Thursday 06/07**	**Friday 07/07**
8:30		Keynote Lecture David Aldridge (GBR)	Keynote Lecture Jurgen Geist (GER)	Social Programme 1) Côa Valley Archaeological Park 2) Visit to freshwater mussels- rivers Tuela and Tua (Douro basin)
9:00				
9:15		Oral Communications	Oral Communications	
9:30				
10:00	Registration			
10:30		Coffee-break	Coffee-break	
11:00		Oral Communications	Oral Communications	
11:30				
12:00				
12:30	Lunch	Lunch	Lunch	
13:45	Opening Session			
14:00	Keynote Lecture Chris Barnhart (USA)	Keynote Lecture Rafael Araujo (ESP)	Keynote Lecture Arthur Bogan (USA)	
14:30				
14:45	Oral Communications	Oral Communications	Oral Communications	
15:00				
15:30				
16:00	Coffee-break	Coffee-break	Coffee-break	
16:30	Keynote Lecture Mary Seddon (GBR)	Oral Communications	Oral Communications	
17:00				
17:30	Oral Communications			
18:00				
18:15			Poster Presentations	
18:30	Keynote Lecture Dave Strayer (USA)	Poster Presentations		
19:45				
20:00	*Welcome "Ice Breaker" cocktail*			Conference Dinner Closing & Awards

Overview and Oral Presentations

September 04

14:00-16:00

Abst.	Author(s)	Title
O1.1	*Invited Speaker:* Chris Barnhart (USA)	Host-specificity of Unionoid mussels: an arms race, or just keeping pace?
O1.2	Douda K, Kubíková L & Horký P (CZE)	A critical role of population level differences in host compatibility of freshwater mussels: *Unio crassus* host matching in fragmented river
O1.3	Tait C (USA)	Freshwater Mussels of a Western American River Basin - a Prehistoric Perspective
O1.4	Lois S, Ondina P, Outeiro A, Amaro R & San Miguel E (ESP)	The actual map of *Margaritifera margaritifera* (L.) in Galicia (NW Iberian Peninsula): A critical area for conservation of freshwater pearl mussel in the south of Europe
O1.5	Mock K, Brim Box J, Chong J, Howard J & Furnish J (USA)	Freshwater mussels in western North America: contrasting phylogeographies in a common landscape
O1.6	Inoue K, Levine T, Lang B & Berg D (USA)	Use of distance sampling to estimate population size and density of the Texas hornshell (*Popenaias popeii*, Lea 1857) in the Black River, NM, USA

16:30-18:30

Abst.	Author(s)	Title
O1.7	*Invited Speaker:* Mary Seddon (GBR)	Update on the status of the Global Freshwater Mollusc Assessment
O1.8	Aspholm P (NOR)	Comparing two measurement methods for inter- and intraspecific variations of year-class cohorts of young Freshwater Pearl Mussel (*Margaritifera margaritifera*) in three rivers in the Pasvik watershed catchment in Northern Norway
O1.9	Zieritz A, Geist J, Kuehn R, Gum B, Vannarattanarat S, Kanchanaketu T, Kovitvadhi U, Hongtrakul V & Kovitvadhi S (AUT)	Molecular species identification of European and Thai freshwater mussels (Unionoida)
O1.10	Karatayev A, Miller T & Burlakova, L (USA)	Long-term changes in unionid assemblages in the Rio Grande, one of the World's top 10 Rivers at Risk
O1.11	Lavictoire L, Moorkens L, Ramsey A, Sinclair B & Sweeting R (GBR)	Development of captive breeding protocols for the critically endangered freshwater pearl mussel *Margaritifera margaritifera*: Impacts of substrate
O1.12	*Invited Speaker:* Dave Strayer (USA)	An exploration of selected aspects of the relationships between nutrients and freshwater mussels (Unionoida)

September 05

08:30-10:30

Abst.	Author(s)	Title
O2.1	*Invited Speaker:* David Aldridge (GBR)	Managing mussel populations for the benefit of freshwater ecosystems
O2.2	Bódis E, Tóth B & Sousa R (HUN)	The invasive *Anodonta* (*Sinanodonta*) *woodiana* as an important resource subsidy
O2.3	Benkö-Kiss Á (HUN)	Data on development and collapse of invasive *Sinandonta woodiana* (Bivalvia, Unionoida) populations in Hungary
O2.4	Riccardi N, Lauceri R, Guerrieri N, Kamburska L, Guarneri I, Cardeccia A, Ferin P, Boggero A & Manca M (ITA)	*Corbicula fluminea* invasion in Lake Maggiore (Italy): population dynamics and comparison of dietary overlap with native mussels
O2.5	Sanz-Ronda F, López-Sáenz S & Palau-Ibars A (ESP)	Physical habitat of zebra mussel (*Dreissena polymorpha*) in the lower Ebro River (Northeastern Spain)
O2.6	Gomes C, Vasconcelos V, Guilhermino L & Antunes A (PRT)	The Asian invasive bivalve *Corbicula fluminea* in Minho and Lima estuaries: a molecular approach

11:00-12:30

Abst.	Author(s)	Title
O2.7	Boon P (SCT)	European guidance on the environmental requirements of freshwater pearl mussel (*Margaritifera margaritifera* L.)
O2.8	Bergengren J,Gezelius L, Eriksson M, Lirås V, Olsson I, Asp T, Zinko U,Herngren H, Proschwitz von T, Lundberg S & Österling M (SWE)	The thick shelled river mussel (*Unio crassus*) brings LIFE+ back to rivers
O2.9	Bespalaja Y, Bolotov I, Makhrov A & Aspholm P (RUS)	Ecology and conservation of the freshwater pearl mussel (*Margaritifera margaritifera*, Margaritiferidae) in the North-West of Russia
O2.10	Callil C & Mansur M (BRA)	How to design a database to be used effectively as a tool for conservation of freshwater mussels? The stones' way in the Central part of Brazil
O2.11	Capoulade M, Dury P, Pasco P-Y & Ribeiro M (FRA)	Conservation of *Margaritifera margaritifera* (Linnaeus, 1758) in the Armorican Massif (Brittany and Lower-Normandy, France)
O2.12	Taeubert J & Geist J (GER)	The relationship between endangered thick-shelled river mussel (*Unio crassus*) and its host fishes

September 05

14:00-16:00

Abst.	Author(s)	Title
O2.13	*Invited Speaker:* Rafael Araujo (ESP)	Knowing and conserving the European (and North African) naiads. Reflections from the South of Europe
O2.14	Burlakova L & Karatayev A (USA)	Biogeography and conservation of freshwater mussels (Bivalvia: Unionidae) in Texas: drivers of diversity and threats
O2.15	Denic M & Geist J (GER)	The freshwater pearl mussel (*Margaritifera margaritifera*) in Bavaria – population status, conservation efforts and challenges
O2.16	Thielen F, Eybe T, Muller T, Bohn T & Sures B (LUX)	The first millimetre – Rearing of juvenile Freshwater Pearl Mussels (*Margaritifera margaritifera*) in plastic boxes
O2.17	Clavijo C, Scarabino F, Carranza A, Martínez G & Soutullo A (URY)	Conservation of freshwater bivalves in Uruguay: opportunities and challenges
O2.18	Gosselin M-P, Lavictoire L & Sweeting R (GBR)	Identification of the factors responsible for the decline of the Freshwater Pearl Mussel (*Margaritifera margaritifera*) in the North Tyne, North-East England, in order to develop a restoration plan for the species.

16:30-18:30

Abst.	Author(s)	Title
O2.19	Henrikson L & Söderberg H (SWE)	Liming saves the Freshwater Pearl Mussel *Margaritifera margaritifera* (L.) from acidification
O2.20	Hua D, Neves R & Jiao Y (USA)	Monitoring survival and growth of laboratory-cultured endangered mussels, *Epioblasma capsaeformis* and *E. brevidens*, released into the Powell River, Tennessee, USA
O2.21	Killeen I & Moorkens E (IRL)	Monitoring freshwater pearl mussels, practicalities and interpretation
O2.22	Larsen B, Saksgård R & Forseth T (NOR)	Host specificity in freshwater pearl mussel *Margaritifera margaritifera* populations in Norway – experimental studies
O2.23	Dimock R & Aldridge D (USA)	Fish Tales and Mussels: Role Reversal in a Fish-Mussel Symbiosis
O2.24	Reis J, Rosa P, Martinez A, Menéndez D & Malveiro S (PRT)	Standard Methods for Evaluating Dam Impacts on Freshwater Mussels

September 06

08:30-10:30

Abst.	Author(s)	Title
O3.1	*Invited Speaker:* Jurgen Geist (DEU)	Towards effective conservation management strategies of endangered freshwater mussels: The step-wise approach
O3.2	Choo J & Taskinen J (FIN)	Temperature-dependent seasonal and annual larval production of *Rhipidocotyle trematodes* parasitizing freshwater mussel, *Anodonta anatina*
O3.3	King T, Shallom J, Eackles M, Johnson R, Lubinski B, Printz J, Lellis W, Wicklow B & Hallerman E (USA)	Conservation genomics of unionids: Insights gained from next generation sequencing of *Alasmidonta heterodon*, *A. varicosa*, and *Elliptio complanata*
O3.4	Prié V, Puilandre N & Bouchet P (FRA)	Phylogeography of French unionids: continental insularity and conservation in an age of global connections
O3.5	Pfeiffer J & Graf D (USA)	Evolution of Asymmetrical Larvae in Freshwater Mussels (Bivalvia:Unionidae)

11:00-12:30

Abst.	Author(s)	Title
O3.6	Machado J & Lopes-Lima M (PRT)	Shell Calcification on Freshwater Bivalves: An Overview
O3.7	Gumpinger C, Scheder C & Csar D (AUT)	The Austrian Freshwater Pearl Mussel Conservation Project
O3.8	Santos P, Peñín E & Palacios J (ESP)	New perspectives for the conservation of the freshwater pearl mussel *Margaritifera margaritifera* in Castilla y Leon (NW Spain)
O3.9	Österling M & Söderberg H (SWE)	Anthropogenic changes of brown trout *Salmo trutta* and the impact on its parasitic mussel *Margaritifera margaritifera*
O3.10	Popov I & Ostrovsky A (RUS)	Rediscovery of the freshwater pearl mussel (*Margaritifera margaritifera*) populations within the territory of the Baltic Sea basin in Russia

September 06

14:00-16:00

Abst.	Author(s)	Title
O3.11	*Invited Speaker:* Arthur Bogan (USA)	Phylogeny of the Unionida: A current assessment
O3.12	Dreher-Mansur M, Pereira D, Pimpão D, Callil C, Ituarte C, Parada E, Peredo S, Darrigran G, Scarabino F, Clavijo C, Lara G, Miyahira I (BRA)	Conservation Status of Freshwater Bivalves in South America: State of the Art, Perspectives and Future Challenges
O3.13	Moorkens E & Killeen I (IRL)	Juvenile *Margaritifera margaritifera* (Bivalvia, Unionoida) – the survival of the cleanest. Sedimentation studies on a selection of rivers
O3.14	Kovitvadhi S & Kovitvadhi U (THA)	Influence of Difference Environment on Growth of Freshwater mussel, *Hyriopsis* (*Hyriopsis*) *bialatus*
O3.15	Kovitvadhi U & Kovitvadhi S (THA)	Reproductive cycle and *in vitro* culture of freshwater mussel glochidia (Bivalvia: Unionidae)
O3.16	Scheder C, Lerchegger B, Jung M, Csar D & Gumpinger C (AUT)	Growth and survival of *Margaritifera margaritifera* glochidia on host fish gills and of juvenile mussels in climate chambers

16:30-18:30

Abst.	Author(s)	Title
O3.17	Miyahira I, Mansur M & Santos S (BRA)	Type material of *Diplodon ellipticus* (Spix in Wagner, 1827) (Unionoida, Hyriidae) rediscovered
O3.18	Stoeckl K & Geist J (DEU)	New aspects and implications for the conservation of the thick-shelled river mussel (*Unio crassus*)
O3.19	Sweeting R & Lavictoire L (GBR)	Captive rearing of the freshwater pear mussel *Margaritifera margaritifera* in the UK – Lessons learned
O3.20	Taskinen J, Ranta M, Välilä S, Salonen J & Oulasvirta P (FIN)	Within-river spatio-temporal relationship between the freshwater pearl mussel *Margaritifira margaritifera* and its fish host *Salmo trutta*
O3.21	Thomas G & Garcia de Leaniz C (WLS)	Behavioural and physiological impacts of freshwater mussel glochidia on juvenile brown trout intermediate hosts
O3.22	Vikhrev I, Bolotov I & Makhrov A (RUS)	Modern conditions of freshwater pearl mussel *Margaritifera margaritifera* (L., 1758) populations in loose floating rivers of the basin of the White Sea south coast (North-west of Russia)

Overview and Poster Presentations

September 05 and 06

18:30-20:00

Abst.	Author(s)	Title
P1	Almeida D, Vasconcelos V & Antunes A (PRT)	Molecular detoxification - a powerful resource to environmental adaptation and survival in Bivalves
P2	Arendt A & Thielen F (LUX)	LIFE11 NAT/LU/857 Restoration of *Unio crassus* rivers in the luxemburgish Ardennes: a summary description of a new project 2012-2018
P3	Artamonova V, Bolotov I, Klishko O, Bespalaja Y, Voroshilova I, Makhrov A & Frolov A (RUS)	Origin and Routes of Expansion of Freshwater Pearl Mussels (*Margaritifera*)
P4	Aspholm P (NOR)	Corrosion rates in shells from dead Freshwater Pearl Mussel (*Margaritifera margaritifera*) from the Pasvik watershed catchment in Northern Norway
P5	Benkő-Kiss Á (HUN)	Changes of some mussel populations in Hungary
P6	Bergengren J, Gezelius L, Eriksson M, Lirås V, Olsson I, Asp T, Zinko U, Herngren H, Proschwitz von T, Lundberg S & Österling M (SWE)	The thick shelled river mussel (*Unio crassus*) brings LIFE+ back to rivers
P7	Burlakova L, Karatayev A, Zanatta D, Tulumello B, Lucy F & Mastitsky S (USA)	*Dreissena* impacts on Unionidae: general trends in North America and Europe and recent findings from Lake Erie
P8	Callil C, Surubim M, Colle A & Silva F (BRA)	Ecological correlates of the *Anodontites trapesialis* (Lamarck, 1819) (Mycetopodidae: Unionoida): The greater freshwater mussel of South America
P9	Capoulade M, Dury P, Pasco P-Y & Ribeiro M (FRA)	Conservation of *Margaritifera margaritifera* (Linnaeus, 1758) in the Armorican Massif (Brittany and Lower-Normandy, France)
P10	Clavijo C (URY)	Critical reduction of *Cyanocyclas* geographic distribution in Uruguay: the shadow of *Corbicula*
P11	Csar D, Scheder C & Gumpinger C (AUT)	The importance of close cooperation of engineering, water legislation and nature conservation for the protection of endangered mussel species
P12	White M, Johnson E & Dimock R (USA)	Expression of HSP70 by *Utterbackia imbecillis* (Bivalvia: Unionidae) in Response to Copper
P13	Douda K, Lopes-Lima M, Hinzmann M, Machado J, Varandas S, Teixeira A & Sousa R (CZE)	The biotic homogenisation of host communities as a threat to local affiliate species: a case study with *Anodonta anatina* (Unionidae)
P14	Douda K, Simon O, Dort B & Švanyga J (CZE)	The relative importance of temperature and food to juvenile growth of *Margaritifera margaritifera* in its natural habitat
P15	Eybe T, Thielen F, Muller T, Bohn T & Sures B (LUX)	Influence of time of excystment on the breeding success of juvenile Freshwater Pearl Mussels (*Margaritifera margaritifera*)

September 05 and 06

18:30-20:00

Abst.	Author(s)	Title
P16	Ferreira N & Pardo I (ESP)	Metabolism adjustment and resistance in the Asian clam *Corbicula fluminea* (Müller, 1774) to osmotic stress in the River Miño estuary
P17	Froufe E, Teixeira A, Lopes A, Cardoso J, Reis J, Machado J, Hinzmann M, Fonseca M, Araujo R, Sousa R, Sobral C, Varandas S, Cortes R & Lopes-Lima M (PRT)	CONBI: Biodiversity and Conservation of Bivalves – Ecogeographic, Genetic and Physiological information
P18	Froufe E, Sobral C, Teixeira A, Lopes A, Sousa R, Varandas S & Lopes-Lima M (PRT)	Development of microsatellite markers and Multiplexed PCR for *Potomida littoralis*
P19	Froufe E, Lopes A, Sobral C, Teixeira A, Sousa R, Varandas S, Araujo R, Machado J & Lopes-Lima M (PRT)	Isolation and characterization of microsatellite loci for *Unio delphinus* and cross-species amplification in other *Unio* species
P20	Gačić Z, Kolarević S, Sunjog K, Kračun M, Paunović M, Knežević-Vukčević J & Vuković-Gačić B (SRB)	Impact of in vitro and in vivo exposure to cytostatics, 5-FU, etoposide and cisplatin on haemocytes of freshwater mussels *Unio pictorum* and *Unio tumidus* using alkaline comet assay
P21	Gnatyshyna L, Falfushynska H & Stoliar O (UKR)	Resilience of adaptive responses in freshwater bivalves (Unionidae) from different populations
P22	Hua D, Neves R & Jiao Y (USA)	Comparison of advanced culture methods for grow-out of freshwater mussels (BIVALVIA:UNIONIDAE) in a controlled environment
P23	Klishko O & Bespalaya Y (RUS)	Biogeochemical diagnostics and estimation of ecological condition of freshwater pearl mussels (Margaritiferidae)
P24	Kolarević S, Knežević-Vukčević J, Paunović M, Kračun M, Vasiljević B, Tomović J, Vuković-Gačić B & Gačić Z (SRB)	Monitoring of DNA damage in haemocytes of freshwater mussel *Sinanodonta woodiana* sampled from the Velika Morava River in Serbia with the comet assay
P25	Larsen B & Saksgård R (NOR)	Recovery of the freshwater pearl mussel *Margaritifera margaritifera* population in an acidified Norwegian river
P26	Larsen B & Karlsson S (NOR)	Freshwater pearl mussel *Margaritifera margaritifera*: Host specificity and genetic variation in Norway
P27	Lavictoire L & Sweeting R (GBR)	Captive rearing of the freshwater pear mussel *Margaritifera margaritifera* in the UK
P28	Lopes-Lima M, Hinzmann M, Sousa R, Varandas S, Machado J & Teixeira A	Portuguese Naiads Life History Traits: Reproductive Cycle and Host Fish Determination
P29	Lundberg S, von Proschwitz T & Bergengren J (SWE)	The thick-shelled river mussel (*Unio crassus* Philipsson, 1788) in Sweden: Distribution, ecology, status, threats and conservation

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Abst.	Author(s)	Title
P30	Lundberg S, von Proschwitz T & Bergengren J (SWE)	The unionoid freshwater mussels of Sweden, status and distribution
P31	Dreher-Mansur M, Bergonci P & Figueiredo G (BRA)	Brooding strategies of *Mytilopsis* from the Amazon River (Dreissenidae)
P32	Martins J, Campos A & Vasconcelos V (PRT)	Molecular adaptations of indigenous and non-indigenous bivalve species to cyanotoxins: the role of glutathione S-transferases
P33	Moorkens E, McGee M, Killeen I, McNally T, Glasgow G & Downes S (IRL)	Practical implementation of freshwater pearl mussel measures in the Republic of Ireland and Northern Ireland
P34	Morais P, Rufino M & Reis J (PRT)	Assessing the morphological variability of *Unio delphinus* Spengler in the Guadiana basin (SW-Iberian Peninsula, Europe) through geometric morphometric analyses
P35	Nakamura Antonacci K, Elbaile Périz E, Muñoz Yanguas M, Catalá Roca C & Salinas Yuste C (ESP)	Captive breeding of the endangered pearl mussel *Margaritifera auricularia*. Large scale laboratory production of juveniles
P36	Nakamura Antonacci K, Muñoz Yanguas M, Elbaile Périz E, Catalá Roca C & Salinas Yuste C (ESP)	Size-specific growth pattern of fresh water mussel *Margaritifera auricularia* in the Ebro river channels (Spain)
P37	Ondina P, Lois S, Outeiro A, Mascato R, Bouza C, San Miguel E & Amaro R (ESP)	Life Margal Ulla, recovery of *Margaritifera margaritifera* (L.) in the Ulla basin (Galicia, NW of Iberian Peninsula)
P38	Österling M & Högberg J (SWE)	The impact of land use on *Margaritifera margaritifera* and its host fish *Salmo trutta*
P39	Oulasvirta P, Aspholm P, Kangas M, Larsen B, Luhta P-L, Olofsson P & Taskinen J (FIN)	Restoration of freshwater pearl mussel populations with new methods – an EU Interreg project in the northern Fennoscandia
P40	Peltanová A, Hruška J, Simon O, Dort B, Spisar O, Bílý M, Kladivová V, Patzenhauerová H & Douda K (CZE)	Action plan for *Margaritifera margaritifera* in the Czech Republic (Central Europe) – concepts, targets and realization
P41	Pereira D, Padula-Paz I, Sofia-Souza A, Tanaka-Suzuki M, Azevedo J, Dreher-Mansur M & Raya-Rodriguez M (BRA)	Toxicity of *Bacillus thuringiensis* sv. *israelensis* on golden mussel, *Limnoperna fortunei* and on ecotoxicological indicators, *Pimephales pomelas* (Pisces), *Ceriodaphnia dubia* (Crustacea), and *Pseudokirchneriella subcaptata* (Algae)
P42	Pfeiffer J & Graf D (USA)	Phylogenetic reanalysis confirms *Lamprotula* (Mollusca: Bivalvia: Unionidae) Polyphyly
P43	Pinheiro-Santos C, Dreher-Mansur M, Mansur-Pimpão D, Aydos-Bergonci P & Figueiredo G (BRA)	Comparative larval morphology of native and invasive freshwater bivalves species
P44	Salonen J, Taskinen J, Kangas M, Luhta P-L, & Moilanen E (FIN)	Electro fishing as a new method to find freshwater pearl mussel (*Margaritifera margaritifera*) populations

September 05 and 06

18:30-20:00

Abst.	Author(s)	Title
P45	Sell J, Mioduchowska M, Kaczmarczyk A, Kilikowska A, Wysocka A, Zając K, Zając T, Trichkova T & Ivinskis P (POL)	Phylogeography of *Unio crassus* in Central Europe
P46	Simon O, Tichá K, Kubíková L, Douda K & Benáková A (CZE)	Detritus from springs as a possible food source for freshwater pearl mussel (*Margaritifera margaritifera*): composition, quantity and origin
P47	Simon O, Douda K, Peltanová A, Patzenhauerová H, Spisar O & Hruška J (CZE)	The situation of *Margaritifera margaritifera* in the Czech Republic – several successfully rejuvenated populations but the absence of natural reproduction
P48	Tantiwisawaruji S, Kovitvadhi U, Pardal M, Maria M & Rocha E (THA)	The nervous system of the peppery furrow shell *Scrobicularia plana* (da Costa, 1778): unveiling morphological features by computer-assisted 3D reconstruction
P49	Taskinen J, Saarinen-Valta M & Suonpää A (FIN)	Growth of *Anodonta anatina* (Unionidae) in lakes differing by their productivity and physical & chemical properties of water
P50	Teixeira A, Varandas S, Hinzmann M, Lopes-Lima M & Sousa R (PRT)	Ecological requirements of autochthonous mussel populations in northeastern rivers (Douro basin) of Portugal
P51	Thielen F, Eybe T & Muller T (LUX)	Culturing *Unio crassus* (L.), first trials from Luxembourg
P52	Välilä S, Knott E & Taskinen J (FIN)	Phylogeography and population genetics of the endangered freshwater pearl mussel (*Margaritifera margaritifera*) studied using mitochondrial DNA
P53	Valovirta I (FIN)	The translocation of the thick-shelled river mussels (*Unio crassus*) from the area of a bridge improvement project in Finland
P54	Varandas S, Teixeira A, Lopes-Lima M, Cortes R & Sousa R (PRT)	Distribution and composition of freshwater fish communities in northeastern rivers (Douro basin, Portugal): Implications for mussel conservation strategies
P55	Varandas S, Teixeira A, Lopes-Lima M, Cortes R & Sousa R (PRT)	Distribution and composition of brown trout in river Paiva (Douro basin, Portugal) and its linkage with freshwater pearl mussel
P56	Vuković-Gačić B, Kolarević S, Sunjog K, Tomović J, Knežević-Vukčević J, Paunović M & Gačić Z (SRB)	Comparative study of genotoxic response of freshwater mussels *Unio tumidus* and *Unio pictorum* to environmental stress
P57	Zając K, Zając T, Adamski P, Bielański W, Ćmiel A, Lipińska A & Klich M (POL)	Good population in bad habitat: on the ecology of the largest population of *Unio crassus* in Poland
P58	Barnhart MC (USA)	Methods for propagation and culture of freshwater mussels (Unionidae)

Abstracts

Oral Communications

Invited speaker

Host-specificity of Unionoid mussels: an arms race, or just keeping pace?

