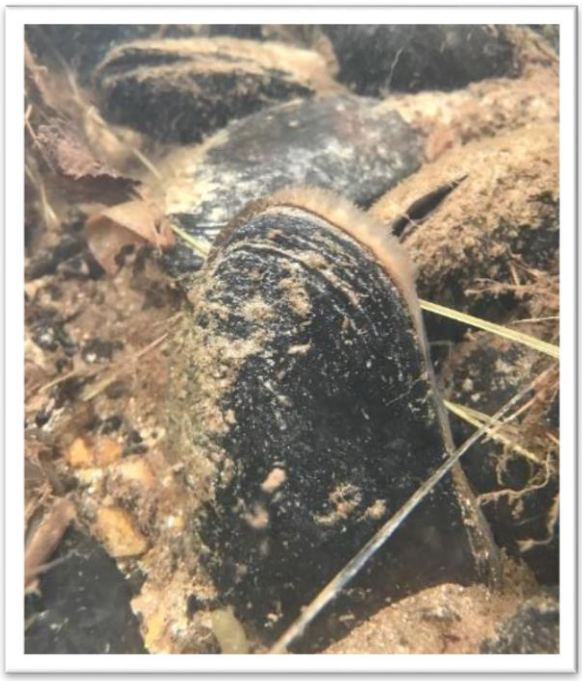
INTERNATIONAL WORKSHOP

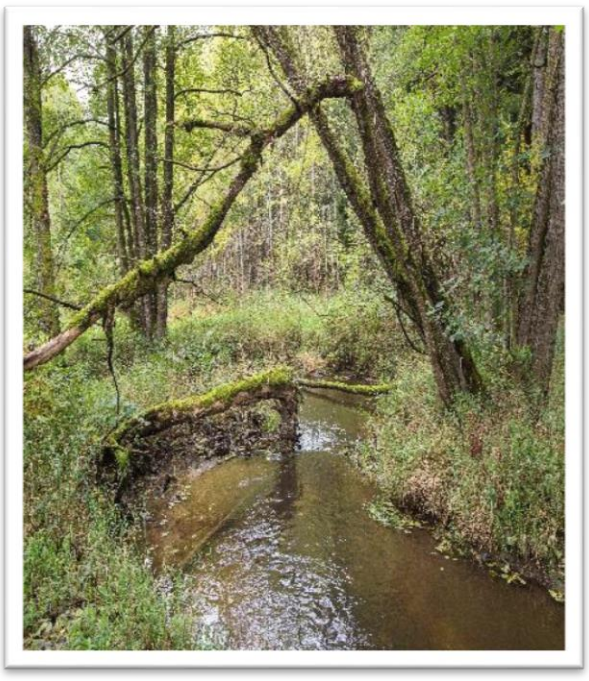
Freshwater mussels: Search for suitable habitats and evaluation of protection measures

Monday 25th March – Wednesday 27th March 2019

Dresden, Germany

Book of abstracts





Margaritifera margaritifera and its potential habitat in Saxony's Vogtland, Germany.

Jointly funded by BMBF and BMU/BFN (Funding Codes: 01LC1313A-D and 3514685E13-I13) and Bayerischer Naturschutzfonds

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90
March 2019

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1 Organizational questions