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Understanding the host relationships of Unionida is critical to the conservation of threatened species. The evolution of mussel host specificity has sometimes been described as an "arms race" but that view can be questioned. Certainly there is intense selection of glochidia, because only those able to metamorphose on available hosts will survive. On the other hand, there is probably little or no selective advantage for fish to immunologically reject glochidia. Glochidia attach indiscriminately to host and non-host species, and subsequent success or failure depends mainly on the fish innate immune system. Encapsulation is an innate anti-ectoparasite response by mobile fish keratocytes. On non-hosts, glochidia are killed within the capsule and/or sloughed. On compatible hosts, glochidia survive and sloughing is delayed until metamorphosis is complete. Although the response to heavy glochidia infections can harm or even kill fish, natural infestations are usually light, and there is apparently no evidence that fish are less stressed by sloughing incompatible glochidia than by hosting compatible ones. Mussel host-specificity is not evidence for the evolutionary adaptation of non-host fish species to reject particular mussels. In fact, the fish that encounter a mussel species most often are most likely to be hosts. Non-hosts or poor hosts are usually species that do not normally encounter the glochidia, and therefore could not be under any selective pressure to develop selective innate immunity. Moreover, the vertebrate TLR receptors that mediate innate immune responses recognize conserved molecular epitopes associated with broad classes of pathogens, not particular species. The ability of glochidia to circumvent the non-specific innate immune responses of host fish is not well-understood but is of great interest, because these adaptations are the basis of host-specificity. In contrast to innate immune responses, the adaptive immune responses of the host are apparently not circumvented by glochidia, and compatible hosts are able to develop at least partial immunity. However, adaptive immunity and antibody production develop slowly and apparently affect glochidia only in repetitive infections of individual fish.

Oral Session O1.1

A critical role of population level differences in host compatibility of freshwater mussels: *Unio crassus* host matching in fragmented river system

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Host-affiliate relationships between freshwater mussels and their fish hosts may determine the success of mussels' reproduction, dispersal abilities and their conservation status. Nevertheless, little is known about the differences in host compatibility on the population level, which can be critical for the persistence of species at particular sites. We studied two populations of the thick-shelled river mussel *Unio crassus* isolated by river fragmentation of the Vltava River basin (Czech Republic) in terms of their host compatibility. The hypothesis whether the two isolated populations of mussels differ in their host-parasite compatibility according to the site-specific composition of fish assemblages was tested. We conducted two series of experimental infections in laboratory conditions and used a ratio between the number of initially attached glochidia per fish and the proportion of them detaching in 24, 48 and 96 hours after the infections as a measure of glochidia-fish compatibility. First, we compared the ability of *U. crassus* larvae from both sites to infect the individuals of three fish species (*Squalius cephalus*, *Phoxinus phoxinus*, *Gasterosteus aculeatus*). Second, we compared the ability of *U. crassus* larvae to infect three groups of *S. cephalus* of different origin (wild-caught *S. cephalus* from the mussels' indigenous or non-indigenous site and hatchery reared specimens). Totally, 168 individually monitored fish were tested. The ability of *U. crassus* larvae to infect particular host fish strains substantially differed in the two studied sites. Hence, even nearby and only recently isolated populations of freshwater mussels may exhibit different host-parasite compatibility patterns. Population level approach to the management of host fish communities is needed at sites of conservation importance for freshwater mussels.

Oral Session O1.2

Freshwater Mussels of a Western American River Basin - a Prehistoric Perspective

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Beginning in 2001, freshwater mussels were systematically inventoried on drainages in the remote Owyhee River Basin of the arid interior western US. Two mussel species, *Gonidea angulata* and *Anodonta* sp., were encountered in the main river, but only *G. angulata* was widespread with multiple age-classes. However, mussel shells found in prehistoric Indian middens located on the main river and a tributary included shell fragments of *Margaritifera falcata* as well as *G. angulata*, indicating that both species were present and accessible for harvest ca. 1000 - 9500 years b.p. Because *M. falcata* relies on salmon and trout for hosts, its absence or scarcity in the mainstem Owyhee could be related to historic extirpation of anadromous salmonids, and the subsequent introduction of unsuitable hosts and piscivorous predators such as nonnative smallmouth bass (*Micropterus dolomieui*) and catfish. Declines in some European *Margaritifera* populations have been linked to trout host densities that drop below a critical threshold. *G. angulata*'s fish host preferences are not fully determined, but may include native sculpins (*Cottus* spp), species less impacted by introduced predators.

Oral Session O1.3

The actual map of *Margaritifera margaritifera* (L.) in Galicia (NW Iberian Peninsula): A critical area for conservation of freshwater pearl mussel in the South of Europe

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Historical and current distribution of *M. margaritifera* in Galicia (NW of Iberian Peninsula) are not well documented. The aim of this work is to know the distribution and conservation status of the species in this area. A combination of qualitative and quantitative sampling methods were applied in order to estimate their distribution, abundance and to detect juvenile presence. The species was detected in 555 sites which were spread in 54 rivers and tributaries belonging to 23 basins. The observed maximum density was 332 ind./m^2, and average density values within a river presents a wide variable range. Furthermore, the presence of mussels less than 65 mm was detected in 11 sites. Taking into account the current distribution of *M. margaritifera* in Iberian Peninsula, this study shows that Galicia presents the highest number of rivers with the species. These new results provide a basis to plan future conservation management measures to preserve the species in Galicia.

Oral Session O1.4

Freshwater mussels in western North America: contrasting phylogeographies in a common landscape

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In the western USA and Canada, there are three genera of native freshwater mussels (Unionoida) currently recognized: *Anodonta*, *Margaritifera*, and *Gonidea*. We compared phylogeographic structure at the continental scale in all three of these genera using both nuclear and mitochondrial markers**.** In *Anodonta* we found deep phylogenetic subdivision among groups of species, and a strong genetic signal of affiliation with major hydrologeologic basins. *Anodonta* population subdivision was generally pronounced, even among proximal populations in the same river systems, and population-level genetic diversity was relatively high. *Margaritifera* and *Gonidea* populations showed strikingly different patterns within and among basins from *Anodonta*, although they occupy many of the same drainages and all three genera are sometimes sympatric**.** *Margaritifera* populations were very distinct with respect to microsatellite allele frequencies, but had very low within-population genetic diversity, often with high numbers of identical multilocus genotypes. We attribute phylogeographic differences to host fish and life history differences among genera. Our findings demonstrate that organisms in a common landscape, with apparently similar ecological roles, morphologies, and general habitats, can have remarkably different phylogeographic signatures.

Oral Session O1.5

Use of distance sampling to estimate population size and density of the Texas hornshell (*Popenaias popeii*, Lea 1857) in the Black River, NM, USA

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Freshwater bivalves are among the most imperilled groups of animals in the world. Although the importance of conservation management of these organisms is well recognized, population viability analysis (PVA) has rarely been used to estimate probability of extinction risk and inform conservation planning. Development of PVA models requires detailed knowledge of population dynamics and accurate estimates of population size and density of target species. *Popenaias popeii* (Lea, 1857), the Texas hornshell, is endemic to the Rio Grande drainage of the USA and Mexico, and is a candidate for listing under the U.S. Endangered Species Act. With the ultimate goal of developing a PVA, we used a distance-sampling method and closed-population mark-and-recapture (MR) to estimate population size and density of *P. popeii* in the Black River, New Mexico. Previous surveys determined that *P. popeii* occurs only along a 14-km stretch of the river. Within this range, we used satellite images to categorize habitat as suitable or unsuitable prior to sampling. We sampled each habitat category by systematically locating 19 sites, each containing three line-transects. Sampling was conducted in June and September 2011. To estimate capture probabilities, MR was conducted at three localities in 2007 and 2008 where *P. popeii* are relatively abundant. Mean capture probability was 0.73 (SE = 0.022; 95% CI: 0.685 – 0.774). Mean densities in suitable and unsuitable habitats were 0.424 (SE = 0.099; 95% CI: 0.253 – 0.640) and 0.033 (SE = 0.0163; 95% CI: 0.001 – 0.065) individuals per square meter, respectively. Considering the lower bounds of capture probability, the estimates of population sizes of the two habitat types were 28170 (95% CI: 15246 – 41094) and 10961 (95% CI: 203 – 21719) individuals, respectively. This is the first study to estimate total population size of a stream considering capture probabilities and accounting for density variation among sites. This information is essential for developing a PVA that will inform conservation management of *P. popeii*.

Oral Session O1.6

Invited speaker

Update on the status of the Global Freshwater Mollusc Assessment

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Freshwater molluscs are one of the most diverse groups of animals living in habitats from polar regions to the tropics in all different waterbodies, from habitat specialists in springs, groundwater systems to species found in large rivers, lakes and estuaries. They are not normally considered as being charismatic creatures, rarely attracting the attention of the popular media, unless in a negative light, as some species play a significant role (as a vector) in the transmission of human and livestock parasites and diseases. This is unfortunate, as they play a key role in the provision of ecosystem services and are essential to the maintenance of wetlands, primarily due to their contribution to water quality and nutrient cycling through filter-feeding, algal-grazing and as a food source to other animals Some species are of high commercial importance to humans as food or ornaments (e.g., clams and some mussels and snails). The FADA review of freshwater animals suggests that there about 5,000 freshwater mollusc species for which valid descriptions exist, in addition to a possible 4,000 undescribed gastropod species. Since 2008, the conservation status of over 2300 freshwater molluscs has been reviewed, through different regional projects, and with other projects in progress we have now assessed nearly 50% of the species at global level. Regional projects in Europe, Asia and Africa have revealed differences in the threats to the freshwater fauna and the proportion of threatened species. A Global assessment of all freshwater invertebrates assessed between 1996-2011 shows that 22.7% are considered threatened (CR, EN, VU), with a further 1.7% Extinct (Darwall *et al*, 2012 unpublished data). This includes all species assessed to 1996, and hence may be slightly biased in regions without comprehensive assessments. The results show that freshwater gastropods are the most threatened group 31.97%, then freshwater crayfish 24.43%, freshwater bivalves 24.19%, freshwater crabs 15.8% and dragonflies 10.10%. The freshwater molluscan fauna has a much higher level of extinction than other freshwater invertebrates - 3.08% of gastropods and 5.45% of freshwater bivalves, compared to 0.7% of Freshwater Crayfish and no Dragonflies or freshwater Crabs. In general there have been proportionately more freshwater molluscs extinctions than the those reported for birds, amphibians and mammals. The current pictures may well be worse than the current reported extinctions, as only species where there have been targeted surveys by skilled surveyors in last known locations are currently listed as EX. All possible extinctions are contained within the Category CR (Pex). This presentation will contain data on the latest updates on the status of the Freshwater Molluscs, including an overview of the different threats to these groups and a discussion of the likely range of % of threatened species considering the number of data deficient species (34% freshwater gastropods, 22.4% freshwater bivalves).

Oral Session O1.7

Comparing two measurement methods for inter- and intraspecific variations of year-class cohorts of young Freshwater Pearl Mussel (*Margaritifera margaritifera*) in three rivers in the Pasvik watershed catchment in Northern Norway

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In the understanding of the recruitment of Freshwater Pearl Mussel (*Margaritifera margaritifera*) in various rivers it is crucial to document on how the population fluctuate. The population strength of the different year classes of this species appears often to have large fluctuations. Much of the documentation in field is based on length and weight of the mussels. However, even when there is a good correlation and age, this is not always exact in regards to what year the young mussel was released from the cyst on its fish host. *Margaritifera margaritifera* from various rivers have different growth ratios and curves. Also individual mussels appear in some rivers to exhibit large variation in size. Another method is to cut the shell of the mussels to read the annual increments and by then find the year of recruitment. However, this implies that the mussel died very recently and that it is known when the mussel died.

In this study, a method was tested on how to read and count the annuli on live mussels without slicing the shell. This is possible to make on young mussels, i.e. younger than 20 years. Umbilicus of older *M. margaritifera* is often eroded and in-readable. The method of length-age and counting of annuli was tested on *M. margaritifera* from different parts within each of three rivers, and then the methods were compared between the rivers. The reveal of the year-classes might point more directly to the parameters that governing the recruitment of *M. margaritifera*.

Oral Session O1.8

Molecular species identification of European and Thai freshwater mussels (Unionoida)

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Accurate species identification is the basis for any efforts towards conservation as well as culturing of freshwater mussels, but due to their extreme phenotypic plasticity, unionoid species identification by morphological characters is notoriously difficult and sometimes even impossible. Today, molecular techniques offer a quick, accurate and reliable alternative to morphological species identification. However, species-specific markers and/or molecular identification keys have so far been developed only for a small number of unionoid groups, most notably, from North America.

We developed the first complete molecular identification key (ITS-1 PCR-RFLP key) for all eight North and Central European unionoid species, as well as species-specific primers for the three Thai unionoid species of "considerable economic potential" (i.e. *Chamberlainia hainesiana*, *Hyriopsis desowitzi* and *Hyriopsis myersiana*). Both methods resulted in 100% accurate assignment of 90 European and 64 Thai specimens, respectively, and thus, facilitate quick, low-cost and reliable identification of adult specimens.

In addition, we provide protocols for quick and reliable extraction and amplification of larval mussel DNA from complete host fish gill arches. Testing of the PCR-RFLP key indicated that this new method can be applied on infection rates as low as three glochidia per gill arch and enables, for the first time, comprehensive, large-scale assessments of the relative importance of different host species for given unionoid populations.

Oral Session O1.9

Long-term changes in unionid assemblages in the Rio Grande, one of the World's top 10 Rivers at Risk

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The Rio Grande is the most endangered river system in the North America and one of the World's top 10 rivers at risk, but is globally important for freshwater biodiversity. Unionid bivalves of the Rio Grande basin used to be represented by a unique assemblage, including four endemic species (*Truncilla cognata, Potamilis metnecktayi*, *Popenaias popeii*, and *Quadrula couchiana*), however surveys from 1998-2001 failed to recover any live endemic unionid species suggesting a sharp decrease in their populations and potential of extinction. We conducted intensive surveys (>200 sites sampled) from 2001-2012 on the Rio Grande and its tributaries in Texas and recovered live *T. cognata, P. metnecktayi*, and the largest population of *P. popeii* ever reported. Overall the unionid assemblage of the Rio Grande basin has changed dramatically during the last century. Decline in species diversity, range fragmentation, local extirpations, and introduction of widespread common species were documented. Two species (*Q. couchiana* and *Quincuncina mitchelli*) are already extinct. Among the environmental factors responsible for the degradation of unionid assemblages, the most important are impoundments, habitat degradation, salinization, pollution, and water over extraction.

Oral Session O1.10

Development of captive breeding protocols for the critically endangered freshwater pearl mussel *Margaritifera margaritifera*: Impacts of substrate

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The freshwater pearl mussel *Margaritifera margaritifera* (Linnaeus 1758) is critically endangered and is currently under threat from a range of anthropogenic factors including habitat degradation, mainly through siltation and nutrient input. Juvenile mussels are particularly vulnerable to poor habitat conditions. Habitat degradation has caused recruitment failure in most English rivers and this has led to dwindling, aging populations. Due to severe population declines in England in recent decades, a captive breeding programme was established in 2007 to rear juvenile mussels with the ultimate goal of reintroducing them back into their native catchments. High juvenile mortality rates had been observed during rearing activities raising questions about optimum culture conditions. The effect of different substrate parameters on the growth and survival of juvenile mussels was investigated by keeping juveniles in different size classes and depths of substrate for 10 months. Growth and survival were recorded every two months. This study is the first to intensively monitor the survival and growth of juvenile *M. margaritifera* in different substrate conditions. Growth measurements taken as part of this investigation show the interruption of growth as metabolic activity falls with falling water temperature. This is a well known phenomenon in molluscs but is little-studied in *M. margaritifera*. This presentation outlines detailed growth and survival rates for first year juveniles, giving us an insight why initial mortality rates are high.

Oral Session O1.11

Invited speaker

An exploration of selected aspects of the relationships between nutrients and freshwater mussels (Unionoida)

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Nutrient loads and nutrient cycling, especially of phosphorus and nitrogen, are among the most important controls on the character of freshwater ecosystems and have been greatly affected by human actions. Despite the widespread importance of nutrients in freshwater ecosystems, the varied linkages between nutrient cycling and freshwater mussel populations have not been thoroughly described. I will explore three of these linkages. First, I suggest that nutrient loads are related to the well-being of mussel populations through several mechanisms, probably producing a nonlinear relationship between nutrient loads and mussel populations. Second, I discuss the ability of mussels to spatially focus nutrients from the overlying water onto the sediments, which has not been fully appreciated, perhaps because nutrient cycling has been viewed chiefly from a volumetric rather than an areal perspective. Third, I discuss the ability of mussel populations to store and release nutrients, introducing time lags in nutrient dynamics and stoichiometry ("nutrient capacitance"). I will close with a speculative analysis of the role of freshwater mussels in the nutrient cycles of pristine river systems, which must have been much greater than in modern rivers, with their high nutrient loads and depleted mussel populations.

Oral Session O1.12

Invited speaker

Managing mussel populations for the benefit of freshwater ecosystems

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Freshwater mussels often represent the dominant component of the benthic biomass of lotic and lentic systems. Their filtration capacity helps to drive systems towards clear water states and their burrowing activity can play an important role in ecosystem engineering. While native freshwater mussels are typically viewed as a positive component of an ecosystem, non-native mussels such as *Dreissena* spp. and *Corbicula* spp. are often viewed negatively.

In this talk I will first review the contribution that mussels can make towards ecosystem functioning, before discussing how native mussel populations can be managed as biological filters. I will draw from practical examples in Europe and Asia. I will then review the more controversial role of using non-native bivalves as tools for the improvement of water quality, with particular reference to current projects in Europe to propagate the zebra mussel, *Dreissena polymorpha*.

Whilst non-native mussels may sometimes offer benefits to ecosystems, and especially those that are in a poor ecological status, it is often desirable to control them within sites of high conservation status. This is particularly the case where invasive zebra mussels threaten endangered native unionid mussels through the smothering of their valves. I will discuss the potential role of an emerging technology, the BioBullet, as an environmentally safe method for managing non-native mussels in the open environment, and consider how this technology could help conserve threatened unionid populations across Europe and North America.

Oral Session O2.1

The invasive *Anodonta (Sinanodonta) woodiana* as an important resource subsidy

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Anodonta (Sinanodonta) woodiana (Lea 1834) was accidentally introduced to Europe by Asian fish species (carrying their parasite glochidium) and was recorded for the first time in the Hungarian Danube stretch in 1984. Recently, this species has been reported frequently along the Middle Danube, also colonizing the side-arms and tributaries. In order to investigate the role of *A. woodiana* as a resource subsidy, we sampled the die-offs of this species at seven sites (four sites in the Danube main-arm, one site in the Danube side-arm and three sites in the River Ipoly, a Danube tributary). Samples were collected in November 2011 when the water discharge was particularly low. Bivalves could not follow the considerable decrease in the water level due to their low locomotion capability, thus massive die-offs of bivalves occurred on the riverbanks due to desiccation. The density and biomass varied among the sites. The lowest density and biomass values were recorded in the Danube tributary (0.01 ind. m^{-2} and 0.69 g wet mass m^{-2}), whilst the highest mean density and biomass values were recorded at the cooling water outlet of Paks Nuclear Power Plant (280.5 ± 110.6 ind. m^{-2} and 29 467.2 ± 12 181.7 g wet mass m^{-2}). This study provides evidence that a habitat affected by heated water can contribute to the aggregation and an extremely large biomass of termophil invasive species. In addition, the recorded mortalities highlight invasive bivalves as a major resource subsidy, possibly contributing with remarkable amounts of nutrients and energy to the adjacent terrestrial food web. This high quality bivalve carrion can be consumed directly by a great number of species such as ants, beetles, spiders, birds and mammals, but probably the major part of this biomass can enter the detrital food web driving changes in microbial biomass and nutrient cycles.

Oral Session O2.2

Data on development and collapse of invasive *Sinandonta woodiana* (Bivalvia, Unionoida) populations in Hungary

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Data on up to 4000 specimens of Unionid mussels from nearly 70 localities were collected and analysed between 1985-1996 from Hungarian waters. Attention was focused on the presence and spread of the invasive *Anodonta* (*Sinadondonta*) *woodiana* (LEA, 1834). Detailed data on all other native species were also collected. Mainly, the productivity, growth and biomass of different species were measured and calculated.

In 2011-2012 some localities were surveyed again to investigate changes on populations, species ratios, and the effects of *S. woodiana* on the native species.

S. woodiana entered Lake Balaton in about 2000. The first detailed survey of the lake was in 2011 and showed that in about 10 years the invasive species already reached 60-70 % of the total biomass in some localities, parallel with the decline of the native *A. cygnea* and *A. anatina*. However, the densities and the ratio of *Unio pictorum* and *Unio tumidus* have not changed.

Another problem is that several collapses of *S. woodiana* populations were observed in the past decade in different parts of Hungary. Lake Balaton is a very important touristic area and so a method to forecast, and determine the periods more susceptible to these massive die-offs can be very useful.

Using previously determined and some new biological data of *S. woodiana*, (growth, maturation, mortality, propagation) give us the opportunity to develop a simple simulation to forecast *S. woodiana* population collapses.

Oral Session O2.3

Corbicula fluminea invasion in Lake Maggiore (Italy): population dynamics and comparison of dietary overlap with native mussels

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The Asian clam, *Corbicula fluminea* (Müller, 1774), was most likely introduced in 2007 in Lake Maggiore, the second largest and deepest lake in Italy. Spatial and temporal variations in abundance, biomass and population structure of *C. fluminea* at 5 sites, investigated since its first discovery in 2010, confirmed the well known ability of this species rapidly to spread in new recipient environments and to achieve densities of thousands per square meter. In few years *Corbicula* has colonized about one third of the lake littoral area and has become the dominant littoral benthic species in terms of abundance and biomass, creating the conditions for a competitive interaction for space and food with native mussels. Indeed, a comparison with previous data has evidenced a strong decline of the most abundant native mussel species (*Unio mancus*), whose actual density is reduced of about 75% after *Corbicul*a invasion. Although native mussel depletion cannot be unequivocally attributed to *Corbicula* impact, the change in bivalve species dominance could lead to changes in the structure and function of the ecosystem. In spite of similar functional roles, unionids and *C. fluminea* are likely to differ in filtering efficiency and trophic niche. Therefore, understanding the role that both native and invasive species play in food-web structure and nutrient cycling is essential for predicting how the ecosystem might be altered. Our study aimed to: *(i)* explore the invasion dynamics of *Corbicula* in Lake Maggiore; *(ii)* compare the trophic roles of the native mussel *U. mancus* and *C. fluminea* through measurements of respective filtration rates and spectrum of food resources. Filtration rates were measured by the clearance method under different experimental conditions and over the whole diurnal cycle. Dietary composition and overlap were determined through the measurement of the elemental and stable isotopic compositions ($\delta^{13}C$ and $\delta^{15}N$) of the respective tissues.

Oral Session O2.4

Physical habitat of zebra mussel (*Dreissena polymorpha*) in the lower Ebro River (Northeastern Spain)

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Dreissena polymorpha is a freshwater bivalve mollusk, native from Black and Caspian seas and it is established since more than a decade in the lower Ebro River basin. This invasive species causes serious ecological and socioeconomic impacts in the ecosystems where it is placed. This paper aims to analyze zebra mussel hydraulic habitat, developing physical models for this species, which indicate its preference and optimal microhabitat requirements. The survey was developed in the lower Ebro River, between the hydroelectric power station of Flix and the Vinebre´s pier (Tarragona province, Northeastern Spain). The data needed to characterize microhabitat use were taken by divers. They collected mussel samples and current velocity, depth and substrate measurements, along 17 transects placed perpendicular to the flow. Physical habitat availability was estimated through a topographical survey of the channel and the flow regimes. With this information, different hydraulic simulations were carried out using the software application River 2D. In this way, habitat suitability curves (HSCs) for the variables mean velocity, depth and shear stress have been obtained. In addition, interaction effects between hydraulic variables on habitat selection and use were studied, developing multivariate resource selection functions (RSFs). As a result, it has been established a close relationship between *Dreissena polymorpha* density and mean flow velocity combined with depth. Its optimal velocity value not exceeds 0.8 m/s and 5 m depth, for usual discharge (Q50%). In the same vein, river reaches with easily movable substrate during high flows (Q95%) are zones with a limited presence of mollusks. Although this species shows a moderate preference in the lower Ebro River, it needs to be noted that zebra mussel has a strong ecological plasticity. Consequently, it can adapt and colonize any lotic ecosystem.

Oral Session O2.5

The Asian invasive bivalve *Corbicula fluminea* in Minho and Lima estuaries: a molecular approach

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The Asiatic clam *Corbicula fluminea* is a non-indigenous invasive species that has rapidly spread throughout worldwide freshwaters and is considered one of the most important invasive bivalves due to the negative impacts caused in the native faunas of invaded ecosystems. This invasive species was detected in two Portuguese estuaries of the Minho and Lima rivers (NW of Iberian Peninsula) in 1989 and 2002, respectively. The existence of ecophenotypic shell variation is noticeable between the two *C. fluminea* populations, this has been attributed to an adaptation to distinct ecological conditions, different origins and/or genetic alterations during distinct migration, or differential selection processes in the two rivers. The Minho River presents a higher population density of *C. fluminea* relatively to the Lima River. To better understand the genetic processes that may contribute to the invasive behaviour of this species, we assessed the variability between populations of *C. fluminea* in the Minho and Lima rivers, employing genetic analysis of mitochondrial DNA (mtDNA) — cytochrome oxidase I (COI) and phylogenetic tools. Previous genetic variability assessment revealed the existence of four haplotypes that diverged by one or two substitutions from the most common haplotype (92.7%) detected in the Minho and Lima populations. Database sequence comparison revealed that this highly frequent haplotype has been previously described in Europe (haplotype I), North America (haplotype form A) and Asia (FW5 haplotype), being commonly found across the Asiatic ecosystems. Our recent molecular analysis revealed that only the *C. fluminea* Asian FW5 haplotype (or European haplotype I) was encountered in the Minho and Lima rivers. This may suggest a bottleneck effect causing the observed reduced genetic variability. However, future studies are necessary to corroborate these results and also to determine how the observed differentiation patterns may influence the invading potential of the *C. fluminea*.

Oral Session O2.6

European guidance on the environmental requirements of freshwater pearl mussel (*Margaritifera margaritifera* L.)

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Freshwater pearl mussel (*Margaritifera margaritifera* L.) is endangered throughout its holarctic range owing to an array of human impacts. Despite protection under national and European legislation its status remains critical. To be successful, efforts at conserving those remaining viable populations and restoring damaged ones require an understanding of the environmental requirements of pearl mussel. This is especially important where advice is needed on the likely effects of new catchment developments. Work is under way by a Task Group of the European Committee for Standardization (CEN) to produce guidance that can be used across Europe for providing consistent advice based on the available scientific evidence. The format of the document has yet to be decided (e.g. CEN guidance standard, CEN Technical Report) but draft text has already been developed at two international workshops, the first in February 2011 and the second in March 2012. These were attended by experts actively working on pearl mussel research and conservation in the UK, Ireland, Germany, Luxembourg, Norway, Sweden and Finland. A third workshop, to include others from southern Europe, is planned in conjunction with the Bragança conference. The guidance document will include sections common to all CEN standards (such as 'Terms and definitions') and will focus on four main areas covering the principal environmental requirements of pearl mussel: water quality (phosphorus, nitrogen, BOD, dissolved oxygen, temperature, heavy metals and toxic substances, turbidity and suspended solids), hydromorphology (flow, physical habitat structure, substrate quality and stability, wood, instream modifications) and fish hosts (species, barriers to migration, genetics and stocking policies). The guidance will also cover information needed to assess plans or projects on rivers with *Margaritifera* populations. It is hoped that this initiative will be useful not only in the conservation of pearl mussel populations but also in providing a template for advice and guidance on other species under threat.

Oral Session O2.7

The thick shelled river mussel (*Unio crassus*) brings LIFE+ back to rivers

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The LIFE-projects objectives

The UC4LIFE+ project (2012-2016) aims to strengthen the conservation status of the endangered thick shelled river mussel (*Unio crassus*) and improve the ecological riverine status within its Scandinavian distribution range. As being a key-stone species, actions beneficial for *Unio crassus* will positively impact overall water quality, biodiversity, including other endangered species, such as Atlantic salmon, bullhead, freshwater pearl mussel and otter.

The actions

The 4.9 M€ project is constituted of three major objectives:

1) Mapping host-fish utilization by *Unio crassus* to ensure successful conservation actions for both *Unio crassus* and host-fish species.

2) Recreate natural river dynamics by restoring structures (*i.e.* substrate and cover) and processes (*i.e.* connectivity and corridor functions).

3) Re-introduction by stocking *Uc*-juveniles and glochidia-infected host-fish.

Oral Session O2.8

Ecology and conservation of the freshwater pearl mussel (*Margaritifera margaritifera*, Margaritiferidae) in the North-West of Russia

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Historically most of the resources of pearls in Arkhangelsk region (North-West of Russia**)** have been concentrated in the Solza River (with the tributary Kazanka) and the Kozha River (with the tributary Syvtuga) where there was a regular and profitable trade of pearls for a long time. Freshwater pearl mussel populations in the Kazanka and Solza Rivers were studied in 2005 and, 2006 and, in the Kozha River (the Onega River Basin) in 2007 and, 2010. The maximum and estimated average densities of pearl mussels in the Solza River is 68 ind./m^2 and 1.4-1.8 ind./m^2, respectively. The proportion of young mussels with a shell length ≤70 mm in the Kazanka was about 7%, whereas in the Solza was (11%). Fish farming contributes to the conservation of this pearl mussel population, as the release of Atlantic salmon juveniles ensures reproduction of the mollusc. The freshwater pearl mussel population in the Kozha is characterized by low density (the average estimation 0.22 ind./m^2). The share of young mussels is <1 %. The role of the direct anthropogenous factor for the population is low, so influence of pearlfishing has not been found. Also we found mixed communities of freshwater pearl mussel with other species of large bivalve mussels from Unionidae. One of the reasons of the low reproduction of freshwater pearl mussel in Kozha River is the decrease of number of the Atlantic salmon in Onega Basin. The second negative factor – is the reconstruction of the Onega hatchery in 1984. This decreased the density of juvenile salmon on spawning-ground below the critical level for the glochidia infection rate for the freshwater pearl mussels. For preservation of a salmon population of the Onega Basin and the freshwater pearl mussel as a whole it is necessary to maintain artificial reproduction and to regulate salmon fishing. This research has been carried out with financial contributions by RFBR grant № 10-04-00897, 12-04-00594-a, 11-04-98815, President of Russia MD-4164.2011.5 and from the Russian Ministry of Science and Education.

Oral Session O2.9

How to design a database to be used effectively as a tool for conservation of freshwater mussels? The stones' way in the Central part of Brazil.

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There are few researchers who are interested in freshwater mussels in Brazil; consequently the available studies are insufficient. With the development policy established in the country, the unbridled expansion of the energy mix has been changing drastically the hydrological dynamics without having enough time to even know the aquatic biodiversity. This scenario is reinforced by the agricultural expansion and the invasion of exotic species such as *Limnoperna fortunei* and *Corbicula fluminea*. Considerable effort has been undertaken to collect information in order to understand the species composition, distribution patterns and their functional importance. Here we present an overview of what has been done in the last years and which was translated in a database and implementation of collections as reference for the region. From carefully selected secondary data and primary data obtained through a hierarchical landscape design, we intend to generate models of distribution and diversity of this group. Nowadays the Malacological collection of UFMT is comprised of 25,260 specimens represented by 49 species, organized into 729 lots duly registered and available on the platform SpeciesLink. Of these, 17 species are representatives of the family Hyriidae, 19 of the Mycetopodidade, 8 species of the Sphaeriidae, 3 species (2 aliens) of the Corbiculidae and 2 species of Mytilidae (1 alien). In parallel, projects and guidelines of the monographs and theses considering the ecology of populations and community approaches seeking to learn about the processes that maintain these species in the environment, have provided relevant information to the processes of government decision-making related to environmental management.

Oral Session O2.10

Conservation of *Margaritifera margaritifera* (Linnaeus, 1758) in the Armorican Massif (Brittany and Lower-Normandy, France)

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Six rivers located in the north-west of France are known to still harbour the main population of *Margaritifera margaritifera*. All these six populations are still reproducing but are only potentially functional and will, without assistance, disappear in the near future. Therefore within a LIFE+Nature project founded by the European Commission and government agencies, a rearing station was built in order to save these populations.

The major goal of this rearing station is to enhance the declining freshwater mussel populations of the area. Firstly, for all the six populations, infected fish were used to collect juvenile mussels at the rearing station. These mussels were subsequently separately reared under intensive laboratory conditions, in order to preserve genetic specificities. Secondly, only for one population, the host fish of *M. margaritifera* were artificially infected with glochidia and immediately released. The reinforcement of mussel wild stocks will be carried out each year by directly reinforcement individuals in rivers substrate and also using methods which make it possible to assess the outcome of *in-situ* operations. However, one rule prevails for these reinforcements: the original watercourse first have to reach a sufficient quality. In 2011, 350 *Salmo trutta fario* have been infected with *M. margaritifera* and were released into only one river. 4 000 other *S. trutta fario* have been infected with more than 3 million glochidia. The collection of the young mussels will occur in spring 2012. These operations will be repeated each year until 2016 in order to culture mussels of various age-classes. The goal of this *ex-situ* conservation operation is to have a batch of about 4 000 pearl mussels aged 4 to 5 years for each of the watercourses at the end of the programme.

Results achieved and problems encountered so far are presented.

Oral Session O2.11

The relationship between endangered thick-shelled river mussel (*Unio crassus*) and its host fishes

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The complex life cycle of the endangered thick-shelled river mussel (*Unio crassus,* Philipsson 1788) - a priority species in aquatic conservation - includes an obligatory parasitic phase on a host fish. Consequently, knowledge on the interaction of *U. crassus* with its host species is crucial for both the development of effective conservation strategies and artificial propagation measures. The core objective of this study was the assessment of the host-suitability of different fish species in the Danube drainage by artificial infestation experiments. To test host availability under natural conditions, fish communities of four functional *U. crassus* populations with juveniles were analyzed. *Chondrostoma nasus*, *Cottus gobio*, *Leuciscus idus*, *Phoxinus phoxinus*, *Squalius cephalus*, *Scardinius erythrophthalmus* and three different strains of *Gasterosteus aculeatus* were identified as suitable hosts for *U. crassus*. In contrast, *U. crassus* was not able to metamorphose on *Acipenser ruthenus*, *Alburnus alburnus*, *Rutilus rutilus,* invasive *Neogobius melanostomus* and introduced *Oncorhynchus mykiss*. In addition, we found pronounced differences in development time of *U. crassus* on different host fishes. In natural *U. crassus* streams, sixteen different fish species were found and abundance of suitable hosts varied considerably. In conclusion, the results from the laboratory infestations and the field investigations strongly suggest that *S. cephalus* is the most important host for *U. crassus* in the Danube drainage, despite the fact that some populations exclusively depend on other hosts. Effective management of host fish populations, especially of low-valued cyprinid fish species clearly deserve a better consideration in the conservation management of *U. crassus* habitats and stream ecosystems.

Oral Session O2.12

Invited speaker

Knowing and conserving the European (and North African) naiads. Reflection from the South of Europe

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During the last years, the taxonomy of the Palearctic Unionoid is suffering a severe change. Although the book of Haas (1969) is still the Bible for "naiadologists", the use of new molecular techniques and the description of biological characters have been successfully tools to unravel some historical taxonomic problems of this shell polymorphic group. For instance, only in the Iberian Peninsula (Araujo et al, 2009) and North Africa, the following 7 species have been recently redescribed (in brackets the names used by Haas): *Margaritifera marocana* (*M. Pseudunio auricularia marocana*), *Unio gibbus* (*U. pictorum delphinus*), *U. tumidiformis* (*U. crassus batavus*), *U. delphinus* (*U. pictorum mucidus* and *U. p. delphinus*), *U. mancus* (*U. elongatulus aleroni* and *U. e. valentinus*), *U. ravoisieri* (*U. elongatulus penchinatianus*, *U. e. durieui* and *U. p. ravoisieri*) and *U. durieui* (*U. elongatulus durieui*).

After an introduction on the native Iberian and North African species, their biology, distribution and conservation status, the second part of the presentation is devoted to show the advances in the conservation of this endangered group of molluscs. A summary of the efforts made in the recovery of the natural naiad populations by habitat improvement, captive breeding and/or restocking is presented. For this, once overviewed the pioneering and current North American projects to protect and recover endangered freshwater mussels (Neves, 2008), I will show some of the ongoing European programs, including the LIFE projects for species of the Habitat Directive. Information on the naiad species, experiments, facilities, food and diets, host fishes and other variables is discussed.

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Oral Session O2.13

Biogeography and conservation of freshwater mussels (Bivalvia: Unionidae) in Texas: drivers of diversity and threats

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The knowledge of geographic patterns of species distribution and the factors contributing to species endangerment is necessary for the development of integrative conservation strategies. We studied the large-scale environmental and anthropogenic factors affecting the diversity of Unionidae using results of our state-wide surveys in all major Texas river basins in 2003 - 2009. Multivariate statistics was used to test for differences among environmental parameters and unionid assemblages in different bioprovinces, and to determine the extent to which the multivariate pattern of species distribution was affected by environmental factors. We found a positive correlation among biotic and environmental similarity matrices, which indicated concordance of the differences among unionid assemblages and environmental factors that could cause these differences. Climate, landscape, geology, and land use type were important factors influencing unionid distribution patterns among biotic provinces. Lake surface evaporation rate and percentage of forest cover on the watershed were among the most important parameters explaining the differences in unionid assemblages. Human population density negatively correlated with the proportion of rare species. The proportion of species found live to the total number of live and relic species found in our surveys, and to the number of historically known species, decreased with the increase in human population density on the watershed. Therefore, increased human population density was associated with the loss of rare species over several decades, but this loss was not recognized because of a lack of assessing the conservation status of unionids.

Oral Session O2.14

The freshwater pearl mussel (*Margaritifera margaritifera*) in Bavaria – population status, conservation efforts and challenges

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The freshwater pearl mussel (*Margaritifera margaritifera*) belongs to the most imperilled bivalves worldwide. Since 2009, pearl mussel conservation and research in Bavaria are managed by the Bavarian Coordination Office for the Protection of Freshwater Mussels. An overview on the current population status, habitat conditions, conservation and research projects is presented with a special focus on the topic of fine sediments. Bavaria holds approximately 60 pearl mussel populations ranging in size between a few single to several 10.000 individuals. Most of the populations have lacked recruitment for several decades and are on the brink of extinction, mostly due to the impact of high rates of fine sediment introduction. A research project on sediment dynamics and fine sediment deposition in pearl mussel streams of different ecological status revealed that some streams are exposed to net fine sediment deposition of up to 20 kg m^{-2} $month^{-1}$. Moreover, degraded habitats were subject to strong temporal variation in physicochemical parameters and low redox values in the stream bed, whereas more intact streams were characterized by more stable and favourable habitat conditions. Along with these investigations a catchment wide case study for detection of erosion hot spots and catchment management was conducted. The results suggest that instream habitat restoration without improvements in the catchment is insufficient for pearl mussel conservation.

Oral Session O2.15

The first millimetre – Rearing of juvenile Freshwater Pearl Mussels (*Margaritifera margaritifera)* in plastic boxes

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In recent decades the Freshwater Pearl Mussel (*Margaritifera margaritifera)* was common in great parts of the Belgian and Luxembourgian massif of the Ardennes and of the German Eifel. Today, these populations have drastically decreased or even went extinct. The last remaining population in the Our River (Luxembourg, Europe) has come close to extinction and will disappear within a few years without assistance.

The objectives of this work were to find out the best rearing conditions for juvenile mussels in order to breed them in the laboratory to a size at which their survival in the wild is more likely.

Different food mixtures (commercial algae, detritus and crushed red bloodworms (Chironomidae)) were fed to juvenile mussels in plastic boxes containing 500 ml of river water during a period of 110 days. To follow the development of potentially harmful ions, the concentrations of nitrate, nitrite and ammonium were analyzed over a period of 8 days in the boxes (maximum time between water exchanges).

The best growth rate of 189% (up to 1.13 mm (SD ±0.30) /box) combined with a survival rate of 80% (101 dead mussels (SD ±163.71) /box) was achieved with a food combination of detritus and algae (Shellfish diet1800 and Nanno3600). The optimal number of mussels/box was 200. Without detritus, ion concentrations increased noticeably in the boxes (ammonium >50%, nitrite >150%), probably explaining higher mortality rates in these groups. When detritus (25 ml) was added, nitrite and ammonium were reduced by more than 50% compared to the initial value (nitrite from 0,11 to 0,05 mg/l and ammonium from 0.36 to 0.14 mg/l) within eight days.

Conclusions: The rearing of juvenile *Margaritifera margaritifera* in boxes is a successful method when algae and detritus are added to 500 ml of river water. Detritus functions not only as a food source but also as a biological filter which reduces harmful ions such as ammonium and nitrite.

Oral Session O2.16

Conservation of freshwater bivalves in Uruguay: opportunities and challenges

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Despite its small size, Uruguay harbors an important diversity of freshwater bivalves. Two main hydrographic basins can be identified in the country: the Merín-Patos system and the Uruguay River basin, both with a high number of endemic species. In addition, historical opportunities (a large number of local collectors, an inspiring cultural environment and the relevance of the Montevideo port) allowed many prominent authors (d'Orbigny, Lea, Pilsbry, Marshall) to describe species upon materials collected from this country. To date, there are 42 freshwater bivalve species reported for Uruguay, of which 39 (93 %) are included in the priority species list for conservation in Uruguay.

To promote conservation of the freshwater bivalves of Uruguay, our team is undertaking the following activities: 1) improvement of the basic knowledge of species (solving taxonomic problems, reanalyzing geographic distributions, studying some ecological aspects); 2) analysis of the impacts generated by invasive species (mytilids and corbiculids) and environmental impact assessment of industrial activities; 3) implementation of conservation tools such as the relocation of critically endangered populations; 4) development of malacological collections suitable for DNA preservation; 5) use of the generated information for the design of the National Protected Area System and 6) knowledge dissemination and participatory research. The consolidation of these initiatives is considered a priority to advance in the development of conservation policies targeting freshwater bivalves in Uruguay.

Oral Session O2.17

Identification of the factors responsible for the decline of the Freshwater Pearl Mussel (*Margaritifera margaritifera*) in the North Tyne, North-East England, in order to develop a restoration plan for the species

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The freshwater pearl mussel (*Margaritifera margaritifera*) is endangered and declining throughout its entire range. On the rivers North Tyne and Rede, North-East England, the pearl mussel population has been estimated at approximately 50,000 individuals (2006) but shows little or no recruitment.

The Tyne Pearl Mussel Project was commissioned to understand the factors responsible for the decline of the freshwater pearl mussel *Margaritifera margaritifera* in the North Tyne catchment and to produce a restoration plan for the species, based on the analysis of existing data and field surveys undertaken as part of this project.

The first year of the project was spent analysing existing data on land use, water quality and physical processes in the North Tyne catchment as well as collecting data on physical habitat characteristics at various sites with and without pearl mussels on the North Tyne and its main tributary, the River Rede, in order to establish the reasons behind the decline in the population.

So far data analysis suggests that changes in land use over the past decades have resulted in a combination of various factors leading to the decline of the freshwater pearl mussel in the North Tyne:

1. High suspended solid loads and siltation as a result of bank erosion, mainly from agriculture but also from forestry activities.
2. Organic enrichment and eutrophic conditions as a result of elevated nitrogen and phosphorus levels. Filamentous algae and the presence of *Myriophillum* spp. at numerous mussel bed locations indicate enriched conditions.
3. The release regime at Kielder Reservoir prevents the occurrence of *M. margaritifera* in the upper reaches of the North Tyne due to continuous, increased shear stress.
4. Physical habitat surveys show that current physical habitat characteristics are not suitable for pearl mussels.

This work emphasises the challenges faced when studying the linkages between environmental factors and the ecology of a species with a complex life cycle.

Oral Session O2.18

Liming saves the Freshwater Pearl Mussel *Margaritifera margaritifera* (L.) from acidification

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Deposition of airborne pollutants during decades has caused large-scaled acidification of lakes and streams in Scandinavia. Liming, i.e. addition of fine grained lime stone, of acidified lakes and streams is used at large scale in Sweden since the 1980's to counteract the toxic effects of acidification.

Inventories and field experiments indicate that stream acidification is one reason for the disappearance of the Freshwater Pearl Mussel *Margaritifera margaritifera* (L.) (FPM). Field experiments show that low pH combined with high contents of inorganic aluminium kill adult FPM while liming increase the survival.

FPM populations show during 1990-2000 lowered status in non-limed streams but an increased status in 89 limed streams. The recruitment of FPM was maintained or improved in limed streams. The shell growth increased after liming and reached levels comparable with the growth prior to stream acidification.

The conclusion is that liming of streams in short time is a measure to save the FPM from acidification. This is also true for other sensitive aquatic species.

Oral Session O2.19

Monitoring survival and growth of laboratory-cultured endangered mussels, *Epioblasma capsaeformis* and *E. brevidens,* released into the Powell River, Tennessee, USA

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Propagation, release, and monitoring of juvenile mussels now represent a viable set of tools to recover endangered mussel species and restore populations damaged by anthropogenic impacts. However, the culture and monitoring of these released populations is a recent phenomenon, possible because of recent advances in propagation techniques and technology. The goal of this study was to monitor releases of federally endangered species to assess their viability and recovery potential in the Powell River, Tennessee, USA. Laboratory-reared sub-adult mussels of the endangered oystermussel (*E. capsaeformis)* and combshell (*E. brevidens)* were released at two sites in the lower Powell River. Three release methods were developed and tested over a 15 month period, to include specimens held in cages, kept in silos, and those that were free-released with attached PIT tags. Released mussels were sampled regularly to determine their growth and survival rates. The recapture rates of PIT-tagged sub-adults of *E. brevidens* exceeded 95%. The free-released mussels were analyzed using mark-recapture methodology to decrease effects caused by repeating sampling on this targeted population. Individual growth rates of recaptured sub-adults were modeled through a von-Bertalanffy equation and compared. Variation in population parameters between the two locations was investigated in order to assess habitat-related factors for guidance in selecting river reaches and providing management strategies for these endangered species. Survival and growth rates over 15 months for the two *Epioblasma* species indicated that water quality and habitat suitability in the lower Powell River of Tennessee appear suitable for conducting large-scale population augmentations of these and other endangered species to implement recovery.

Oral Session O2.20

Monitoring freshwater pearl mussels, practicalities and interpretation

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Various different methods are currently in use in Britain and the Republic of Ireland, to monitor populations of the freshwater pearl mussel *Margaritifera margaritifera*. These include total counts of sections within a river, transverse transects, transects parallel to the bank, and counts with plot areas. However, there are very few long-term monitoring studies. In this paper we describe the rationale for monitoring, the methods employed, and site selection. We will then use examples from rivers in Britain and Ireland to highlight the problems associated with monitoring, and then focus on one river in northern England and one in western Ireland where year on year monitoring has been carried out for 7 years and 9 years respectively. The results from these monitoring transects within these rivers have revealed changes in mussel numbers and distribution across the channel. We discuss these results and how they should be interpreted, and conclude with an evaluation of the usefulness of such monitoring.

Oral Session O2.21

Host specificity in freshwater pearl mussel *Margaritifera margaritifera* populations in Norway – experimental studies

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The freshwater pearl mussel *Margaritifera margaritifera* has a parasitic stage on salmonid fish. Mussel larvae (glochidia) are quickly lost from fish species other than those of their suitable hosts; in Europe: Atlantic salmon *Salmo salar* and brown trout *Salmo trutta*. However, field studies have shown that survival of glochidia is often restricted either to salmon or trout. The objective of this study was to test whether parasite infectivity (mussel larvae prevalence and loads) differed between salmonid hosts in different freshwater pearl mussel populations. The experimental study was performed at the NINA Research Station at Ims, south-western Norway between August 2006 and January 2007 with hatchery reared yearlings (age 0+) of Atlantic salmon, migratory and resident brown trout from the River Figgjo catchment. In August, 4, 6, and 10 gravid mussels respectively, were collected from River Svinesbekken, River Flotåna, and River Figgjo (all in south-western Norway), and placed individually in flow-through tanks containing salmon and trout. Resident brown trout is the only salmonid found in River Svinesbekken and River Flotåna as opposed to River Figgjo where both Atlantic salmon and migratory/resident brown trout are common. Glochidia were found encysted on the gills of all three groups of fish, albeit at very different frequencies in the different rivers. In River Figgjo glochidia prevalence and infection intensity after 37 days post exposure was much higher for Atlantic salmon (100% and 263 mussel larvae) than for migratory brown trout (20% and 14 mussel larvae). No data on resident brown trout. After 106 days the prevalence was still 100% for Atlantic salmon but no glochidia was longer found on migratory or resident brown trout. In River Flotåna glochidia was only found on migratory and resident brown trout. In River Svinesbekken glochidia prevalence and infection intensity after 37 days post exposure was much higher for migratory brown trout (100% and 216 mussel larvae) than for Atlantic salmon (13% and 1 mussel larvae). No data on resident brown trout. After 106 days the prevalence decreased to 75 and 95% for migratory and resident brown trout, respectively. However, no glochidia were found on Atlantic salmon. Variation in host response and susceptibility to mussel larvae must be taken into account when designing management plans and reintroduction and captive breeding programmes for the freshwater pearl mussel.

Oral Session O2.22

Fish Tales and Mussels: Role Reversal in a Fish-Mussel Symbiosis

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Upon release from the marsupial water tubes (brood chambers) of a gravid mussel (Order Unioniformes), glochidia larvae of most species have an obligate requirement to attach to the fins or gill filaments of a suitable host fish species. Specificity of host fish varies among species of mussels, but successful attachment of a glochidium is followed by its encapsulation by migration of epithelial tissue, forming a cyst. Subsequent development and metamorphosis to the juvenile take place within the cyst, with some nutrients being derived from the impaled host tissue. In a reversal of this conventional vertebrate host-invertebrate symbiont relationship, the European bitterling fish *Rhodeus amarus* (Cyprinidae) undergoes fertilization and early development within the water tubes of the gills of several species of mussels. Male bitterling establish a territory around one or more mussels and ultimately lead a gravid female to a prospective host. Prevailing evidence suggests that females assess the suitability of a mussel by monitoring water from the mussel's exhalant siphon. Reduced flow or low oxygen may indicate the presence of bitterling larvae already within a given mussel and deter the female from oviposition. If a mussel is acceptable, the female bitterling rapidly inserts a long ovipositor through the exhalant siphon of the mussel and forcibly ejects ova into water tubes of any demibranch. Following oviposition, the male immediately releases sperm near the inhalant siphon where they are drawn into the interior of the mussel's gill and fertilization occurs *in situ*. We employed video endoscopy to image bitterling eggs and larvae within the gills of *Unio pictorum*. Eggs and embryos are deep within a water tube, oriented such that larval fish are head downward. Tails of fully grown larvae project into the suprabranchial cavity, sometimes with nearly every water tube housing a fish. A fish may spontaneously flex its tail, and a slight mechanical stimulus can induce synchronous tail waving among several individuals. The fish ultimately swim out of the mussel via the exhalant siphon. This presentation will include video imaging of live, active bitterling within a host mussel.

Oral Session O2.23

Standard Methods for Evaluating Dam Impacts on Freshwater Mussels

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During the course of several large hydroelectric projects planned or underway in Portugal, the need to obtain consistent, objective and comparable data about freshwater mussels' communities living in the affected rivers was crucial. Of particular importance was the need to obtain reliable data about the distribution and abundance of each species. Target species were *Anodonta anatina*, *Margaritifera margaritifera, Potomida littoralis* and *Unio delphinus*. The rivers where the studies took place are medium sized rivers, located at Mediterranean climate region, with a significant annual flow variation but never being reduced to disconnected pools (permanent flow). Studies were designed to reduce the effect of the season of sampling, but were most effective when water level is low. A combination of semi-quantitative samplings and habitat characterization was used to study the distribution of each population, while scuba-diving transects were used to evaluate the densities of each species. In some cases, when the target species was rare and where feasible, exhaustive sampling of all the distribution area was done. Fish data and mussel length distribution were used together to evaluate the population trend and explain patterns of distribution. The data collected allowed to evaluate the impacts of dams in terms of the distribution, abundance and population trend of each species, as well as to propose minimization and compensation measures if relevant.

Oral Session O2.24

Invited speaker

Towards effective conservation management strategies of endangered freshwater mussels: The step-wise approach

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Most of the large freshwater bivalves in Europe are in decline. Conservation management has to take difficult decisions concerning definition of conservation targets, as well as concerning prioritization of populations and selection of appropriate conservation measures. In many cases, effective conservation is hampered by a lack of information on the main factors for decline in specific situations, or by a lack of decisions on conservation prioritization along with monetary limitations. This contribution proposes a step-wise strategy for improving the conservation management of freshwater mussels. In a first step, information on species distribution, census population size and demography needs to be collected using standardized methodology. In a second step, bottlenecks in the life cycle need to be identified, starting from fecundity in adult mussels to host fish suitability and density towards the status of the post-parasitic phase. Typically, ecological reference information from functional populations needs to be collected for the identification of crucial thresholds. In a third step, information on the genetic diversity and differentiation is being incorporated into decision-making, aiding in identification of priority populations which can be assigned to ranks according to their contribution to the species´ gene pool. Ecological, genetic and socioeconomic assessments can then be merged for effective decision making on conservation management. Ultimately, long-term conservation objectives need to be defined. In some cases, short-term mediation action, such as supportive breeding of priority populations, can be a useful tool to secure valuable populations and to mitigate Allee-effects. The advantages and challenges of the rigorous step-wise approach are illustrated using examples of European Unionid mussels.

Oral Session O3.1

Temperature-dependent seasonal and annual larval production of *Rhipidocotyle* trematodes parasitizing freshwater mussel, *Anodonta anatina*

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Unionid mussels can be infected by bucephalid trematodes, which use mussels as their first intermediate hosts to produce cercarial larvae that leaves the mussel to infect the next host in their life cycle. Two bucephalid trematodes, *Rhipidocotyle campanula* and *R. fennica* are known to infect the duck mussel, *Anodonta anatina*. It is also known that bucephalid infection will lead to decrease growth, reproduction and survival of *A. anatina*. Cercariae production in unionid mussels, a vital component of the parasite's overall transmission and life cycle success is directly influenced by temperature. Thus, the predicted global warming may increase or decrease parasite local abundance and cause geographic range extension or reduction of parasites with possible consequences for host populations and community dynamics. The objective of this study was to investigate the larval production of the two *Rhipidocotyle* species in their molluscan host, *Anodonta anatina* (Unionidae) in different temperature regimes. The mussels were from two populations, Haajaistenjoki River and Kuusaankoski River. Mussels were marked and allocated to three temperature treatments—high, intermediate and low—such that the mean August temperatures were 18, 17 and 14 ^{o}C, respectively. Between May 31 and October 28, every third week, mussels were individually monitored for cercarial emergence in the laboratory. Seasonal and annual cercarial larvae production was markedly temperature-dependent. Emergence of *R. campanula* started already in late May, whereas for *R. fennica* not until July. The mean period of ceracarial production was about 60 days longer in *R. campanula* than in *R. fennica*, giving probably an advantage for *R. campanula* in northern areas where short summer is limiting occurrence of the parasite. In high temperature, the total annual cercariae production was clearly higher for *R. fennica* than for *R. campanula*, but the opposite was found in low temperature. Results suggest that *R. campanula* would be better adapted to low temperatures while *R. fennica* should have an advantage in high temperature habitats or areas. Overall mortality rate of *Anodonta* mussels was highest in high temperature, amongst individuals that shed *R. campanula* cercariae and individuals that shed both *R. campanula* and *R. fennica*.

Oral Session O3.2

Conservation genomics of unionids: Insights gained from next generation sequencing of *Alasmidonta heterodon*, *A. varicosa*, and *Elliptio complanata*

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Freshwater bivalves (unionids), which are among the most threatened animals in North America, present major taxonomic quandaries and other significant challenges to conservation biologists attempting to maintain ecological and evolutionary processes within and among populations. Unionids are phenotypically plastic as both morphology and conchology are susceptible to environmental influences. External phenotypes are not an infallible guide to the partitioning of genetic diversity and may not reveal true genetic relationships because the rate of change is not the same in all lineages and evolution may cause species to converge as well as diverge. However, relatively little information is available on the amount or distribution of genetic diversity present at any taxonomic level in freshwater bivalves. If a goal of conservation efforts is to permit the continued evolution of species (or any unit of management), then it is important to establish the genetic and taxonomic relationships among managed individuals or populations. Moreover, little is known about the physiology of unionids, impeding conservation efforts; in particular, knowledge of genes mediating adaptation and conferring resiliency in the face of ecological challenge is scant. Against this backdrop, we have sequenced cDNA and gDNA libraries for genomes of the dwarf wedgemussel (*Alasmidonta heterodon*), brook floater (*Alasmidonta varicosa*), and eastern elliptio (*Elliptio complanata*). We assembled contiguous sequences, identified expressed sequence tags (ESTs), have annotated contigs and singletons from genomic shotgun libraries, and isolated thousands of microsatellite and single nucleotide polymorphism loci for each of the three genomes. This information represents an enormous database which now provides the conservation community with the necessary markers for phylogeographic and phylogenetic utility, and a suite of functional genomic tools for these non-model organisms. This research moves unionids solidly into the genomics era.

Oral Session O3.3

Phylogeography of French unionids: continental insularity and conservation in an age of global connections

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For the past millennia, freshwater mussels were "prisoners" within hydrographic basins, within and between which dispersion was carried out by host fishes. However, in France artificial connections between main drainages are now the norm, and navigation canals and fish translocation artificially connect previously isolated drainages. Notwithstanding this globalization of fluvial connections, species such as *U. crassus* have become so scarce that populations may be isolated in the few remaining favourable river stretches, counteracting artificial dispersion possibilities. This study performs molecular analyses of French unionids in order to define evolutionary lineages and clarify their still unclear taxonomy in a conservation and outreach perspective. Sampling includes both a random sample of main drainages and a targeted sampling of type localities. The results show a direct correlation between genetic structuring and hydrosystems organization, suggesting a still limited impact of artificial fluvial connections. Conversely, some species were found isolated outside of their cohesive range and this is believed to result from artificial fish translocation. Like elsewhere, systematic surveys of historical localities show an important decline of mussel populations, sometimes to the point of extirpation. Our results question the philosophy and long-term goals of unionid conservation action: should our state of reference be the fast-eroding genetical units of the 19th century, or should we pragmatically accept Operational Conservation Units aligned with the ongoing globalization of fluvial connections and fish translocations?

Oral Session O3.4

Evolution of Asymmetrical Larvae in Freshwater Mussels (Bivalvia:Unionidae)

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Freshwater bivalves are a paraphyletic assemblage of over 15 different bivalve families. This "group" is united not on the basis of common ancestry but by sharing several convergent life history traits adapted to life in freshwater. These convergent life history traits (i.e. restriction to freshwater and parental brooding) are shared by numerous freshwater bivalve lineages including the most specious family the Unionidae (commonly referred to as naiads or freshwater mussels). The Unionidae differ in comparison to other freshwater bivalve lineages (e.g. Sphaeriidae and Cyrenidae) because of their unique phoretic life history that utilizes specialized larvae, called glochidia, to parasitize freshwater fishes.

Glochidia and its various morphological types have been important characters in freshwater mussel systematics for over a century and remain a phylogenetically informative criterion at most major taxonomic levels. Despite its demonstrated taxonomic utility, several glochidial morphologies have never been considered in an evolutionary capacity, including asymmetrical glochidia. Asymmetrical glochidia are characterized by having a prominent marginal process on one of the two glochidial valves, dissimilar to all other known glochidial morphologies, which are consistently symmetrical. The genera bearing asymmetrical glochidia (i.e. *Contradens, Pseudodon, Solenaia, Trapezoideus,* and *Physunio*) are currently classified in two different subfamilies, and the most recent phylogenies are inadequate to determine whether asymmetrical glochidia arose independently in two largely sympatric subfamilies or is a trait that evolved once in a common ancestor of these genera.

The objective of this research is to test whether asymmetrical glochidia are products of a single evolutionary event (i.e. are synapomorphic) or an adaptive convergence (i.e. are homoplastic). This research uses a molecular phylogenetic approach that utilizes mitochondrial (CO1, 16S) and nuclear (28S) genes to test the monophly of the genera reported to have asymmetrical glochidia. Tree estimation methods utilized include maximum parsimony, maximum likelihood and Bayesian inference. The results of this research will be discussed in the context of freshwater mussel larval evolution and classification.

Oral Session O3.5

Shell Calcification on Freshwater Bivalves: An Overview

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The shell calcification of the freshwater bivalve is a well regulated and complex process, balanced between haemolymph and shell compartment, in which calcium carbonate gets embedded in an organic matrix consisting mainly of soluble and insoluble compounds. The regulation of the extrapallial fluid composition (shell side) and thus the shell formation is mainly due to the outer mantle epithelium (OME) activity. The OME electrophysiological studies combined with other approaches by further several years, on seasonal cycle of freshwater bivalve life, showed us a very interesting puzzle of calcification mechanisms. Among these results were various parameters present such as: seasonal correlation of trans-epithelial ionic current, permeability and electric potential; fluid titration; pH, pCO_2, pO_2, HCO_3^- ; Ca^{2+}, other ions and organic compound analyses in both fluids and in the shell nacreous layer growing under normal, acidosis, alkalosis and sub-lethal toxicity conditions. The ionic transport model added to all other correlations supported the new proposal for designing an integrative and complex shell calcification theory applied to the freshwater bivalves. As a main conclusion, it is possible to describe a seasonal active proton pump, instead of the active calcium transport, and the CO_2 component as the major pH buffering system (around 10 mM HCO^{3-}). The seasonal pCO_2 acid-base influence on the haemolymph pH, associated to the organic acids effect, induce the pH decrease during spring/summer, while it increase during autumn/winter supporting a respiratory/metabolic acidosis or an alkalosis situation, respectively. So, the respiratory/metabolic acidosis is indicated as a determinant factor promoting calcium and HCO_3^- releases from the dissolution of calcareous concretions in the mantle and gills of *A. cygnea.*

Oral Session O3.6

The Austrian Freshwater Pearl Mussel Conservation Project

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In 1993, Moog et al. indicated the Upper Austrian River Waldaist as "Austria's best remaining pearl mussel river with a population of outstanding significance that deserves utmost protection". At that time, 20,000 *Margaritifera margaritifera* specimens were found in the river. Nowadays, the remnants of this largest Austrian population only come up to 2.774 mussels. As *M. margaritifera* is listed in Annex II of the Habitats Directive, Austria is obliged to designate special areas of protection for it. Beyond that, in 2011 the Upper Austrian government decided to launch an extensive conservation project that deals both with captive breeding and the restoration of habitats.

In a first step, an appropriate site for the construction of a breeding facility was decided on: a fish farm that receives its water from a tributary to the river system in which the largest remaining mussel bed is situated. In a portable cabin two channel systems were installed which are supplied with stream water separately from one another. Each flow-through system consists of a long, narrow "mussel channel" in which a natural stream bed has been imitated, and of a wider downstream channel that shelters the host fish and is therefore referred to as "fish channel". Into each "mussel channel" 50 adult mussels that were picked from the River Waldaist and the River Naarn, respectively, were transferred. Each fish channel holds 250 young-of-the-year brown trout (*Salmo trutta* f. *fario*). As the water flow passes through the "mussel channel" first and consequently through the "fish channel", the host fish are infected with mussel larvae that are emitted by gravid adults without any further human intervention. In late autumn, the infected fish are transferred to special cages that have been installed in an adjacent fish pond. In early spring, they are put into large cylindrical water basins with conical bottoms from which the water is pumped in closed circuit through a fine-meshed sieve. Juvenile mussels that drop from their hosts are caught within the sieve and can be collected periodically.

Meanwhile, tributaries in the catchment systems of the Rivers Aist and Naarn are scrutinized towards their suitability for releasing the gained juvenile mussels. Habitat suitability, hydrochemistry, redox potential, temperature regime and other criteria are analyzed. Finally, juvenile mussels are used for biomonitoring in order to find out the most appropriate habitats. The overall aim of the project is the establishment of reproductive populations in fully restored habitats that grant for the survival of the highly endangered mussel species.

Oral Session O3.7

New perspectives for the conservation of the freshwater pearl mussel *Margaritifera margaritifera* in Castilla y Leon (NW Spain)

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The work done by the Junta de Castilla y Leon and the Confederación Hidrográfica del Duero in the Negro River (NW Zamora) between 2003 and 2012 have improved the scientific knowledge of the freshwater pearl mussel *M. margaritifera* (Linnaeus, 1758) and ecological conditions of the river which houses the main population in Castilla y León (NW Spain). Among the recent developments, should highlight the actions taken to ensure that his natural host -the brown trout *Salmo trutta* var. *fario*- is able to go up the Negro River, the location of new colonies of naiads and the detection of some individual next to young adulthood. Although these achievements do not change the delicate conservation status of this mussel in Castilla y León, the cooperation of both governments opens new perspectives for a possible recovery, guiding the future working lines to: 1) continuation of the annual monitoring of the species, its host and its habitat, 2) specific protection plan for the main colonies of mussels, 3) grouping in colonies of isolated, at risk and/or biologically non-functional mussels, 4) implementation of a controlled trout infestation with glochidia and 5) adoption of concrete measures to protect and promote brown trout populations.

Oral Session O3.8

Anthropogenic changes of brown trout *Salmo trutta* and the impact on its parasitic mussel *Margaritifera margaritifera*

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The freshwater pearl mussel *Margaritifera margaritifera* is a highly threatened mussel that is dependent on healthy populations of its host fish brown trout (*Salmo trutta*). Here, we studied the parasitic stage on host fish of freshwater pearl mussels living in the Maljan tributary, situated in the Ljungan catchment, Sweden. We were interested in how four different host fish strains differed in their function as hosts for the Maljan mussels. The original host fish strain of the Maljan mussels, the Ljungan Sea trout, used to migrate from the sea to spawn in tributaries like Maljan. Today, eight migration barriers in the mainstream hinder the Ljungan trout to reach Maljan and many other tributaries. However, Maljan still has a reproducing trout population, the Maljan strain. To compensate for the fish loss caused by the migration barriers, the hatchery reared Oxsjö strain is released between the eight dams in the mainstream. Another brown trout strain, the Konnevesi strain is also a commonly released hatchery reared strain in the area, and may live sympatric to mussel populations. In the laboratory, Maljan mussel larvae were encapsulated on the gills on young-of-the-year brown trout from all four trout strains. Two weeks after the encapsulation event, between 85 % and 100 % of the trout strains were encapsulated with mussel larvae. After 8 weeks, between 40 % and 92 % of the trout strains had encapsulated larvae on their gills. The Ljungan trout had the highest larval densities on its gills at the end of the experiment, which may result in a higher recruitment of juvenile mussels from the Ljungan trout compared to the other trout strains. Therefore, intact migration routes for fish may result in improved recruitment of threatened unionid mussel species. Release of hatchery reared fish in close connection to mussel populations should be handled with care.

Oral Session O3.9

Rediscovery of the freshwater pearl mussel (*Margaritifera margaritifera*) populations within the territory of the Baltic Sea basin in Russia

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Freshwater pearl mussels were almost non-studied within the Russian part of the Baltic Sea basin, although pearl fishing existed for a long time. During 2006-2011 we undertook a wide search for the remnant populations to evaluate their condition. Using archives and museum collections, we have found nine populations, although some distant areas remain unexplored. In the rivers flowing directly to the Baltic Sea and to the Ladoga Lake, all known populations survived, while in the rivers of the southern part of this territory (Ilmen' Lake basin) almost all became extinct: among 30 rivers we have only found one population. In addition to overfishing during XVII-XIX centuries, this extinction might be partially explained by an increase of the water hardness after washing-out of calcareous geological layers. In these "southern" rivers pearl mussels were replaced by *Unio crassus*.

The surviving populations differ in respect to their condition. Four of them are very small, being on the edge of extinction, although still reproducing. The others are more numerous. In a small section of one river an extremely high density of mollusks was recorded – up to 1000 individuals per 1 m². However this population declined significantly over the last decades: only dead mollusks were noted in the half of the river.

Apart of overfishing, the reasons for the *Margaritifera* decline are different in different countries. While in the rest of Europe mussels suffer greatly from the destruction of the natural riverside vegetation (followed by siltation and water acidification), in Russia this factor is less significant. Hydrotechnical constructions and extermination of salmonids are obviously the most significant factors of the negative impact.

Oral Session O3.10

Invited speaker

Phylogeny of the Unionida: A current assessment

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Doubt regarding the history of higher level Unionida bivalve phylogenesis has impeded attempts to understand evolution within the group and to establish a stable, phylogenetic classification system. Previous and often conflicting estimates of Unionida phylogeny, especially those dealing with interfamilial relationships, stem principally from an insufficient amount of data. For example, the two largest published analyses of Unionida phylogeny both utilized a total of only 1,182 characters. An additional source of data is the comparison of the male and female mitochondrial DNA which are reciprocally monophyletic. Doubly Uniparental Inheritance (DUI) of male and female mitochondrial DNA analyses in Unionida support a long history, over 200 million years and document the long stability of the clade, lacking the masculinization characteristic of Mytilidae. Family level monophyly is supported for Hyriidae, Margaritiferidae and Unionidae but family level separation in the Etherioidea is less clear. Etherioidea lack any evidence for DUI. Recently published subordinal nomenclature proposed by Hoeh and co-authors (Unionoina and Hyrioina) rejects the traditional, two superfamily nomenclature (Unionoidea & Etherioidea) as initially proposed by Parodiz and Bonetto. Furthermore, a cemented unionoid lineage, *Pseudomulleria,* is confirmed as a member of the Unionidae. These phylogenetic relationships indicate that hyriids, rather than margaritiferids, are a product of the basal cladogenic event in the ancestral Unionida lineage. Current analyses strongly support (1) the glochidium as the ancestral Unionida larval type, (2) endobranchial brooding as ancestral for the Unionida, (3) cementation having evolved independently at least three times within Unionida bivalves and (4) doubly uniparental inheritance of mtDNA (DUI) having been lost in the ancestral etherioid lineage.

Oral Session O3.11

Conservation Status of Freshwater Bivalves in South America: State of the Art, Perspectives and Future Challenges

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South America, with an area of 17,819,100 square kilometers, represents 12% of the World land area and is home to 6% of the World population. It includes several major river systems as the Amazon, Orinoco and Paraná/Río de la Plata basins, with a total drainage area of 9,583,000 km². These systems and other smaller include areas of endemism, diversity hotspots and unique landscapes. In this continent live 160 known species of bivalves distributed in the families, Hyriidae (63 species), Sphaeriidae (42), Mycetopodidae (38), Corbiculidae (14), Dreissenidae (1), Lyonsiidae (1) and Mytilidae (1). Five invasive species occur in South America: the mytilid *Limnoperna fortunei*, and the corbiculids *Corbicula fluminea*, *Corbicula largillierti*, *Corbicula fluminalis* and *Corbicula* sp. The taxonomic status of many species needs revision. So far, an illustrated catalog of the native bivalve fauna of South America is lacking and little is known about the preferred habitats for many species, their population status and reproductive aspects of native species. Among the threats to conservation of native bivalves, human activities such as the construction of dams, deforestation, erosion and river siltation, water pollution and competition with invasive species are the most significant. In addition, the critical revision of the official list of endangered species and the development of research programs aiming the monitoring and management of bivalve populations is strongly needed in order to determine conservation strategies. Finally, education programs with view to raise awareness about environment subjects, is also urgently needed.

Oral Session O3.12

Juvenile *Margaritifera margaritifera* (Bivalvia, Unionoida) – the survival of the cleanest. Sedimentation studies on a selection of rivers

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Previous studies have shown that the key loss of *Margaritifera* populations is through lack of success of recruitment of juvenile individuals through habitat deterioration. Geist & Auerswald (2007) demonstrated the usefulness of redox potential measurements in the assessment of river bed habitat suitability for juvenile survival.

In this study, a range of habitats in a number of Irish and UK rivers were examined for habitat characteristics, redox potential measurements, and juvenile survival. The results are related to catchment inputs and sediment loads.

The results demonstrate that apparently minor land use changes can disrupt mussel recruitment, and that addressing problems at source can be ultimately more successful and cost effective than intercepting sediment loads along pathways.

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Oral Session O3.13

Influence of Different Environment on Growth of Freshwater Mussel, *Hyriopsis* (*Hyriopsis*) *bialatus*

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Glochidia of the freshwater pearl mussel *Hyriopsis* (*Hyriopsis*) *bialatus* were cultured in an artificial medium consisting of M199, fish plasma (*Cyprinus carpio*) and antibiotics/antimycotic at a ratio of 2:1:0.5 (v/v). They were reared at a density of 2,000 glochidia per dish (10 ml of artificial medium) under sterile conditions until they transformed into juveniles. The culture dishes were incubated at 25 °C with a constant supply of 5% CO_2. The duration of glochidia development until the juvenile stage was 8 days. After transformation, early juvenile mussels were reared in a closed recirculating aquaculture system. The system was composed of a particulate filter cabinet, a macrophyte (*Limnophila heterophylla*) filter cabinet, a biological filter cabinet, a water resting cabinet, and plastic culture units. Mussels were fed twice a day on a 1:1 mixture of *Chlorella* sp. and *Kirchneriella incurvata* until 90 days. Those freshwater pearl mussels were divided into 2 batches with 3 replications. The first batch was brought to rear in 2-diameter cemented ponds containing sand at the floor and water was pumped at flowing rate of 5 liters per minute throughout 24 hours from Boraphet Swamp, Nakhon Sawan Province, the natural habitat of these mussels. For the second batch, mussels were continuing to rear in a closed recirculating aquaculture system until they had 170 days old then transferred to cemented ponds (like above). Later on, those two batches were reared until they had 410 days old. From this study, it was found that the first batch had highly significant difference ($P<0.01$) in growth than the second. There were: weight of juveniles 29.89±1.80 vs. 12.85±1.24 g; lengths of 86.36±1.87 vs. 63.42±2.26; and heights of 61.15±1.15 vs. 47.75±2.06 mm, respectively; equation of shell length with time in days of rearing mussels in 90-410 and 170-410 days equal to shell length = $-44.549+0.558day-0.001day^2$ and shell length = $-71.414+0.541day-0.001day^2$ with coefficient of determination (R^2) equal to 0.995 and 0.997, respectively.

Oral Session O3.14

Reproductive cycle and *in vitro* culture of freshwater mussel glochidia (Bivalvia: Unionidae)

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Adult of freshwater mussels (Unionidae), *Chamberlainia hainesiana, Contradens contradens, Ensidens ingallsianus*, *Hyriopsis (Hyriopsis) bialata*, *Physunio eximius*, *Pilsbryoconcha compressa*, *P. exilis*, *Scabies crispata, S. phaselus*, and *Trapezoideus exolescens* were collected from Mun River Basin, northeastern Thailand. The mussels were sexed by microscopic observation of sperm and ova in fluid drawn from the gonads. Each species of female and male mussels at a ratio 1:1 were cultured together in a round-bottomed net (45 cm in diameter and 30 cm in height) in an outdoor earthen pond and fed with natural food occurred in the pond. An observation for reproductive cycle and marsupial development was carried on every month throughout the year. Mature glochidia of each species were cultured in artificial medium containing 3.5 ml of M199 medium, carp plasma (*Cyprinus carpio*), and antibiotics/antimycotic (100 µg/ml carbenicillin, 100 µg/ml gentamicin sulphate, 100 µg/ml rifampin, and 5 µg/ml amphotericin B) at a ratio of 2:1:0.5 (v/v/v), respectively. Approximately 21×10^2 mature glochidia were cultured in each dish under sterile conditions. Culture dishes were placed in a plastic box and incubated with a constant supply of air with 5% CO_2 at 25°C and ambient humidity. From this study, the reproductive cycle and marsupial development of *E. ingallsianus*, *H. (H.) bialata*, *P. compressa*, *P. exilis*, *P. eximius*, *S. crispata* and *S. phaselus* were continuing preceded all year round except *C. hainesiana*, *T. exolescens* and *C. contradens* only in the winter. The marsupia in both outer and inner demibranch were found in *E. ingallsianus*, *P. exilis* and *S. phaselus* except *C. contradens*, *C. hainesiana*, *H. (H.) bialata*, *P. compressa*, *P. eximius*, *S. crispata* and *T. exolescens* found only in outer demibranch. It was found that mature glochidia of six mussels which could transform from glochidia to juvenile, i.e. *E. ingallsianus*, *H. (H.) bialata*, *P. exilis*, *P. compressa*, *S. crispata* and *S. phaselus* with survival percentage from 82.8±8.9 to 96.3±1.1. All surviving larvae (100%) ultimately transformed into juveniles, including 6 to 11 days of transformation duration.

Oral Session O3.15

Growth and survival of *Margaritifera margaritifera* glochidia on host fish gills and of juvenile mussels in climate chambers

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In the course of the "Austrian Freshwater Pearl Mussel Conservation Project" a preliminary study was carried out in a millrace of the Gießenbach brook in Upper Austria, starting in August 2010. At that time, 200 host fish – juvenile brown trout (*Salmo trutta* f. *fario*) – were released into an enclosed stretch of the millrace situated downstream of an only recently discovered *Margaritifera margaritifera* population. The fish were infected naturally when the gravid mussels emitted their larvae, and were kept in the millrace throughout the winter months. During that hibernation period, host fish were examined at four-week intervals. At every examination date five fish were killed, the numbers of glochidia per fish were counted and the diameters of a total of 20 glochidia per fish measured. From October 2010 to February 2011, growth was relatively slow with a mean total increment of only 20 µm – from 220 µm to 240 µm. From February to late April, growth increased perceptibly and larvae reached body lengths of up to 343 µm.

In late April the host fish were transferred into a large cylindrical water basin from which the water was pumped in closed circuit through a fine-meshed sieve in order to collect the juvenile mussels that dropped from their hosts. During that crucial period no measurements were taken. The first viable mussels were collected in early June. Collections were repeated daily until the end of June, when no more juveniles were found in the sieve.

The juvenile mussels were transferred to the laboratory, where they were kept in plastic boxes under constant temperature conditions of 18°C. Water was exchanged once a week, in the course of which survival and growth rates were examined. Survival rates were very low during the first week in the climate chamber (only 37.18%) but increased continually and markedly: After two weeks they reached 64.86%, after three weeks 69.98%, and after four weeks 81.86%. After the first month in the laboratory, hardly any dead mussels occurred anymore; survival rates finally reached 100% and remained at that level all winter long. As long as the temperature was kept at 18°C, growth rates were very high: From early July till Mid-October the mean total length increased from 625 to 1,560 µm. Then, hibernation was initiated by stepwise decreasing the temperature to 6°C. Growth ceased almost immediately, whereas survival remained at its high level.

Oral Session O3.16

Type material of *Diplodon ellipticus* (Spix in Wagner, 1827) (Unionoida, Hyriidae) rediscovered

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Diplodon is a South American genus of freshwater mussels belonging to Hyriidae (Paleoheterodonta, Unionoida). The real diversity of this genus is unknown due to taxonomic problems and little amount of studies. *Diplodon ellipticus* is the type species of this genus and the original description is poor considering distinguishing features. The lacking of conspicuous characters on the shell induced many authors to aggregate more or less similar elliptical *Diplodon* species building a confusing complex. Ihering (1890) presented a more detailed description, drawings and measurements of original material. After him the type material was considered lost. Almost a century later, Fetcher (1983) published a work about Spix collection at Zoologische Staatssammlung München in Germany. She illustrated all types properly, except the type of *D. ellipticus*. Fetcher (1983) stated that she didn´t find any specimen with the same measurements as the ones presented in previous works and illustrated her work with pictures from other shells. Recently, the first author had the opportunity to analyze the collection of Spix. The lot identified as the type of *Diplodon ellipticus* is the one used by Fetcher (1983), and also contains labels of other authors asserting that this are not the type specimens. They also agreed in suggesting that the drawings of Ihering (1890) are until present days the best representation of *D. ellipticus*. In the same drawer, there is another lot with one shell and two conflicting labels. One label identifying this sample as *Diplodon* (*D.*) *charruanus* (Orb.), a common species in south Brazil. The other label shows the name *Unio ellipticus* Spix, in an old fashioned hand writing but unidentified and undated. Inside the right valve of this specimen is written "*ellipticus*", but again without a name or a date. This specimen is remarkable similar in outline to *D. ellipiticus* original descriptions. Our measurements, taken directly from this specimen are really close to that presented by Ihering (1890). We believe that this specimen is the real type of *D. ellipticus* and changed place sometime between the works of Ihering (1890) and Fetcher (1983).

Oral Session O3.17

New aspects and implications for the conservation of the thick-shelled river mussel (*Unio crassus*)

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The thick-shelled river mussel *Unio crassus* was formerly one of the the most abundant freshwater bivalve species in central Europe. As a result of significant declines within the last century, the species is now considered highly endangered in several European countries; therefore, *U. crassus* is listed in annexes II and IV of the EC Habitats Directive. Since only few successfully reproducing populations remain in Germany, various conservation efforts targeting habitat restoration for juvenile and adult *Unio crassus* have been initiated. Within the scope of statewide conservation efforts, the Bavarian Coordination Office for the Protection of Freshwater Mussels aims to help design sustainable conservation strategies for *U. crassus*. The conservation management approach integrates joint efforts of research institutes and government organizations, thus cross-linking basic and applied science to nature conservation in practice. In this paper, new aspects regarding habitat requirements of *U. crassus* will be presented, since knowledge on the autecological and synecological requirements of this species has been scarce so far. Analysis of stream substratum quality, which is seen as one of the key parameters for functional freshwater mussel habitats, revealed that *U. crassus* is more tolerant to adverse habitat conditions than previously assumed. In particular, physicochemical parameters such as redox potential, chemical condition of the interstitial system as well as high fine sediment deposition previously attributed to declines in thick shelled river mussel populations were found to be weak predictors for the occurrence and the recruitment of this species. We conclude that species-specific habitat requirements of different unionids have to be considered to implement effective conservation strategies.

Oral Session O3.18

Captive rearing of the freshwater pearl mussel *Margaritifera margaritifera* in England – Lessons learned

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The freshwater pearl mussel *Margaritifera margaritifera* is critically endangered (IUCN 2011) and in decline throughout the whole of its range. In response to declining populations in England, the Freshwater Biological Association, Environment Agency and Natural England have embarked upon a captive rearing programme to boost juvenile mussel numbers in nine English pearl mussel populations. Captive-reared juveniles will eventually be used to augment wild populations. Here we describe the activities of the Freshwater Pearl Mussel Ark Project since its inception in April 2007 (Lavictoire & Sweeting 2012), and present key findings from captive rearing activities. The freshwater pearl mussel exploits salmonids as its host but we have observed that different populations of pearl mussels exploit different species of host fish in captivity. This finding has been confirmed in the wild by electrofishing in pearl mussel catchments. Our observations indicate a preference in each mussel population for either salmon (*Salmo salar*) or trout (*Salmo trutta*) with some pearl mussel populations exploiting other hosts such as Arctic charr (*Salvelinus alpinus*). Glochidial encystment levels vary depending upon the pearl mussel population and the host fish species but encystment rates of up to 5000 glochidia per fish have been observed with no demonstrable deleterious effects on the host. To date, small numbers of juvenile mussels have been reared to three (~50 individuals) and four (~120 individuals) years old respectively. Juvenile mortality is high during the first year post-excystment and monitoring of juveniles less than three years old is difficult due to their small size. Research is being conducted to try and identify the factors limiting juvenile survival post-excystment in an attempt to increase juvenile survival and increase the efficiency of the captive rearing programme.

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Oral Session O3.19

Within-river spatio-temporal relationship between the freshwater pearl mussel *Margaritifera margaritifera* and its fish host *Salmo trutta*

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We investigated seasonally the spatial occurrence of the fish host, the resident brown trout *Salmo trutta*, in relation to the spatial distribution of the freshwater pearl mussel *Margaritifera margaritifera* in a tributary of Lutto River, Finland, located in Tuuloma River catchment flowing to the Arctic Ocean. The 3 km long target river was first divided into 46 sections and investigated for the occurrence of pearl mussels. Then 12 highest-density sections were selected to represent mussel sites and 12 non-mussel sections to represent control sites. A seasonal electro fishing was done every 3rd week from May 27 to September 22, 2009. Highest water temperature, 16.9 C, was observed on July 29. The mean density of trout from May to September was higher in control sites (24 ind/m^2) than in mussel sites (15 ind/m^2). In fact, on May 27 there was no trout at all on the mussel sites. After that the proportion of trout caught from the mussels sites increased, reaching the highest level, 55 %, on July 29—exactly at the time when the fully developed glochidia started to drop from the gills of trout. From July 29 to the next sampling point, August 18, the proportion of trout caught from mussel sites decreased to about 30 %, staying at that level to the end of the study. Mean number of glochidia per fish was higher in mussel sites than in control sites both in early season (old glochidia) and in autumn (new glochidia). In addition, there was a positive correlation between mussel density and glochidia abundance in fish after the emergence of new glochidia in autumn. Thus, the results suggest that that the infection of fish is affected by mussel density. Furthermore, although the trout density in general was higher in control sites, it could be calculated that the density of glochidia shed from the fish to mussel sites was many times higher than to control sites since the glochidia-bearing trout aggregated to the mussels sites just at the time of glochidia drop from the fish—indicating the importance of local dynamics in the relationship between the fish and the mussel.

Oral Session O3.20

Behavioural and physiological impacts of freshwater mussel glochidia on juvenile brown trout intermediate hosts

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Trophically-transmitted parasites often alter the behaviour of their intermediate hosts to make them more vulnerable to predation, which facilitates the parasite's transmission to the next host. Non-trophically transmitted parasites, however, depend upon the survival of their hosts for their own survival. Consequently, the impact of non-trophically parasites on host behaviour and physiology has seldom been examined. We investigated the physiological and behavioural responses of juvenile brown trout to encysted glochidia of the freshwater pearl mussel, *Margaritifera margaritifera* for up to 160 days post-exposure. Glochidia abundance was positively correlated to host body size and was accompanied by significant spleen enlargement at 31 days post-exposure, but other physiological impacts were slight. We suspect an anti-glochidial immune response was probably mounted by the fish, but it appears to be short-lived and to peak at one month post-exposure. The time to emerge from a hide, a proxy for risk-avoidance behaviour, was positively related to glochidia loads at all times post-encystment, and was significantly greater among encysted trout than among unexposed, control fish. The scent of a sympatric mammalian predator (*Lutra lutra*) in the water significantly decreased risk-taking behaviour and induced spatial avoidance in brown trout, regardless of glochidia abundance or infection status. Results indicate that the freshwater pearl mussel does not impair predator recognition or spatial avoidance of its host, whilst potentially increasing host survival by making it more risk-averse, thereby limiting contact with predators.

Oral Session O3.21

Modern conditions of freshwater pearl mussel *Margaritifera margaritifera* (L., 1758) populations in loose floating rivers of the basin of the White Sea south coast (North-west of Russia)

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At present time we have observed a decreasing or extinction of *M. margaritifera* populations in regions with a high degree of human impact. On the other hand pearl mussel populations are stable in conditions of low anthropogenic pressure and thinly populated areas. However we know little about ecosystems that were under anthropogenic pressure but which human activities in these areas are reducing or extinct. In some of these ecosystems we can observe the process of restoration of pearl mussel populations that were close to extinction. Our research was conducted on Nimenga (and tributaries Ydma and Akan) and Maloshujka rivers. These rivers belong to the basin of White Sea south coast and are situated westward from the Onega river basin. In the past this region has suffered from severe logging, especially at the river Nimenga. As the research shows the Nimenga and the Maloshujka have small pearl mussel populations that consist mainly of old specimens. Juvenile mussels are absent in the samples from the Nimenga. This could be explained by loose floating impact. We suppose that the pearl mussel populations' recovery in the Nimenga takes place upstream and downstream from the Ydma confluence. The Ydma river was a refugium for pearl mussels during intensive forestry impact to the Nimenga. Moreover insufficient density of salmon fry is slowing down the process of population recovery.

This investigation have financial support from Russian Foundation of Basic Research (projects 10-04-00897, 11-04-98815, 12-04-00594), grant of President of Russia (МД - 4164.2011.5.), grant of Ural Branch of RAS, travel grant of The Malacological Society of London; a Society logo is and State Special Program of Ministry of Science and Education of Russia.

Oral Session O3.22

Abstracts

Poster Presentations

Molecular detoxification - a powerful resource to environmental adaptation and survival in Bivalves

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Animals of the Bivalvia class appeared during the Cambrian explosion and comprise around 20,000 living species. Bivalves exhibit a great range of behaviors, ecological adaptations and habitats, being highly sensitive to environmental changes. Due to their filter feeding behavior and respiratory purposes, bivalves accumulate large amounts of several aquatic pollutants. Such toxic compounds may increase the cellular levels of reactive oxygen species (ROS), causing the death of the organisms. Thus, mechanisms for detoxification of ROS are vital for the survival of bivalves. This fact explains the great diversity of encoded proteins involved in antioxidant defense of the cells (detoxification genes), some of which include: superoxide dismutases (SODs); cytochrome P450 (CYPs); glutathione S-transferases (GSTs); metallothioneins (MTs); cholinesterases (ChEs); glutathione peroxidases (GPx); glutathione reductases (GRs) and catalases (CATs). However, limited knowledge exists on the bivalve's molecular detoxification mechanisms, so here we assessed the phylogenetic relationships and evolutionary dynamics of these protein families in bivalves, namely SODs due to their primary role in the defense against ROS in aerobic organisms. Moreover, the results provide insight to understand the pivotal role of SODs in adaptation to challenging environments (e.g. habitat degradation).

Poster Session P1

LIFE11 NAT/LU/857 Restoration of *Unio crassus* rivers in the luxemburgish Ardennes: a summary description of a new project 2012-2018

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The thick shelled river mussel *Unio crassus* a formally abundant species of semi-lentic river habitats in Luxemburg has dramatically declined within the last fifty years. Small populations remain in the two rivers Our in the three country region of Belgium, Germany and Luxembourg and Sûre on the Luxemburgish Belgian border with about 9.000 individuals respectively 32.000 individuals. The two crucial problems of these catchments are the heavy load of fine sediments causing a clogging of the interstitial pore system, the key habitat used by juvenile mussels during the first years and the eutrophication. The aims of the present project are to improve the habitat quality of the two rivers Our and Sûre and to strengthen the existing populations by different actions.

An initial mapping phase in order to locate the siltation problems and the main entrances of nutrients, mainly from agriculture, will help to guide the further implementation of measures which consists in installing fences along the rivers to protect the banks against cattle erosion, in installing of water gutters on forestry and agricultural roads to prevent that the sediment loaded rain runoff runs directly in the rivers and in proposing to farmers agri-environmental measures in order to reduce in the catchment amounts of nutrients and fines.

In order to strengthen the existing populations of the two rivers the rearing facility at the Mill of Kalborn, will be used to develop rearing methods for *Unio crassus.* The propagated mussels will be released at well selected sites into the river Our and Sûre after they had been kept in captivity for 3 to 4 years.

Poster Session P2

Origin and Routes of Expansion of Freshwater Pearl Mussels (*Margaritifera*)

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Data on the shell morphology and the distribution of the haplotypes of the COI mitochondrial gene, as well as paleontological materials, suggest that the genus *Margaritifera* has originated from Southeast Asia. The Tethys Sea played the main role in its original expansion. Species of freshwater pearl mussels intermediate between the modern European and Far Eastern species, including the fossil *M. occulta* (Maderny, 1972) and the modern *M. (Dahurinaia) transbaicalica* (Klishko, 2008), have been found in the former coastal regions of this sea. The morphological analysis of European freshwater pearl mussels differing in the shell shape and classified into separate comparatory species *M. margaritifera*, *M. elongata,* and *M. borealis* (Bogatov et al., 2003) has not shown hiatuses between them (Sergeeva et al., 2008), with the three species sharing the same set of mtDNA haplotypes. Thus, the species statuses of these forms have not been confirmed; all of them belong to the species *M. margaritifera*.

The distribution of mtDNA haplotypes indicates that, as the glacier receded, *M. margaritifera* spread to northern Europe along two routes similar to those of the spread of the Atlantic salmon (*Salmo salar*), the fish host of the mollusk at the larval stage. The freshwater pearl mussel expanded along the Atlantic coast and across the watershed between the Baltic and White seas. In the same period, it reached the northeastern regions of North America.

Poster Session P3

Corrosion rates in shells from dead Freshwater Pearl Mussel (*Margaritifera margaritifera*) from the Pasvik watershed catchment in Northern Norway

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In the search for *Margaritifera*, there is often found remains of shells from dead mussels in the rivers. Then the question arises: How long is it since this mussel died? Can the shell be used to tell about the death rates of the mussel population? Or even the reason for their death. The estimated time of death of the mussel can be important in cases where there is a possibility that a specific event or occasion may be related to the death of the mussel. Empty shells that are found appear to have different degrees or stages of corrosion. The rate of corrosion through 10 years is shown for *Margaritifera margaritifera* from one river in Northern Norway.

Poster Session P4

Changes of some mussel populations in Hungary

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Population dynamics of Unionid mussel populations (species ratios, abundance, biomass, growth habit) was surveyed between 1990-96. Some important localities were surveyed again in 2011-2012 and the earlier data were compared to the present status. The attention was focused on the presence and spread of the huge and invasive *Sinanodonta (Anodonta) woodiana* (LEA, 1834), but detailed data of all other native species were monitored as well. Mainly the productivity, growth, biomass of different species were measured and calculated.

The investigations showed some changes in the populations, which may be the effect of *S. woodiana* to the native species. Moreover results showed the dispersion of *S. woodiana* in some localities, and the parallel decrease of the native *Anodonta* species (*A. cygnea, A. anatina*).

The ecological pressure from *Sinanodonta woodiana* to the native *A. cygnea*, and *A. anatina* is valid, but *Unio pictorum* and *Unio tumidus* seem to be tolerant to the presence of *S. woodiana*.

Poster Session P5

The thick shelled river mussel (*Unio crassus*) brings LIFE+ back to rivers

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The LIFE-projects objectives

The UC4LIFE+ project (2012-2016) aims to strengthen the conservation status of the endangered thick shelled river mussel (*Unio crassus*) and improve the ecological riverine status within its Scandinavian distribution range. As being a key-stone species, actions beneficial for *Unio crassus* will positively impact overall water quality, biodiversity, including other endangered species, such as Atlantic salmon, bullhead, freshwater pearl mussel and otter.

The actions

The 4.9 M€ project is constituted of three major objectives:

1) Mapping host-fish utilization by *Unio crassus* to ensure successful conservation actions for both *Unio crassus* and host-fish species.

2) Recreate natural river dynamics by restoring structures (*i.e.* substrate and cover) and processes (*i.e.* connectivity and corridor functions).

3) Re-introduction by stocking *Uc*-juveniles and glochidia-infected host-fish.

Poster Session P6

Dreissena impacts on Unionidae: general trends in North America and Europe and recent findings from Lake Erie

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The continued invasion of zebra mussels (*Dreissena polymorpha*) and quagga mussels (*Dreissena rostriformis bugensis*) in North America and Europe has threatened the survival of native unionid mussels. We used data from multiple waterbodies in Europe and North America to test if the impact of *Dreissena* on unionids depends on densities of dreissenids in a waterbody, time since invasion, and *Dreissena* species. We found a strong positive linear relationship between the number of zebra mussels per unionid host and *Dreissena* density in a waterbody. There was an overall trend for increase of attached dreissenid weight with unionid host's size during the first 10 years after *Dreissena* invasion, however, this adverse impact reduces beyond 10 years after the recorded invasion. We also found that while impacts of zebra mussels on unionids are well described, there is little comparable data for quagga mussels. Considering that the overall dreissenid density in Lake Erie has declined over the last decade, zebra mussels have been almost completely replaced by quagga mussels, and the fact that quagga mussels have weaker attachment strength, we hypothesized that the adverse impact of dreissenids on unionids is now less than the early stages of the invasion. We conducted extensive surveys of unionids in lakes Erie and St. Clair in 2011, and recorded the number, weight, and species of dreissenids attached to unionids shells. Confirming our hypothesis, most of the unionids found were free of dreissenids, and infested unionids had fewer attached dreissenid mussels than in the early 1990s. Despite the quagga mussels' lake-wide dominance, zebra mussels were more often found on unionids, and their number and weight per host unionid were higher than those of quagga mussels.

Poster Session P7

Ecological correlates of the *Anodontites trapesialis* (Lamarck, 1819) (Mycetopodidae: Unionoida): The greater freshwater mussel of South America

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Porting the status of the bigger of native bivalves, *A. trapesialis* is the species of widest distribution in South America, occurring in all river basins in Brazil. The Cuiabá River basin, which drains the most extensive floodplain of the planet, was the scene for twenty years of studies related to morphology, biometry, growth, reproduction, incubation, host-parasite relationship, filtration and toxicology of this freshwater mussel. The morphological apparatus which allows the wide demibranch an average filtration rate of $1L.g^{-1}$ (dry weight).h^{-1} at 25°C, adding the fact that they are simultaneous hermaphrodites with continuous production of gametes, maintain a trade-off between growth and reproduction orchestrated by the hydrological cycle imposed by periodic flood pulse that although not present in a specific host parasitic relationship are more than enough arguments to describe the adaptive success of the species. The framework of information allowed us to establish relations between the mussels and the environment in order to understand one by the other and vice versa, reinforcing the original idea to list this species as an ecosystem sentinel species worthy of an exclusive program for conservation.

Poster Session P8

Conservation of *Margaritifera margaritifera* (Linnaeus, 1758) in the Armorican Massif (Brittany and Lower-Normandy, France)

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Six rivers located in the north-west of France are known to still harbour the main population of *Margaritifera margaritifera*. All these six populations are still reproducing but are only potentially functional and will, without assistance, disappear in the near future. Therefore within a LIFE+Nature project founded by the European Commission and government agencies, a rearing station was built in order to save these populations.

The major goal of this rearing station is to enhance the declining freshwater mussel populations of the area. Firstly, for all the six populations, infected fish were used to collect juvenile mussels at the rearing station. These mussels were subsequently separately reared under intensive laboratory conditions, in order to preserve genetic specificities. Secondly, only for one population, the host fish of *M. margaritifera* were artificially infected with glochidia and immediately released. The reinforcement of mussel wild stocks will be carried out each year by directly reinforcement individuals in rivers substrate and also using methods which make it possible to assess the outcome of *in-situ* operations. However, one rule prevails for these reinforcements: the original watercourse first have to reach a sufficient quality. In 2011, 350 *Salmo trutta fario* have been infected with *M. margaritifera* and were released into only one river. 4 000 other *S. trutta fario* have been infected with more than 3 million glochidia. The collection of the young mussels will occur in spring 2012. These operations will be repeated each year until 2016 in order to culture mussels of various age-classes. The goal of this *ex-situ* conservation operation is to have a batch of about 4 000 pearl mussels aged 4 to 5 years for each of the watercourses at the end of the programme.

Results achieved and problems encountered so far are presented.

Poster Session P9

Critical reduction of *Cyanocyclas* geographic distribution in Uruguay: the shadow of *Corbicula*

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The South American endemic corbiculid genus *Cyanocyclas* Blainville, 1818 comprises about fifteen nominal species described from Uruguay. From these, only two are currently considered as valid: *Cyanocyclas limosa* and *Cyanocyclas paranensis*. Several authors have reported population declines of these species after the settlement and spread of the invasive genus *Corbicula*, including in some localities the disappearance of *Cyanocyclas*. In this context, the historical and current geographic distribution of *Cyanocyclas* spp. in Uruguay is reviewed. To do that, 70 localities in which *Cyanocyclas* spp. have been previously reported, were surveyed. Surprisingly, only in five of these locations *Cyanocyclas* is still present. The main threats related with the disappearance of *Cyanocyclas* spp. were the presence of the invasive bivalve *Corbicula fluminea* (97 % of localities studied) and urban contamination (32 % of localities studied). In addition to *Cyanocyclas limosa* and *C. paranensis* were found at least three morphotypes of *Cyanocyclas* not attributable to any of these species, therefore the effect of reduction could be more severe than expected. The latest populations of *Cyanocyclas* remain in headwaters on sandy/clay bottoms, where *Corbicula* spp. are not present or are scarce. Management in these habitats is the main opportunity of conservation of these species but "*ex situ*" conservation should be also evaluated.

Poster Session P10

The importance of close cooperation of engineering, water legislation and nature conservation for the protection of endangered mussel species

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In Austria – as well as in most other European countries – freshwater mussels belonging to the Unionid family are amongst the most endangered aquatic species, some of them already being threatened with extinction. Certain species (like the freshwater pearl mussel *Margaritifera margaritifera*) are quite well-studied, as species conservation projects have been dealing with them for decades, whereas exceptionally little is known about others. The river mussel, *Unio crassus*, for example, was considered to be restricted to a single isolated population in Upper Austria. Survey data on its distribution are largely lacking, scientific studies are mostly limited to SACs (where subjects of protection have to be recorded).

Three of the most spectacular recent discoveries of formerly unknown Austrian freshwater mussel populations were not made in the course of scientific surveys with mussels as target species, but turned out as by-products of engineering projects or water-legislative issues. The channelized and heavily reinforced lower reach of the Leitenbach brook in Upper Austria was restored by constructing a new streambed, resembling the brook's former meandering course. Before the discharge was redirected into the new river bed, fish, crayfish and mussels had to be recovered from the old reach and transferred to an unimpaired section. In the course of this recovery, the largest ever documented Upper Austrian population of *Unio crassus* was recorded, comprising some 880 mussels – among them the youngest known Upper Austrian specimen. In the lower reach of the River Naarn 123 freshwater pearl mussels were found incidentally in the course of construction works for a flood protection dam – *M. margaritifera* had not been reported from that area until then. *M. margaritifera* was also discovered for the first time in a millrace that actually ought to have been filled up as its riparian rights had expired. Those three examples underline the immense importance of a preferably close cooperation of engineering, water legislation and nature conservation, as scientific research alone cannot grant an effective area-wide protection of endangered species.

Expression of HSP70 by *Utterbackia imbecillis* (Bivalvia: Unionidae) in Response to Copper

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The biology of the freshwater mussel *Utterbackia imbecillis* makes it an excellent biological indicator of the conditions of aquatic ecosystems. It has a broad distribution in the Eastern US in both lentic and lotic habitats, and is abundant. As with other freshwater bivalves, its sedentary habits and suspension feeding lifestyle make it a promising candidate as a sentinel species. This study examines the effects of acute copper stress on the cellular physiology of *U. imbecillis* by evaluating the transcript expression of the molecular chaperone, HSP70, in adductor muscle, mantle, and gill tissues using RT-PCR. The first mRNA sequences to be published for this species are reported and are highly similar to those published for other bivalves. Expression of the HSP70 gene in adductor muscle was significantly elevated after a 24-h exposure to 100 ppb Cu but returned to control levels after an additional 24 h in control conditions. There were tissue-specific differences in the effects of dosage on HSP70 expression, with adductor muscle and gill tissue having a significant increase in expression upon exposure to 25 and 100 ppb, respectively. At 200 ppb, transcript expression in all three tissues was highly variable and not significantly different from controls, which is suggestive that this concentration may have induced tissue damage. *Utterbackia imbecillis* clearly is sensitive to this heavy metal, as shown by the time- and dose-dependent changes in HSP70 gene expression we have described. Future efforts should explore responses to chronic exposure to copper, as well as developing a suite of biomarkers to complement the analysis of HSP70.

Poster Session P12

The biotic homogenisation of host communities as a threat to local affiliate species: a case study with *Anodonta anatina* (Unionidae)

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Unionid bivalves are increasingly being used as a model group for the research of host-affiliate relationships in freshwaters. In this study, we aimed to assess the ability of an affiliate (dependent) species to maintain its host specificity traits under the conditions of biotic homogenization of host communities. We used a European freshwater mussel *Anodonta anatina*, which is considered to be a wide host generalist of native fish species, and we compared the compatibility of its glochidia with native versus non-native fish species in two distinct European regions (Vltava River Basin - Czech Republic; Douro River Basin - Portugal). We then projected the obtained host-compatibility data into the recent progress of biotic homogenization of fish communities and estimated the loss of host resources. Our experiments showed a significant lower capacity of *A. anatina* glochidia to parasitize the non-native fish species compared to native fish species in both the central and peripheral parts of its distribution range. As a result, the increasing presence of non-native species within fish communities across Europe may significantly reduce the availability of the mussel's host resources. Biotic homogenization of host communities may thus lead to the over-proportional decrease of host availability even for host generalists, such as the freshwater mussel *A. anatina,* and may have broad consequences for their population dynamics. Further studies are needed to understand the effects of biotic homogenisation on the host resources of unionid bivalves and other affiliate species that were formerly considered to be safe from host limitation.

Poster Session P13

The relative importance of temperature and food to juvenile growth of *Margaritifera margaritifera* in its natural habitat

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The unfavourable conservation status of freshwater pearl mussel (*Margaritifera mararitifera*) elicits increasing efforts in research devoted to the description of its habitat demands. Yet, there remain many unresolved questions that limit conservation decision-making in this field. Particularly the lack of natural recruitment in *M. magraritifera* population, as a result of decreased juvenile survival, seems to be a critical but poorly understood process. In this study, we address the role of main environmental variables for juvenile growth of *M. margaritifera* in its natural conditions. We used in-situ caging methods (sheet cages) to expose juvenile mussels to their natural Central European habitats in sub-mountain conditions with varying temperature and food conditions. Totally, we used 63 in-situ caging systems (each with 10 individually kept juvenile mussels) distributed in three replicates at 21 sites of Blanice and Teplá Vltava River basins (Czech Republic) during the summer season 2011 (June – September). Preparatory culture of experimental juveniles that generated young mussel of ~ 1 mm size was used before testing. We applied a continual temperature monitoring (10 min interval) and three series of C:N ratios analyses of detritus at each site to describe the supposed main growth-related environmental variables. Recorded high survival rates of exposed juveniles (overall survival rate 82%) and significant correlation of recorded juvenile growth between replicated caging systems ($r=0.97$, $p<0.001$) corroborates the usability of this in-situ monitoring approach for assessing the growth conditions of juvenile *M. margaritifera*. The results of analysis of habitat variables suggest predominant role of temperature conditions to juveniles' growth in sub-mountain Central European area and further specify the patterns of growth. The observed effects of available food quality on the juveniles' performance are discussed. The results may help to clarify the role of environmental factors in explaining the lack of natural recruitment in *M. margaritifera*.

Poster Session P14

Influence of time of excystment on the breeding success of juvenile Freshwater Pearl Mussels (*Margaritifera margaritifera*)

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Rearing in captivity and successive release of the endangered Freshwater Pearl Mussel (*Margaritifera margaritifera* L.) is one possibility of increasing the likelihood of its survival in different rivers. Because of time consuming rearing methods, it is important to choose the strongest and healthiest mussels in order to have the highest possible number of fittest survivors and fast growing mussels in a shorter period of time. Another method used to rear a high number of mussels is the collection of "mussel seed" early in the year by artificially increasing the temperature in the tanks of a "juvenile mussel collection station" containing infected host fish to induce the excystment of juvenile mussels. Using this method, it is possible to have multiple excystment periods consecutively in one year and to increase the total number of mussels. However, there is no data available regarding the rearing success of juvenile mussels collected in a preterm excystment period.

In this study two excystment periods (one artificial in January and one natural in May) were observed and the growth and survival rate of juvenile mussels was compared in order to find out if artificial excystment periods may influence the breeding success of the mussels negatively. Furthermore the growth and survival rate of the mussels was observed in dependence on time of excystment during both excystment periods. An early excystment cycle (January) did not influence the growth or survival rate of the juvenile *Margaritifera margaritifera* and individuals collected during the middle of the excystment period were among the most suitable for captive breeding. Growth up to 1 mm or more in 110 days and a survival rate of 62- 98 % was observed. The survival rate of the mussels from the natural excystment cycle was lower than that of the early excystment cycle (7-38 %) presumably due to poorer water quality conditions in the river water; thus, an early excystment cycle can be an advantage if river water conditions become worse in spring and summer (e.g. high nitrite or ammonium concentrations, pesticides), as the juvenile mussels grow to become less sensitive before fertilisers or pesticides are used in the catchment area of the river.

Poster Session P15

Metabolism adjustment and resistance in the Asian clam *Corbicula fluminea* (Müller, 1774) to osmotic stress in the River Miño estuary

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The success of an invasive species in the colonization of new habitats depends strongly on the physiology of the species and in how it can adapt to the new environment. In this study we experimentally approached the metabolic resistance of the Asian clam (*Corbicula fluminea*) at the osmotic stress imposed by the changing salinity conditions existing in the River Miño estuary. It is known that different stressors like heavy metals or temperature, may influence the Asian clam metabolic activity provoking in the individual the valve closure movement, which is directly related with the reduction in oxygen consumption. The objective of this study is to determine how salinity influences the distribution of the Asian clam in the Miño estuary, identifying metabolic rate variation at different salinities to establish the species range of tolerance. Individuals of Asian clam were collected in Eiras, a locality on the right side of the Miño estuary, at nine kilometers distance to the mouth, and brought to the laboratory in containers with the help of air pumps. Individuals were selected on the basis on their uniform size (15 mm antero-posterior axis). The experiment comprised laboratory incubation under different salinity concentrations (5, 7, 15, 20 and 24 parts per million), with a control on distilled water. The incubated individuals showed a clear tendency to inactivity when salinity was higher than 20 ppm. Similarly, at those levels, they approached null oxygen consumption rate values. Our results indicate that when Asian clams where exposed to different salinities surpassing its optimal salinity range, clams changed their metabolism and passed to an anaerobic stage, dying when the exposure to high values of salinity was for a time higher than 19 days. These results confirm the mechanisms behind the adaptation to estuary changing conditions of the Asian clam, seeming to allow its establishment in changing salinity areas, prior to its colonization of the upper part of the estuary where the clam preferred freshwater conditions are.

Poster Session P16

CONBI: Biodiversity and Conservation of Bivalves – Ecogeographic, Genetic and Physiological information

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The Unionidae (Mollusca) is the largest of six freshwater mussel families being among the most endangered fauna in the world and globally in decline. Basic life history data, estimates of population size and structure, and assessments of population genetic structure are lacking or sparse worldwide, including Iberia.The project CONBI with a multidisciplinary team of experts was recently funded by FCT (Portuguese Science Ministry) and aims to fill the gap of knowledge on the status of the Unionidae family in the Iberia, in the wide context of biodiversity conservation. It is drawn in a new and complementary way: by considering the complex genetic interactions among different species from the same habitats, comparing their (genetic) relationships with the European populations, and also by describing (and including the obtained information in the overall analysis) their main biological features such as distribution, environmental requirements, population structure, reproductive season, larval stage and host fish. From a conservation and management perspective, the goals of this project can be used to the development of future conservation strategies by the identification of Evolutionary Significant Units (ESUs) and Management Units (MUs). Several outcomes are already achieved, e.g., the isolation and characterization of microsatellite loci for *Potomida littoralis* and *Unio delphinus* and the growth rates, reproductive cycles and host fishes of *Anodonta anatina*, *A. cygnea*, *Potomida littoralis* and *Unio delphinus*. Others are currently being developed e.g., microsatellite markers for *A. anatina* and the evaluation of genetic diversity of *P. littoralis* and *U. delphinus* in their whole distribution range.

Poster Session P17

Development of microsatellite markers and Multiplexed PCR for *Potomida littoralis*

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Potomida littoralis (Cuvier, 1798) is a widespread species in Western and Southwestern Palearctic, including northern Africa and the Middle East. Surprisingly, little is known about this species, including its conservation status, phylogenetic relationships and distribution of its genetic diversity. Here, we describe the isolation and characterization of the first microsatellite markers for *P. littoralis*. New polymorphic microsatellite loci were isolated using a 454 GS-FLX Titanium pyrosequencing of enriched DNA libraries carried out following manufacturer's protocols (Roche Diagnostics) and sequenced on a GsFLX-PTP. In order to improve genotyping throughput as well as cost-effectiveness, two multiplex-PCR reactions (ten markers each) were designed to amplify the new loci, procedure still uncommon for this number of markers (amplification of eight or more markers in one single PCR reaction). For the first choice of loci to take onto further testing, we chose two sets of 10 primers pairs each, taking into account several criteria such as: the size of the resulting amplicons (small and large loci to maximize their capillary separation), the different motif classes (we chose perfect di- tris- and tetranucleotides motifs with simple repeats only) and, evidently, the compatibility of the primers from the different loci for PCR multiplexing. After this trial, sixteen loci were selected (eight in each PCR) and allelic variation was tested on three populations (25 individuals each) from three major Iberian River basins: Douro, Tejo and Guadiana Rivers. Number of alleles ranged from 2 to 25 and the heterozygosity levels ranged from 0.546 to 0.581 for observed heterozygosity (H_o) and from 0.543 to 0.619 for expected heterozygosity (H_e). Overall, the new 16 microsatellite loci described here are well resolved and highly polymorphic (averaging 10 alleles per locus), confirming their utility for population genetic studies and consequently for effective conservation measures in *P. littoralis*.

Poster Session P18

Isolation and characterization of microsatellite loci for *Unio delphinus* and cross-species amplification in other *Unio* species

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The taxonomic status of *Unio delphinus* (Spengler, 1793), morphologically similar to *Unio pictorum* (Linnaeus, 1758) and often synonymized with it, was recently been re-evaluated based on morphological and molecular characters, and the validity of *U. delphinus* as a distinct species was confirmed. This species is confined to the Iberian and Moroccan Atlantic basins where it is often the most abundant species and this study reported for the first time its genetic diversity using highly polymorphic microsatellite loci. New polymorphic microsatellite loci were isolated using a 454 GS-FLX Titanium pyrosequencing of enriched DNA libraries carried out following manufacturer's protocols (Roche Diagnostics) and sequenced on a GsFLX-PTP. Of the reads obtained, we selected 1227 that contained a microsatellite inserts with perfect motifs and simple repeats only, from di- to tetranucleotide, suitable for primer design. The amplicon sizes vary from 90bp to 320bp. Of these, 46.0% are dinucleotides, 25.6% trinucleotides and 28.4% tetranucleotides. The most frequent dinucleotides motifs, with similar frequencies, are CA, GT, TG, AC and TC with 5-9 repeats in the most of times. Within trinucleotides the ACA motif is significantly more frequent followed by GTT, TTG and CAA motifs. In the tetranucleotides, GTAT motif clearly stands out but also frequent is the TGTA and ATGT motifs. The number of repeats varied from 5-20. In order to improve genotyping throughput as well as cost-effectiveness, we intent to design and optimize at least two multiplex-PCR reactions of ten markers each. However, before that, we started by conducting initial PCR reactions in simplex to validate selected loci and ascertain optimal annealing temperatures. Distinct DNA samples from three different populations (Douro basin, isolated Mira Lagoon and Guadiana River) were used in these amplifications for each locus alone. Additionally, cross-species amplifications are also being performed for each locus using individuals from *U. tumidiformis*, *U. pictorum*, *U. tumidus*, *U. mancus*, *U. ravoisieri*, *U. gibbus* and *U. crassus*.

Poster Session P19

Impact of *in vitro* and *in vivo* exposure to cytostatics, 5-FU, etoposide and cisplatin on haemocytes of freshwater mussels *Unio pictorum* and *Unio tumidus* using alkaline comet assay

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Impact of acute exposure to cytostatics, most frequently used in cancer therapy, was studied on haemocytes of freshwater mussels *Unio pictorum* and *Unio tumidus*. Prior to exposure, mussels were held on acclimation in controlled laboratory conditions. Exposure was performed *in vivo* (for 72h in aquarium) and *in vitro* conditions (haemocytes were exposed to test compounds in microtubes for 10' and 30'). Groups of 5 mussels were exposed to base analog 5-FU (4, 40 and 100 µM), topoisomerase inhibitor etoposide (4, 40 and 100 µM) and alkylating-like drug cisplatin (0.29, 2.90 and 7.25 µM). For positive control treatment with $CdCl_2$ was used (4, 40 and 100 µM), while as negative control mussels were held in control aquarium with clean water. Images of 250 nuclei per each concentration of test substance were analyzed with a fluorescence microscope and scored using analysis software (Comet Assay IV Image analysis system, PI, UK). Statistically significant increase of DNA damage ($p<0.05$) was recorded for all *in vivo* performed experiments. However, in experiments performed *in vitro* only $CdCl_2$ induced genotoxicity. Lack of genotoxic effects of tested cytostatics can be attributed to mechanism of action which implies replication process.

Poster Session P20

Resilience of adaptive responses in freshwater bivalves (Unionidae) from different populations

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Previous studies have described either pollution-induced activation or repression of biological responses to adverse effects in animals inhabiting polluted sites and representing different phyla. Unfortunately, at present very few studies have investigated the performance of biological responses with regard to the long-term subjecting of a population to adverse effects. The key goal of present study was to study the effect of previous history of population on the adaptive ability of bivalve mollusks, well known accumulator of toxic metals, in the exposure to metals.

Freshwater male bivalve mollusks (Unionidae) from agricultural polluted (A) and forestry (F) sites were subjected to 14 days of exposure to copper (Cu^{2+}, 10 $\mu g \cdot L^{-1}$), zinc (Zn^{2+}, 150 $\mu g \cdot L^{-1}$) or cadmium (Cd^{2+}, 15 $\mu g \cdot L^{-1}$). The toxic effect on the mussels at site A was confirmed by higher levels of Cu, Zn and Cd and metallothionein (MT) concentration in the specimens. Signs of cytotoxicity, oxidative stress response, elevated apoptotic activity and vitellogenin-like proteins (Vtg-LP) concentration and low ethoxyresorufin-*O*-deethylase (EROD) activity were also seen in this group.

Despite some common effects of exposures (genotoxicity, elevation of apoptotic activity and/or Vtg-LP level), general responses assessed by Centroid Grouping Analysis, were strongly dependent on the origin of mussels. Exposed mussels from site F were able to elevate MT and accumulate metals in their tissues. Conversely, in the mussels inhabiting polluted site A, exposures provoked the avoidance of metal accumulation, elevation of protein oxidation and EROD levels and reduction of lysosomal membrane stability, demonstrating that they had exceeded the point past which they were able to mount adaptive responses.

Poster Session P21

Comparison of advanced culture methods for grow-out of freshwater mussels (BIVALVIA: UNIONIDAE) in a controlled environment

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Propagation and grow-out of a sufficient number of juveniles for release to natal rivers has become a primary strategy to recover and restore populations of endangered mussel species. This strategy has been limited by the difficulty in rearing large numbers of juveniles under controlled conditions. In this study, a range of cost-effective methods, including a closed-system mesocosm with continuous feeding technology and an open water recirculating system with pond water usage, were developed and tested. Young juveniles of two endangered species (*Epioblasma brevidens* and *E. capsaeformis*) and three common species (*Villosa iris*, *V. vanuxemensis* and *Medionidus conradicus*) were propagated and reared in three different culture systems, and juveniles were successfully reared to large sizes for release. However, survival and growth rates of juvenile mussels in early life stages varied among culture systems, and was associated with different environmental factors. The survival and growth rates of cohorts were monitored in a time series to provide progressive changes in cohort parameters. Demographic models of individual growth and cohort survival were used to compare the indices of population growth of these multiple species reared within the three culture systems. Results showed that the growth and survival rates of young mussels varied among culture systems, with the greatest growth rate in open-water recirculating systems with pond water, and greatest survival rate in the closed mesocosm with continuous algae supply. The demographic indices of mortality and growth of juvenile mussels revealed a species-preference structure in selection of the most suitable culture system.

Poster Session P22

Biogeochemical diagnostics and estimation of ecological condition of freshwater pearl mussels (MARGARITIFERIDAE)

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The conservation of rare and endangered species of freshwater pearl mussels is demanding effective assessment of their ecological conditions. High concentrations of heavy metals are accumulated in mollusk tissues during their vital functions, and these contaminants may have toxic and cumulative effects. Ecological conditions of bivalves, as well as other groups of benthic invertebrates, could be estimated by heavy metal bioaccumulation indicators in tissues taking into account the different appearances of pathologies. Ecological conditions of *Margaritifera* (*Dahurinaia*) *transbaicalica* populations from the refuge lake Arey and the Ingoda River (the Amur River basin, Transbaikalye, Russia) were estimated with the help of biogeochemical diagnostics of heavy metal accumulation in several organs (mantle, gills, liver, foot, adductors). Concentrations of Fe, Mn, Zn, Sr, Cr, Cu, Ni, Pb, Mo, Cd, Co in the mollusk tissues were determined by mass-spectrometry with inductively coupled plasma (ISP MS) and in the water by method of atomic absorptive spectrometry (IIS). The integral accumulation of investigated heavy metals in tissues reaches 18.6–23.2 g/kg (dry weight) but content of the same elements in water was 0.08–0.12 mg/l. Average bioaccumulation indicator of heavy metals for *M.* (*D.*) *transbaicalica* population from the Arey Lake was up to 0.252, and no pathology was detected on mussels. Heavy metals bioaccumulation indicator of pearl mussels from the Ingoda River varied from 0.291 to 0.528. The highest value was detected in a polluted area. The deformity and increased corrosion of shells, necrosis of tissues of gills, liver and mantle were noticed for mollusks with the highest bioaccumulation indicator. Gills and liver are the most sensible to toxic pollution of habitat. Ecological condition of *M.* (*D.*) *transbaicalica* population from the Arey Lake was estimated as safe, while from the polluted Ingoda River as poor. This work is financially supported by the RFBR Grant No 12-04-00594-a.

Poster Session P23

Monitoring of DNA damage in haemocytes of freshwater mussel *Sinanodonta woodiana* sampled from the Velika Morava River in Serbia with the comet assay

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This study was undertaken to investigate genotoxic response of the freshwater mussel *Sinanodonta woodiana* to environmental pollution at two sites in the Velika Morava River. The alkaline comet assay was used and the olive tail moment (OTM) was chosen as a measure of DNA damage. The assay was performed on the haemolymph directly upon sampling, from May 2010 to February 2011. In order to assess the base line DNA damage the mussels sampled in August were subjected to acclimation for 30 days in a controlled laboratory environment. During acclimation, a gradual decrease in the OTM was observed ($p = 0.027701$) reaching a maximum after 10 days ($p < 0.001$). The seasonal differences in response to environmental stress were recorded in mussels collected from both sites. The level of DNA damage was significantly higher in summer in comparison with the rest of the year. The values of OTM significantly correlated with the concentration of zinc ($r = 0.6248$), temperature ($r = 0.7006$) and dissolved oxygen ($r = 0.7738$). The effect of temperature on zinc- and cadmium-induced genotoxicity was confirmed *in vitro*.

Poster Session P24

Recovery of the freshwater pearl mussel *Margaritifera margaritifera* population in an acidified Norwegian river

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The freshwater pearl mussel *Margaritifera margaritifera* is threatened throughout its range, and is the subject of recovery programmes in many countries. The main causes of its decline are anthropogenic influences on aquatic systems. During its life cycle the freshwater pearl mussel is dependent on the presence of salmonids as hosts for its larvae. Freshwater acidification has eliminated or reduced populations of Atlantic salmon *Salmo salar* in many rivers in Norway, among them the river Ogna in the south-western part of the country. Periodical fish mortality was observed in this river, and the freshwater pearl mussel population fell to a low level in the 1980s. A liming project was initiated in 1991. The effects of liming on the freshwater pearl mussel were assessed every third year from 1999 to 2011. Prior to liming (1980 – 1987) the mean annual pH was 5.2 – 5.8. Liming produced a gradual increase in the mean annual pH level to 6.6 in the late 1990s, while the density of Atlantic salmon fry increased from <20 to 60 - 90 individuals per 100 m². Recruitment to the freshwater pearl mussel population was completely absent for many years, resulting in a predominance of older individuals (length 110 – 135 mm) in the 1980s. However, mature specimens have been found, and their glochidia survive, attaching themselves to the gills of the Atlantic salmon host fish. Finds of a few young mussels in 1999 (4% of the total number of mussels found) indicated that recruitment was recovering from 1991. In 2002, the proportion of visible young mussels increased to 36%, dominated by mussels of the year classes 1991 – 1998. In 2005 and 2008 about two thirds of the mussels were found to be younger than 15 and 18 years respectively. The range of the freshwater pearl mussel has expanded from 4.0 to 5.5 km of the river, and in 2011, young mussels were found at eleven of twelve study sites. Liming has been an important measure in the River Ogna in the 1990s. There have been positive trends in water chemistry indicators, stocks of fish, and freshwater pearl mussels in the first years of liming. The survey indicated that mussel populations have the potential for recovery when the conditions improve. However, the river is still sensitive to acid water and continues to be dependent on a steady supply of lime. Lack of mussels younger than 10 years, and decreasing levels of calcium indicates a change to suboptimal conditions again in the 2000s.

Poster Session P25

Freshwater pearl mussel *Margaritifera margaritifera*: Host specificity and genetic variation in Norway

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The critically endangered freshwater pearl mussel *Margaritifera margaritifera* requires Atlantic salmon *Salmo salar* or brown trout *Salmo trutta* as a host to complete their life cycle in Europe. In Norway, a large number of populations have been characterized as almost exclusively hosting either Atlantic salmon or brown trout, even when both hosts are present. In rivers where salmon were introduced by stocking of juveniles above the naturally anadromous reach, no glochidia were found on the Atlantic salmon, although they were found on the local brown trout. Furthermore, there are examples within the same river, where there are distinct populations affiliated with either Atlantic salmon or brown trout, but not both, although both species are available. In such rivers, the trout affiliated mussels release and attach their brooded glochidia earlier than the salmon affiliated mussels. These observations raise a number of questions, for example: Are there two functionally different types of fresh water pearl mussel? To test the hypothesis that genetic variation within and between populations of freshwater pearl mussel is explained, not only by geography, but also by host affiliation we used eight microsatellite markers to estimate genetic variation within and between 25 sampling localities of freshwater pearl mussel, distributed in four geographical regions in Norway, each represented by *a priori* classified trout- and salmon-mussel localities. Within populations, the brown trout hosting mussel populations had significantly lower allelic richness and expected heterozygosity than the Atlantic salmon hosting mussel populations. The genetic differentiation between brown trout hosting mussel populations was very large (F_{ST} = 0.382), and significantly larger than between Atlantic salmon hosting mussel populations (F_{ST} = 0.039). The overall genetic variation was explained to a larger extent by host affiliation (F_{CT} = 0.10) than by geographical location (F_{CT} = 0.0084). Collectively these results suggest that there are strong reproductive isolations between freshwater pearl mussel populations, and in particular between those hosting brown trout. More importantly, our results indicate that brown trout and Atlantic salmon affiliated mussel populations have different genetic characteristics and might represent distinct evolutionary lineages. This is important to consider with regard to restoration and management plans for this species.

Poster Session P26

Captive rearing of the freshwater pearl mussel *Margaritifera margaritifera* in the UK

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The freshwater pearl mussel *Margaritifera margaritifera* is critically endangered (IUCN 2011) and in decline throughout the whole of its range. The Freshwater Pearl Mussel Ark Project was set up by the Freshwater Biological Association (FBA), Natural England and the Environment Agency in 2007 to rear juvenile mussels for reintroduction into their native catchments.

This project has had success in encysting host fish species with glochidia, collecting metamorphosed juveniles upon excystment and rearing juveniles to over four years old (Lavictoire and Sweeting 2012). Collection of viable juvenile mussels has been achieved for all nine populations currently part of the captive rearing programme. We have observed differences in host fish preference and therefore glochidial loading in different pearl mussel populations. We have also carried out a successful encystment trial on a lesser-known host, Arctic charr (*Salvelinus alpinus*), where viable juveniles were collected. This outlines our incomplete knowledge of the interactions between glochidia of *M. margaritifera* and potential host fish species and provides a case for further research to be carried out. We have had limited success in rearing juvenile mussels post-excystment. Mortality rates are high and little is known about appropriate husbandry for juvenile mussels. Small numbers of juveniles have been reared to four years old. Mortality rates decrease with age but monitoring of very young (0-2 years) juveniles remains difficult due to their small size. Research to identify the factors limiting juvenile survival is being conducted at the FBA in an attempt to increase juvenile survival and increase the efficiency of the captive rearing programme.

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Poster Session P27

Portuguese Naiads Life History Traits: Reproductive Cycle and Host Fish Determination

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Freshwater mussels or naiads (Bivalvia, Unionoida) are among the most critically threatened faunistic groups worldwide. This decline is mainly provoked by habitat loss and fragmentation, habitat degradation, introduction of invasive species, among other biotic and abiotic alterations. Additionally, conservation efforts have been hampered by a lack of life-history information for most species, particularly for traits such as age at maturity, growth rate, longevity, and fecundity. These bivalves have a complex reproductive behavior where their larvae (glochidia) parasitize and depend on specific fish species as hosts for metamorphosis and upstream dispersion. In the present study we describe the reproductive cycle and successfully determined the host fish species for *Anodonta anatina, Anodonta cygnea*, *Potomida litorallis* and *Unio delphinus* from the north of Portugal. Histological techniques were used for the reproductive cycle. To study the hosts, glochidia were extracted from each species and exposed to distinct fish species that co-occur in the same basin. The fish species that successfully transformed glochidia in juveniles were then considered valid hosts. Interestingly, with the exception of *A. cygnea*, almost all effective hosts were native fish species.

Poster Session P28

The thick-shelled river mussel (*Unio crassus* Philipsson, 1788) in Sweden: Distribution, ecology, status, threats and conservation

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The thick-shelled river mussel, *Unio crassus*, is the rarest of the *Unio*-species in Sweden. The species has disappeared from many of its former sites. The reproductive success in the remaining populations is poor. **Distribution -** *Unio crassus* has a pronounced south-eastern distribution, reaching from the province of Skåne in the south to the province of Uppland and the southern part of the province of Dalarna in the north. The Swedish populations all belong to the nominotypical subspecies *U. crassus crassus*, which inhabit the northern area of the latest glaciation in Europe. **Ecology -** *U. crassus* occurs in rivers and streams. Hostfish mapping using barcoding on glochidia found on several fish species in one stream habitat has shown that common bleak, *Alburnus alburnus*, roach, *Rutilus rutilus* and burbot, *Lota lota*, was infected, with the highest glochidial load on *A. alburnus*, but the abortion grade was not tested. Mainly in the province of Skåne, minnow, *Phoxinus phoxinus*, is most common in habitats with *U. crassus*, while bullhead, *Cottus gobio*, is common in *U. crassus* habitats to the north of its distribution range. **Status -** About 70 records are known from the period after 1950. The total number of localities is approximately 110. **Threats -** Eutrophication, dredging, as well as cutting of trees and bushes on the banks exhibit severe threats against the species. Habitat fragmentation of the water courses through blocking and wrongly applied regulation of the water flow have definitely had negative consequences for *U. crassus.* **Conservation -** The species has been classified as endangered (EN) in the latest version of the national Swedish red-list and is also a protected species by law. It is listed in the Annex II of the Habitat and Species Directive of EU (Natura 2000). A national conservation plan has recently been worked out. Monitoring, including studies of population size, age structure and reproductive success, is in progress for some of the populations. A LIFE-project for restoration of several *U. crassus* stream habitats has started in 2012.

Poster Session P29

The unionoid freshwater mussels of Sweden, status and distribution

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Sweden harbours seven native species of large freshwater mussels belonging to the Unionoida order. Three of them are red-listed both nationally and internationally and a fourth species is on the national red-list. Since the 1920th two non-native, alien, species have appeared. In the early 1990s, work began to map and conduct environmental monitoring of mussels in Sweden. A new standard protocol for monitoring of all native species of large freshwater mussels in Sweden is today in practice.

Margaritifera margaritifera (Linnaeus). Freshwater pearl mussel. The species has a rather wide distribution in Sweden, from Skåne in the south to Lapland in the north, but many of the populations are small with insufficient recruitment and the current trend is of degenerating status. In the national red-list *M. margaritifera* is placed in the category EN (endangered). Today 551 Swedish watercourses host freshwater pearl mussels but only half of them have viable populations.

Unio pictorum (Linnaeus). Painter´s mussel. The species is rather rare and exhibits a mainly eastern – south-eastern distribution in Sweden. The occurrences are restricted to a few water systems. The species has been placed in category NT (near threatened) in the national red-list.

Unio tumidus Philipsson. Swollen river mussel. The species is the commonest of the three *Unio* species occurring in Sweden. It can be found in both lakes and water courses. The distribution is predominantly eastern – south-eastern, but more and more localities have been detected also in western Sweden.

Unio crassus Philipsson. Thick-shelled river mussel. This, the rarest of the Swedish *Unio* species, has been placed in category EN (endangered) in the national red-list. It has a pronounced eastern-south-eastern distribution, with large distribution gaps, between the river systems in which it occurs. The intense and aimed monitoring for this species in many south and east Swedish provinces has resulted in the detection of several new localities.

Anodonta anatina (Linnaeus). Duck mussel. This species is the most common and wide-spread of the Swedish large freshwater mussels, occurring in all kinds of waters, from the province of Skåne in the south to northernmost Lapland in the north.

Anodonta cygnea (Linnaeus). Swan mussel. The distribution and habitat selection of this, larger close relative of *A. anatina*, is far more restricted than that of its sister species. Like in *U. tumidus* (cf. above) the species is commoner in the southern and eastern parts of Sweden, compared to the western. The northern limit of *A. cygnea* approximately follows the *limes norrlandicus*-zone in middle Sweden.

Pseudanodonta complanata (Rossmässler). Depressed river mussel. The geographical distribution of the species resembles that of *U. tumidus* (cf. above), but *P. complanata* is considerably rarer and the occurrences are in most districts very sparse. The species has been placed in category NT (near threatened) in the national red-list. There are large distribution gaps, especially in western Sweden. The sparse and specimen poor populations make the species especially vulnerable.

Sinanodonta woodiana (Lea). Chinese pond mussel. *S. woodiana* is a forcefully invasive species, and it constitutes a clear threat to the native fauna of large freshwater mussels. Different species of carp fishes (Cyprinidae) function as hosts. The first Swedish record was made in a stream below the outlet from a carp breeding in the province of Skåne 2005. A second record was made in western Sweden (S of Göteborg) in a garden pond with goldfish 2007.

Dreissena polymorpha (Pallas). Zebramussel. In Sweden *D. polymorpha* was first found in Lake Mälaren in 1925. Unlike the case in other parts of Europe, no explosive or rapid spread of the species has taken place. Really abundant occurrences have mainly been found in the eastern parts of Lake Mälaren and some watercourses connected with this part of the lake. In 1968 *D. polymorpha* also was found in Lake Hjälmaren. Since then several records have been made there and in the river Eskilstunaån, which is connecting the lakes Mälaren and Hjälmaren.

Brooding strategies of *Mytilopsis* from the Amazon River (Dreissenidae)

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Inside pallial chamber of 50 adult samples of *Mytilopsis lopesi* Alvarenga & Ricci (1989), from middle and lower Tocantins river, Amazon Basin, embryos in different developmental stages were found. Morphology of 161 brooding samples was observed under optic microscope and SEM. The software AxioVision-Zeiss was used in order to measure larval and young shells: length (from 90µm to 987µm), high (from 78µm to 1030µm), length of umbo near the limit of prodissoconch I (from 82µm to 140µm) and the distance between umbo and anterior extremity (= shoulder, from 60µm to 324µm). Morphometrical relations between variables were verified through simple linear regression. The relation between length and shoulder revealed that brooding samples grows isometrically until 400µm (r^2= 0,95). After that the pattern changes to an irregular growing without relation between variables (r^2= 0,11), denoting a major development of posterior region in relation to anterior, adopting the mytiloid form. The relation between length and high was isometric, before (r^2=0,98) and after (r^2=0,93) 400 µm, with a strong degree of association between those variables. Morphology revealed that *M. lopesi* is euviviparous presenting long termed brood care of embryos from larval stage until juvenile (shell length ± 987µm). Larvae and juveniles are carried outside branchiae but inside pallial chamber attached to the parent's mantle forming a structure like a button. The small brood size (just to 65 individuals) and the presence of juveniles in advanced stage similar to adults, suggest: that *M. lopesi* do not present planktonic larval stage but brood care just to a mytiloid juvenile as a protection against water drifting; releasing is sequentially; and that the growing of clusters on the environment is very slow, not offering macrofouling risk like *Dreissena polymorpha* and *Limnoperna fortunei* or the estuarine *Mytilopsis leucophaeta,* recently detected for the first time in South America at the mangroves of Recife, Northeast Brazil. The aim of this study is to distinguish the native species and larvae from the invasive as a support to the management and the conservation of native bivalves (ELETROBRAS-FURNAS).

Poster Session P31

Molecular adaptations of indigenous and non-indigenous bivalve species to cyanotoxins: the role of glutathione S-transferases

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Freshwater bivalves such as invasive and indigenous species are characterized by having high filtration rates and for occasional accumulation of cyanobacteria and their toxins. Physiological adaptations to cyanotoxins enable bivalves to resist to cyanobacterial blooms but this ability differs among species. The most common cyanotoxins in freshwater ecosystems are the hepatotoxic microcystins (MCs). Tolerance to MCs is not yet studied in bivalves and it might be related with a higher efficiency of the glutathione-S-transferase system (GSTs). This comprises a group of detoxification enzymes that catalyze the nucleophilic addition of glutathione to a wide variety of endogenous and xenobiotic compounds.

The aim of this study is to characterize and compare cytosolic GST activity and kinetics in Corbiculids and Unionids in order to obtain a better understanding of the role of GSTs in the physiological response of indigenous and non-indigenous bivalves to MCs exposure. GSTs were purified from the two bivalves species (whole body) by glutathione–agarose affinity chromatography and substrate specificity determined photometrically for 1-chloro-2,4-dinitrobenzene (CDNB), 1, 2- dichloro-4-nitrobenzene (DCNB), 4-nitrobenzyl chloride (pNBC) and ethacrynic acid (ETHA). Additionally, differences in GST characteristics among the two species were studied using purified enzyme samples through comparative kinetic and inhibition experiments with MC-LR variant.

Results support the important role of GST enzymes in detoxification of MCs in both mollusks and it is plausible that bivalves GST catalytic activities are reflective of their evolutionary adaptations to diverse ecological strategies (indigenous and non-indigenous).

Poster Session P32

Practical implementation of freshwater pearl mussel measures in the Republic of Ireland and Northern Ireland

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The island of Ireland supports a large proportion of the Freshwater Pearl Mussel (FPM) populations remaining in Europe. Virtually all of these populations are at unfavourable conservation status and evidence suggests that recruitment of juvenile mussels to the adult population has substantially failed in recent decades. This project, which runs from 2011 to 2014, is funded by the European Union's INTERREG IVA programme, as part of the environment strand, under Priority 2.2 and is being undertaken in Northern Ireland and the border region of Ireland. The project has three main tasks: 1) the preparation of management plans for the 3 Northern Ireland Natura 2000 catchments. 2) Testing of practical measures designed to protect mussel populations. This will establish what actions are likely to be effective and cost efficient and will include agriculture, forestry and septic tank systems. 3) Drafting codes of practice for various sectors to ensure they are sustainable in pearl mussel catchments. Such detailed technical guidelines are required to assist agencies, local authorities, public authorities and key stakeholders in relation to proposed developments, and will include road, water and sewerage infrastructure, housing and industrial development, wind farming, water abstractions and river modifications, agricultural practices, peat extraction, quarrying and mining.

Poster Session P33

Assessing the morphological variability of *Unio delphinus* Spengler in the Guadiana basin (SW-Iberian Peninsula, Europe) through geometric morphometric analyses

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The morphological variability of freshwater bivalve species, observed between and within river basins, may hamper its correct identification even by experienced researchers. Classic morphometric measurements, i.e. shell height, width and thickness or its relationships, might be insufficient to distinguish populations and/or species. These issues may be overcome using geometric morphometric methods, which permit to analyse the complete shape of the individual independently of size. Thus, we aimed to test the usefulness of two geometric morphometric tools, landmarks and sliding semi-landmarks analyses, to evaluate de morphological variability of *Unio delphinus* Spengler in different habitats of the Guadiana basin- river, stream and estuary. We used 13 landmarks for the shell interior (teeth, muscle scars, pallial line) and 30 sliding semi-landmarks for the shell contour. Estuarine specimens were more similar to animals collected in the streams, which were clearly differentiated from the river specimens. Morphometric differences were not related with the size of the analysed specimens. Two factors might contribute to the morphological variability of freshwater bivalves- the environmental setup to which bivalves are exposed, and the genetic differentiation between populations. These factors should be explored simultaneously in future investigations, to untangle their combined effect on influencing the morphology of bivalve shells.

Poster Session P34

Captive breeding of the endangered pearl mussel *Margaritifera auricularia* (Spengler, 1793). Large scale laboratory production of juveniles

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Margaritifera auricularia is currently one of the most threaten aquatic invertebrates worldwide. It is considered in danger of extinction and its reproduction is very limited in the natural habitat. Therefore, its captive breeding is an essential tool for its recovery. The Recovery Plan for this species in Aragon was approved in 2005. Since then, captive actions have been intensified.

February 2010, 66 adult reproductive mussels were extracted from the adjacent channels to Ebro river and were taken to the laboratory, where they were kept under an Automatic Collection System (ACS), which had been especially designed with the aim to collect glochidia. 132 fish were used for the juvenile's production. 122 out of 132, were Siberian sturgeons (*Acipenser baeri*), being 14 of them over one meter large. Ten out of 132 fish, were Czech sturgeons (*A. ruthenus)*, smaller in size but as useful as the Siberian sturgeons in terms of infestation and metamorphosis of *M. auricularia* juveniles. Contact between glochidia and fish gills was made by the direct injection of a concentrated glochidium solution in fish gills. Infested fish were kept under an approximately temperature of 15ºC during 20-21 days. After, they were isolated in conic tanks where they stopped being fed. Temperature increased up to 20ºC during the following 10 days, moment in which the first juveniles started to detach. For the first time, a large scale production of juveniles was obtained. Production was estimated in 250.000 living juveniles, which were used in different experiments.

Progress made in juvenile's laboratory breeding is limited to almost five months survival and a maximum shell length of 1 mm. At present, works to design a proper diet for captive breeding are under development. The aim is to achieve bigger size juveniles that may be eventually introduced in their natural habitat.

Poster Session P35

Size-specific growth pattern of fresh water mussel *Margaritifera auricularia* (Spengler, 1793) in the Ebro river channels (Spain)

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Growth rate of freshwater pearl mussel *Margaritifera auricularia* was analysed in an irrigation channel close to Ebro river. Analyses were carried out by measuring the maximum length of shells collected during the months of 2010, 2011 and 2012 years. Currently the species' smallest size living specimens have been found in this channel. The smallest individual was 51,4 mm length when found the first time. Measurements were taken to 54 individuals, of which 15 were smaller than 100 mm. The relationship between the initial shells size and annual growth rate were fitted with best fit negative power curve such as $y=a*x^{-b}$ (R^2=0,6759; p<0,001). Excluding bigger individuals than 120 mm. the relationship has a much better fit (R^2=0,7891; p<0,001). The latter, offers better results to relate length and age of individuals. Growth rate and size values are inversely proportional. Growth rate of 50 mm young specimens increases almost 20% of their initial length. As they grow, the rate slows down and when reaching about 110 mm growth, percentage does not exceed 1,5% of their initial length. Adult specimens present small growth to the point that an important amount of individuals suffer a decrease in their maximum length. This is probably due to shell erosion. Among the bigger individuals (150-160 mm) selected for the study (n=208), –which were measured in different moments within over a one year interval-, 50% showed slight decrease values (percentage growth= 2.18, percentage decrease= -2,21). Therefore, these individuals present a negative net growth.

Actions in Aragon region in relation to this species started back in 1996. Since then, doubts have arisen about the existence of breeding of *Margaritifera auricularia* population in Ebro river basin. During the last three years, 27 specimens under 100 mm (from 51 mm to 100 mm) have been registered and their age varies between 7 and 17 years, which shows that the complete reproductive cycle is still occurring within the natural habitat.

Poster Session P36

Life Margal Ulla, recovery of *Margaritifera margaritifera* (L.) in the Ulla basin (Galicia, NW of Iberian Peninsula)

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The Ulla River is the second largest river system in Galicia (NW Iberian Peninsula) with a basin area of 2.803 km^2 flowing into the Atlantic Ocean. This basin presents populations of freshwater pearl mussel, *Margaritifera margaritifera* (Linnaeus, 1758), and pyrenean desman, *Galemys pyrenaicus* (E. Geoffroy St. Hilaire, 1811), which are considered biological indicators and umbrella species for the freshwater ecosystems of Galicia. Unfortunately, anthropogenic pressures in this basin are affecting the health and biotic integrity of this aquatic ecosystem and, consequently, the populations of these species are of conservation concern.

The Margal Ulla Life project (2010-2015) was designed to achieve the recovery of both species in the Ulla Basin and, as a result, it will identify ways to improve the health of this river system.

The main actions to improve FPM populations are:

- Improve the knowledge about the distribution and status of the populations in the basin.
- Implement management measures to recover the habitat.
- Identify management units using ecological and genetic information.
- Develop captive rearing activities.
- Supportive breeding programs that attempt to augment natural populations that are threatened with extinction.
- Monitor reintroduction and habitat recovery.

Poster Session P37

The impact of land use on *Margaritifera margaritifera* and its host fish *Salmo trutta*

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The freshwater pearl mussel (*Margaritifera margaritifera*) has declined dramatically throughout its range and is faced with recruitment problems in most of the streams where populations still persist. In this study, spatial information on landscape features along 38 Swedish streams with known recruitment status were analyzed in an effort to determine if landscape usage could be used to discriminate between streams with and without recent recruitment of the mussel. Nine different landscape features, measured in stream corridors of 50 and 150 m, were analyzed in relation to mussel recruitment and host fish (*Salmo trutta*) density. Additionally, 9 different water chemical factors were related to mussel and host fish status. Both mussel recruitment and trout density were found to be negatively related to clear-cuts, and mussel recruitment was also negatively related to high water color, which has been shown to be correlated with high nutrient content, one of several adverse effects of clear-cutting. In addition, high proportions of lakes and ponds were found to be positive for recruitment and for trout. The results indicate that forestry activities may negatively affect recruitment of freshwater pearl mussels and its host fish. Reductions of forestry activities and the retaining of intact riparian zones next to streams may be important conservation measures for the freshwater pearl mussel.

Poster Session P38

Restoration of freshwater pearl mussel populations with new methods– an EU Interreg project in the northern Fennoscandia

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The main goal of this Finnish-Norwegian-Swedish project is to develop the co-operation between Nordic authorities and research institutes for the conservation of freshwater pearl mussel (*Margaritifera margaritifera*). Moreover, we aim to develop new methods for restoration of the declined and non-recruiting mussel populations. The project started in June 2011 and ends in May 2014. An important part of the project is to provide updated information on the conservation and management of freshwater pearl mussel populations for those target groups who are involved with the management of river environment or whose decisions or activities may influence on the state of the rivers. In addition, the project includes (1) analyses of the state of the freshwater pearl mussel populations and their habitats, (2) analyses of toxicological substances in the mussel beds and from the mussels themselves, (3) genetic analyses of the populations, (4) experiments with host fish and juvenile mussel cultivation and (5) searching for new populations as well as development of new searching methods. The project area covers the whole northern Fennoscandia. The project is funded by the European Union Interreg IV A program and by the nine participating project partners.

Poster Session P39

Action plan for *Margaritifera margaritifera* in the Czech Republic (Central Europe) – concepts, targets and realization

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The present occurrence of *Margaritifera margaritifera* in the Czech Republic (CZ) is divided to 3 conservation units (CU) in 2 areas (S and W Bohemia) with irregular population distribution on 5 main localities. The protection of particular sites is guaranteed by the system of special areas of conservation according to the national and European legislation including one site situated in Šumava National Park (UNESCO Biosphere Reserve, IUCN Red List Ecosystem). Action Plan for *M. margaritifera* in CZ has been organized by Nature Conservation Agency of the Czech Republic (NCA CR), a governmental body for nature protections and conservation, since 1982. Thirty years of cooperation between scientific research and nature protection resulted in development of unique "Czech method" of semi-natural rearing (Hruška 1992, 1999), which helps to enhance the food (organogenic detritus) supply flow and rejuvenate overaged population. Biotope quality and population structure of *M. margaritifera* (including the largest colony in the Central Europe at Blanice River) has been improved with application of this method (see details in Simon, Douda et al., this conference). The present protection activities are aimed at 2 main goals: (1) to improve the habitat quality (to restrict water pollution including prevention of emergency conditions, prevent the negative effects of land-use changes that alter the temperature regime of streams and support natural way of nutrient flow), (2) to restore natural reproduction and stabilize age structure with at least 20% of juveniles in each population. For more information or cooperation, please visit our website (www.zachranneprogramy.cz) or contact the authors via e-mail.

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Poster Session P40

Toxicity of *Bacillus thuringiensis* sv. *israelensis* on golden mussel, *Limnoperna fortunei* and on ecotoxicological indicators, *Pimephales pomelas* (Pisces), *Ceriodaphnia dubia* (Crustacea), and *Pseudokirchneriella subcaptata* (Algae)

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The Asian golden mussel invaded South America via ballast water in the 1990s. This invasion caused irreparable environmental damage like the declining population of native mussels (mainly Hyriidae and Mycetopodidae) and marginal emergent vegetation on lakes and rivers. The biofouling formed on equipment for water treatment systems and hydroelectric plants caused economic damage never before recorded in continental waters. Chemical and physical methods are commonly used to control the golden mussel. However, the use of pathogens to control this species has not been reported so far. The *B. thuringiensis* sv. *israelensis* (Bti) is widely used in Brazil to control the dengue vector, *Aedes aegypti*. Use of this microbial agent to control insects is recommended by the Ministry of Health of Brazil. In order to control the golden mussel, this study aimed to evaluate the effectiveness of two Bti commercial products, one product with aqueous formulation (AS) and other with dispersible granules (WG). Bioassays were conducted in beakers containing 250 mL water reconstituted and ten adult's individuals of *L. fortunei.* Three concentrations of the product (0% as control, 0.2%, 0.4%, and 0.8%) were tested, each concentration quintuplicate. The higher mortality (100%) was obtained with the high product concentration of AS, when used 2 mL of the product, followed by 55% with 1 mL and 20% with 0.5 mL, differing significantly of the control. The WG was not effective in controlling the pest. The toxicity test of the AS formulation was done with fish *Pimephales pomelas*, microcrustacean *Ceriodaphnia dubia*, and algae *Pseudokirchneriella subcaptata*. The concentrations 0.5, 1 and 2 mL showed acute toxicity to all organisms evaluated. The high toxicity may affect the benthic community, including native bivalves subject to the impact of invasive species, pollution and dam construction. The use of Bti to control invasive bivalve requires the continuity of scientific research directed to bioprospecting strains less toxic to aquatic organisms, however effective on golden mussel decline. The standardization of ecotoxicological evaluation methods using native bivalve should be required to get the licence for commercial using of the formulated products.

Poster Session P41

Phylogenetic reanalysis confirms *Lamprotula* (Mollusca: Bivalvia: Unionidae) Polyphyly

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Despite our knowledge of convergent evolution and the homoplastic nature of shell characters in the Unionidae, conchological similarities still form the basis of freshwater mussel classification in the Indotropics. Further confounding our ability to provide systematic stakeholders a biologically useful classification is that molecular phylogenetic studies have failed to sample many Indotropical lineages. However, a recent molecular phylogeny of mitochondrial DNA recovered the Asian freshwater mussel genus *Lamprotula* as polyphyletic (Zhou *et al.,* 2007 Cur. Zool. 53(6): 1024-1030). However, the methods of analysis (i.e. incongruent data sets analyzed with differing tree estimation methods and limited taxon sampling) were incomplete to derive convincing conclusions. We set out to augment this published dataset to test the validity of the polyphyletic nature of *Lamprotula* and associated family-group level relationships. We confirm that *Lamprotula* is polyphyletic, while recovering many family-group level relationships that are not present or inconsistent with the initial analysis.

Poster Session P42

Comparative larval morphology of native and invasive freshwater bivalve species

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Asian bivalve invaders occurring in Brazilian freshwater environments are *Limnoperna fortunei* (Dunker, 1857), *Corbicula fluminea* (Müller, 1774), and *C. largillierti* (Philippi, 1884). Two other species, *C. fluminalis* (Müller, 1774) and *C. sp.* not yet identified, live in very restricted areas of southern Brazil. Despite the bivalves are easily differentiated in the adult stage, their development and larval forms are highly similar especially in their last planktonic larval stages. Samples of 10 species (seven native and three invasive larvae) were measured to differentiate larva in their specific levels and also from some native bivalve larvae sharing the same environment. Multivariate canonical discriminant factors (CDA) were employed to analyze measured variables, since the main idea is to annul the influence of size discrimination between shapes, resulting in the identification of the variable or variables responsible for separating the larvae from each species. The results obtained from the CDA found that *Diplodon obsolescens* showed the highest values, while *Limnoperna fortunei*, the lowest. It is possible to differentiate, *C. fluminea* and *L. fortunei* by larval conformation and by measuring the hinge length. Comparing the three invasive species, *L. fortunei* has proportionally the smallest measurement of length and height and the shortest hinge. *C. largillierti* has the most elongated hinge among the three species. A second CDA without the presence of *L. fortunei* elucidates more clearly the differences between the larval forms from the other species, using variables of hinge lengths. In this second analysis, the species *Diplodon* and *Prisodon* (*D. obsolescens*, *D. hylaeus*, *D. suavidicus* e *P. obliquus*) are differentiated from other native species, as well as from the two invasive species (*C. fluminea* e *C. largillierti*). This study aims to distinguish the invasive larvae from one another and from the native larvae, based on three measures related to the larval shell length, height, and hinge length as a support to the management of invasive species and the conservation of native bivalves (ELETROBRAS-FURNAS).

Poster Session P43

Electrofishing as a new method to find freshwater pearl mussel (*Margaritifera margaritifera*) populations

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Despite the rareness and large number of studies and publications of fresh water pearl mussel (*Margaritifera margaritifera*), it is quite obvious that all populations of this species are not found yet. Traditionally pearl mussel populations have been searched by visual observation with diving. However, diving can be time-consuming, demanding and expensive, and it may need lot of equipments to be carried to wild areas without roads.

Pearl mussel glochidia larva leaves its host fish in northern Finland by July, at the size of 400-500 µm. At the beginning of the summer the size of larvae is 200-250 µm and they can be easily seen in their host fish gills by naked eyes by opening slightly the operculum. After that short examination the fish with glochidia larvae can be released alive back to the river. Therefore fishing and quick check of host fishes in the field could provide a cost-effective, non-destructive way to find unknown populations of pearl mussels. At the same time the information of populations' reproductive ability, and therefore vitality, would also be received. It is worth noting that in June and July in the Finnish *Margaritifera* rivers of the present study no other unionoid species larvae are present in fish.

The electrofishing method was tested in two tributaries of River Iijoki, northern Finland, inhabiting resident brown trout population, in 2011 by doing the fast examination in the field and then studying the numbers of glochidia microscopically in laboratory. In the first tributary, the infection status (infected/uninfected) assessed with a quick dip in the field was correct in 17 fish out of 18. In the second tributary, status was correct in 17 out of 22 fish. No false positive records were achieved, and the field-assessment was 100% correct in all cases in which the number of glochidia per fish was at least 20. However, in September, when new glochidia started to infect to fishes, the field-assessment was not reliable due to the small size of glochidia.

In the poster we also report 2012 results of the method applied to tens of northern Finnish rivers with no prior knowledge about the occurrence of pearl mussel (or even salmonid fish).

Poster Session P44

Phylogeography of *Unio crassus* in Central Europe

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A phylogeographic analysis of mitochondrial DNA sequence variation was carried out to infer the geographical distribution of the genealogical lineages of the freshwater mussel *Unio crassus*. The genetic analyses of 250 individuals from 25 sites covering the central European part of distribution range were performed using a fragment of the cytochrome oxidase (*cox1*) gene. Phylogeographic relationships among thick shelled river mussels were determined from the distribution of 33 mtDNA haplotypes detected in the samples. *Unio crassus* in the study area belong to two distinct mitochondrial phylogroups. The geographical distribution of these lineages is non-random, a largely allopatric, implying likely descent from the southern Danube and Dniester (periphery of Black Sea) basins as possible palaeorefugia. Although the genetic affinities of the populations are the closest within the same drainage basin, shared haplotypes were observed even between distant localities and different river systems. This points to a high degree of historical gene flow among populations and supports the hypothesis that genetic relationships within *U. crassus* in central Europe reflect palaeogeographical relationships between river systems during the Pleistocene.

Poster Session P45

Detritus from springs as a possible food source for freshwater pearl mussel (*Margaritifera margaritifera*): composition, quantity and origin

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Freshwater pearl mussel, unlike most of Unionids, does not use as a major food source the algal suspensions, but organic detritus. Since the nineties, the "Czech method" of rearing juvenile pearl mussels successfully used the fine detritus from helocrene-type springs as an effective food source. Therefore, our research was focused on the qualitative and quantitative characteristics of the detritus in these and other springs in the southern part of the Czech Republic (Blanice River catchment, Sumava foothills). Microscopical analysis of detrital samples from various microhabitats of 52 springs showed relatively uniform representation of components: 49% (SD 13.7) faecal pellets, 26% (SD 8.0) plant residuals and 21% (SD 9.6) amorphous matter, on average. The presence of living algal cells was observed in only a small number of springs, and generally it was 4% of the total mass. The annual monitoring of detritus, washed out from 11 helocrenes (seven-day cumulative proportional sample of suspended detritus) showed average outputs of 3.1 mg-l^{-1} (SD = 2.51) of dry mass with a predominance of medium size fraction (63-250µm). Compared to FPOM in streams, the material had relatively suitable nutrient ratios (C:N=14.7; SD=2.3 and N:P=10.5; SD=4.1). Moreover, the most favourable nutrient ratios were recorded in the finest fraction (below 63µm) that corresponds to food particles used by the freshwater pearl mussel. The average C:N ratio of the leaf litter from the same spring areas was 41.0 (SD 14.3), which is significantly higher value than in the detritus, but less suitable. Thus, in detritus there are likely incorporated the living cells of microorganisms, increasing the nutritional value of the detritus. According to this assumption, microbiological analyzes of detritus found a large amount of living prokaryotic cells of Archaea and Bacteria domains. There remains a question of the effective transport distance of detritus from the springs to pearl mussel habitats in the specific watershed. In previous studies from other watersheds the average transport distance is estimated at 4-8 km per day. Nevertheless, primary river network connectivity in the monitored basin decreases with landuse changes and a large proportion of spring brooks seeps in. Detritus from these springs will no longer reach the river.

Poster Session P46

The situation of *Margaritifera margaritifera* in the Czech Republic - several successfully rejuvenated populations but the absence of natural reproduction

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The territory of the Czech Republic is situated at the south-eastern margin of freshwater pearl mussel's (*Margararitifera margaritifera*) European range. The species disappear from the majority of its sites during the 20th century. All the populations situated in the Baltic Sea catchments (Odra River basin) were lost before 1990. The present occurrence of *M. margaritifera* is restricted to several small and isolated populations near the upper altitude limit of its natural distribution in the Vltava and Saale River basins (Elbe River basin - Nort Sea), including border streams with Germany and Austria. Population genetic analysis based on 12 microsatellite markers revealed the existence of three distinct groups that should be considered as a separate conservation units. Age structure of the Czech *M. margaritifera* populations demonstrates the radical lack of natural recruitment at all sites since the second half the 20th century. Therefore, artificial rearing programs (see details in Peltanová et al., this conference) for *M. margaritifera* have been established for seven local populations in order to offset the lack of natural recruitment. Mainly the semi-natural propagation method developed by J. Hruška was used. Between 40 and 20 000 juvenile mussels were released at particular sites. After the completion of its juvenile stage in interstitial habitat (5-15 years), the sub-adult mussels were successfully recorded on the surface of river bottom at several sites (constituting 4-5% of the population at two sites, sporadically occurring at the other sites). Nevertheless, regarding the long period of interstitial life at these oligotrophic sites, the overall effect of propagation efforts can not be fully determined yet. The actual number of adult specimens declined to approximately 10 000 individuals at the most valuable Central European site (Blanice River) and to even much lower numbers at other sites. The overall numbers of both juvenile and adult mussels is thus estimated to be lower than 100 000 individuals. Despite the unfavourable population status, recent decrease of water pollution at *M. margaritifera* sites and the other adopted conservation actions may help to prevent its population decline.

Poster Session P47

The nervous system of the peppery furrow shell *Scrobicularia plana* (da Costa, 1778): unveiling morphological features by computer-assisted 3D reconstruction

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The morphology of the nervous system (NS) of *Scrobicularia plana* was never studied in fine detail, namely as to the 3D organization of ganglia and nerves. A better description of the NS of that economically important bivalve is worth not only because of a zoological interest, but also due to evidences that many pollutants disrupt the NS of bivalves, with effects *inc*. on breeding. We started disclosing the anatomy of the NS of the species, using 3D reconstruction techniques applied to ganglia and interconnecting nerves. We used males and females from the Mondego River estuary (Portugal). The animals' dimensions were measured before fixation in 10% neutral buffered formalin, overnight at RT. Dehydration was with ethanol and embedding in paraffin. Animals were serially sectioned (30 µm thick) along the sagittal plane, using a fully motorized microtome. Hematoxylin and eosin stained sections were photographed under light microscopy. Images were saved in JPG (2560 x 1920 pixels) and then worked in the software BioVis3D. Both 3D reconstructions and morphometry data were derived, separating the cortex and medulla. Data depicted three types of bilaterally symmetrical ganglia. The cerebral ganglia are pear-shaped, both located laterally to the mouth, between it and the posterodorsal end of the anterior muscle. The pedal ganglia are fused, showing a subspherical shape, being located in a median plane, between the gonad and foot. The visceral ganglia are also fused, having a lobular shape, very close to the posterior adductor muscle. The overall preliminary total volumes of cerebral, pedal, and visceral ganglia are: 35.5 x 10^6, 93.9 x 10^6, and 209.7 x10^6 µm^3, respectively. The total surface areas are: 5.0 x 10^6, 1.1 x 10^6, and 2.7 x 10^6 µm^2. The neuronal rich (cortical) region made 61% of the ganglia volume, and the inner part, rich in neural processes and glial cells, filled 39%. From each cerebral ganglia, one long parallel nerve emerged, connecting them with each fused visceral one. Another pair emerged from the dorsal and ventral surfaces of each pedal ganglion. Bigger animals tended to have larger ganglia, and this deserves further research. This study offered a new view on the qualitative and quantitative anatomy of the NS of *S. plana*.

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Poster Session P48

Growth of *Anodonta anatina* (Unionidae) in lakes differing by their productivity and physical & chemical properties of water

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Freshwater mussels of the family Unionidae are wide-spread aquatic organisms, but many species and populations have recently declined. Unionids may have a significant contribution to the function of the river or lake ecosystem. Growth of unionid mussels can vary significantly from population to population, but the role of water quality parameters in determining the growth rate of unionid mussels is poorly known. We studied the growth of *Anodonta anatina* in relation to pH, conductivity, turbidity, colour, total phosphorus, phosphate phosphorus, total nitrogen, chlorophyll a, alkalinity and calcium in 14 Finnish lakes. Mussel ages were determined from the annual growth rings of the shell, and length at each age was measured. The length of the third annulus was used as the measure of growth. To avoid the influence of between-year variation in growth conditions, only mussels between 3 and 4 years of age were included. When analysing correlations between individual water quality parameters and mussel growth rate, we found a positive relationship of the mean growth to total nitrogen, turbidity, colour and chlorophyll a. Due to the inter-correlated nature of water quality variables, factor analysis was used to reduce the water quality variables into two principal components. The first principal component (PC1) included pH, conductivity, alkalinity and the concentrations of calcium and total nitrogen. The second principal component (PC2) included total phosphorus, phosphate phosphorus, total nitrogen, chlorophyll a, turbidity and colour. Regression analysis indicated that PC2, only, has a statistically significant contribution to mussel growth. Therefore it can be concluded that factors related to productivity, nutrients, colour and turbidity (PC2) were more important for growth of *A. anatina* growth than those related to water hardness (PC1). Thus, growth of mussels in the present material was higher in productive, nutrient-rich, dark-water, turbid lakes.

Poster Session P49

Ecological requirements of autochthonous mussel populations in northeastern rivers (Douro basin) of Portugal

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Ecological requirements of autochthonous mussel populations present in three Portuguese northeastern water courses, Tâmega, Tua and Sabor Rivers (Douro basin), were studied. *Margaritifera margaritifera*, *Potomida littoralis*, *Unio delphinus* and *Anodonta anatina* populations were sampled during spring/summer of 2009, 2010 and 2011. Water quality, habitat (using River Habitat Survey methodology) and microhabitat used by mussel populations were analyzed. The ecological characterization was complemented recurring to the algae, macroinvertebrate and fish communities, following the Water Framework Directive procedures. Preference curves were developed for the juvenile and adult of the different species. *M. margaritifera* populations occupied permanent current and highly shaded microhabitats, buried in the fine sediments (gravel and sand) deposited in the interstices of coarse substrate (cobbles and boulders). *U. delphinus* and *A. anatina* are naturally distributed along the middle and lower sections, reaching high densities in sediment zones located in the lateral arms of the main rivers. *P. littoralis* was typically found in pebble zones of middle channel arms, with higher water currents. Many of these populations are threatened by the future reduction in the available habitat and by biotic shifts (authochtonous fish displaced by alien species) that can be expected from big dam constructions established by Portuguese governmental policies. Conservation measures must consider ecological monitoring, specific legislation and translocation programs for threatened mussel populations and a global ecosystem protection, namely in high ecological integrity areas.

Poster Session P50

Culturing *Unio crassus* (L.), first trials from Luxembourg

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Many freshwater mussels in central Europe are seriously threatened due to anthropogenic habitat changes in most river catchments during the last decades. Among them is also the thick shelled river mussel *Unio crassus* (L.). In Luxembourg this species was abundant in many rivers in the low mountain range of the Ardennes. However in only two rivers, small remaining populations are left. The only sustainable way to save these populations is to bring their habitats again in a condition where natural reproduction is possible. One possibility to enhance small populations is to release laboratory-reared individuals. In Europe not many freshwater mussel species are artificially reared, and most propagation projects deal with the Freshwater Pearl Mussel *Margaritifera margaritifera*. The intent of the present study was to establish a method for captive breeding of *Unio crassus*.

Between March and April, gravid females of *Unio crassus* were searched in the Our river in northern Luxembourg and transported to the rearing facility at the Mill of Kalborn. Here they were placed in an artificial stream supplied with river water at a natural temperature regime. Between April and June mature glochdia could be collected with the help of a pipette at several occasions. The glochidia were transferred immediately to a tank containing minnows (*Phoxinus phoxinus)* as a host fish. After the infestation the minnows were transferred in a "juvenile mussel collection station". After three weeks, freshly metamorphosed juveniles could be collected from the sieve. In the following weeks the juvenile mussels were kept a) in static systems (plastic boxes without substrate) with a weekly water exchange and fed with natural detritus and commercial algae and b) in small aquaria with sand as substrate, a pump for current and they were fed with commercial algae. The growth and survival rates of the juveniles held in the different systems were reported. With both systems it was possible to culture juvenile *Unio crassus* successfully.

Poster Session P51

Phylogeography and population genetics of the endangered freshwater pearl mussel (*Margaritifera margaritifera*) studied using mitochondrial DNA

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The freshwater pearl mussel (*Margaritifera margaritifera* L.) is one of the most endangered freshwater mussels in the world. Freshwater pearl mussel populations are declining in Europe as a result of increasing human activity and habitat loss. In Finland, at the start of the last century, there were 200 pearl mussel rivers—at the end of the century there were only 70 rivers where the species occurred. This study investigated the genetic structure and variability of 17 freshwater pearl mussel populations originating from Finland, Russia, Ireland and Spain using mitochondrial cytochrome oxidase subunit I sequences (*COI*). *COI* sequences of 11 populations were from the NCBI gene bank and *COI* sequences of the rest 6 populations were collected from those populations for this study. By their haplotype richness, number of unique haplotypes and diversity index, Finnish and Russian populations were genetically more diverse than those from Ireland and Spain. Haplotypes from geographically closer populations showed less difference in their nucleotides than haplotypes from distant populations. Results show a high degree of differentiation of Finnish pearl mussel populations and thus emphasize how important it is to maintain these populations in future. The *COI* gene also indicates the existence of two evolutionary lineages: one extending northwards from Ireland and the other extending southwards from Ireland.

Poster Session P52

The translocation of the thick-shelled river mussels (*Unio crassus*) from the area of a bridge improvement project in Finland

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Finland has agreed with the EU to upgrade, on the Finnish side, Highway 7 from Turku to St. Petersburg, to motorway standard by 2015. The motorway will cross the River Kymijoki, in which lives a population of thick-shelled river mussels, a species protected by law. The protected mussels will have to be translocated upstream from the bridge crossing because there being no other way to save the threatened specimens. In Finland, such mussel surveys are carried out by the Research Group for Large Mussels (*Margaritifera* and *Unio crassus*), the work of which group is a collaboration between WWF Finland and the Finnish Museum of Natural History. Since 1978, this research group has surveyed about 5000 kilometres of underwater study lines, each one metre wide. To improve the accuracy of the collecting method we have used lead-core ropes to divide up the river bottom into areas for a precise survey of mussels and the subsequent specimen collecting. The survey area in the River Kymijoki was about 2000 m^2, divided into 84 collecting lanes. The number of specimens of large mussels was 35 572, of which 7 011 were the threatened *U. crassus* species. The average density of *U. crassus*/m^2 was 3.6, i.e. for every 100 m^2 an average of 360 specimens was translocated. The *U. crassus* population consists mainly (67 %) of middle-aged specimens (length 50-74 mm). Young specimens (<50 mm) made up 29 %, and very old specimens (length >74 mm) only about 4 % of the total. Before translocating the *U. crassus* mussels, we marked the left valve of each specimen with a white and sticky substance (Casco Marin & Teknik) which continues to harden in water. The translocation area is already home to some *U. crassus* specimens, hence the marking is one way to recognize the translocated specimens. The translocated population will be monitored in 2012 and again in 2014. However, the translocated population was only one tenth of the whole population (80 000 *U. crassus*) that live very near to the motorway project downstream. Therefore, the act of translocation on its own should not be viewed as a reason for anyone to ignore other environmental rules governing the area in question.We have established that the thick-shelled river mussel is present in 30 rivers in Finland. However, only seven of these rivers belong to the EU Natura-2000 network.

Poster Session P53

Distribution and composition of freshwater fish communities in northeastern rivers (Douro basin, Portugal): Implications for mussel conservation strategies

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Freshwater mussel populations (*Margaritifera margaritifera*, *Unio delphinus*, *Anodonta anatina* and *Potomida littoralis*) of three tributaries of the Douro basin are threatened by several factors (e.g. river regulation, pollution, habitat perturbation and the introduction of exotic species). It is known that host fish, manly autochthonous species, are essential for the life cycle and conservation of these naiad populations. Freshwater fish communities present in Tâmega, Tua and Sabor rivers are composed by autochthonous salmonid (*Salmo trutta*), cyprinid (*Squalius carolitertii, Squalius alburnoides, Pseudochondrostoma duriense, Achondrostoma oligolepis, Luciobarbus bocagei*) and cobitid (*Cobitis calderoni*) resident populations and an increasing number of exotic species (*e.g. Esox lucius, Micropterus salmoides, Lepomis gibbosus, Gambusia holbrooki, Gobio lozanoi, Carassius auratus, Cyprinus carpio, Sander lucioperca*). Diadromous species are limited to eel populations (*Anguilla anguilla*) and a low number has been detected only in the Tâmega river.

A good biological quality and biotic integrity can be found in many headwater streams of Tâmega, Tua and Sabor rivers. For instances, in the Rabaçal and Tuela streams (Tua basin), inside the Montesinho Natural Park, only autochthonous fish species are present and trout populations reach high densities supporting the most viable freshwater pearl mussel (*Margaritifera margaritifera*) populations of Portugal. However, other mussel populations (*U. delphinus*, *A. anatina* and *P. littoralis)* present in the lower part of the three rivers are severely threatened by river regulation (3 big dams are nowadays in construction), which will promote the disappearance of autochthonous host fish species and the dominance of exotic species.

Poster Session P54

Distribution and composition of brown trout in river Paiva (Douro basin, Portugal) and its linkage with freshwater pearl mussel

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The freshwater pearl mussel *Margaritifera margaritifera* has attracted much interest in recent years not only due to its interesting life cycle and ecology but also, and most importantly, for its decline which has left many populations extinct or seriously depleted. This endangered species are threatened by several factors (*e.g.* weirs for watering and hydroelectric power, pollution, habitat perturbation and overfishing). It is known that host fish (brown trout), are essential for the life cycle and conservation of these naiad populations. So, this study was conducted in 2012 to evaluate fish community and to characterize the ecological status of the river Paiva as essential factors for maintaining healthy pearl mussel populations.

Freshwater fish communities present in river Paiva are composed only by autochthonous salmonid (*Salmo trutta*) and cyprinid (*Squalius carolitertii, Squalius alburnoides, Pseudochondrostoma duriense, Achondrostoma oligolepis, Luciobarbus bocagei*) resident populations. A good ecological integrity can be found over almost the entire water course and the brown trout populations reach high densities in the upper parts of river Paiva supporting viable freshwater *Margaritifera margaritifera* populations. However, despite host fishes exist throughout the entire water course, in the lower part (approximately 30 Km) their presence is vestigial which is accompanied by a strong decrease in mussel population density.

Efforts to maintain or even to improve water quality and protect instream habitat are needed to fully restore environmental conditions for the native fish community and stocked brown trout in the river Paiva, mainly in the lower parts.

Poster Session P55

Comparative study of genotoxic response of freshwater mussels *Unio tumidus* and *Unio pictorum* to environmental stress

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The aim of this work was to investigate and to compare genotoxic response off reshwater mussels *U. tumidus* and *U. pictorum* exposed to the same level of environmental stress. Mussels were collected from the site Orešac located on the River Danube and held on acclimation for 10 days in controlled laboratory conditions prior to exposure at 4 sites on the rivers Sava and Danube in the area of the city of Belgrade. The samples of each species were taken after 7, 14 and 30 days of exposure. The mussels sampled immediately after acclimation were used as controls. Comet assay on haemocytes and gill cells was used for assessment of genotoxicity and the tail intensity was chosen as the most relevant measure of DNA damage. The acclimation period of 10 days appeared to be sufficient for DNA damage recovery in both tissues of *U. pictorum* and in haemocytes of *U. tumidus*. During exposure, alterations of DNA damage measured in tissues of *U. pictorum* were more correlated to measured concentrations of pollutants in comparison with tissues of *U. tumidus,* indicating higher sensitivity of *U. pictorum.* Among studied tissues, haemolymph of *U. pictorum* showed the highest correlation with level of pollution and therefore we recommend this tissue as the most reliable indicator for detection of genotoxicity.

Poster Session P56

Good population in bad habitat: on the ecology of the largest population of *Unio crassus* in Poland

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Although *Unio crassus* still occurs in many sites in Poland, it is seriously threatened with extinction. The rate of extinction of many important populations in the recent years has been high, despite significant improvement in ecological state of the running waters. The population in the Biała River (S Poland) is the largest and the best studied in Poland. Approximately 60 000 adult individuals was found in ca 30km-long section of the middle course of the river, with local density exceeding 1000 individuals per 100m of the river course. In order to determine ecological factors responsible for the distribution and size of this population, we studied the species density, its distribution in microhabitats, local age structure, growth curves of individuals, in relation to habitat features which had been suggested before as important for this species: water chemistry, fish species composition, river morphology and training works along the river. The results implicate that the main factors responsible for the species distribution and numbers are related to natural river morphology and fluvial processes.

Poster Session P57

Methods for propagation and culture of freshwater mussels (Unionidae)

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Propagation and culture methods for Unionidae have advanced rapidly over the past decade. In laboratory culture, 15-L recirculating downweller systems fed with micro-algal suspensions have proven useful for early grow-out, but require continuous feeding and frequent cleaning to maintain water quality. Staging larger (>0.5 mm) juveniles into larger (80-L) recirculating upweller systems has proven useful and these systems require less intensive care. When juvenile size exceeds 3-5 mm, continued growth and survival are greatly enhanced by moving to outdoor systems and natural food supply. Most native mussels live in rivers, but new methods permit pond-culture of riverine species. The use of pond culture decreases the investment in artificial foods and greatly increases the number of animals that can be held for grow out. Pump-driven floating upweller systems designed to accommodate mussels in ponds, and indoor raceway upweller systems using natural water have been applied economically and show greatly improved growth and survival rates relative to lab culture with artificial foods. Ten species have been successfully cultured for up to 3 years using these systems. Substrate appears to be unnecessary for good growth and survival. Although shell form is altered in some species when cultured without substrate, the animals bury readily and apparently behave normally when placed in substrate. Growth rates are similar to or faster than those observed in the wild, and several species have reached sexual maturity and reproduced.

Poster Session P58

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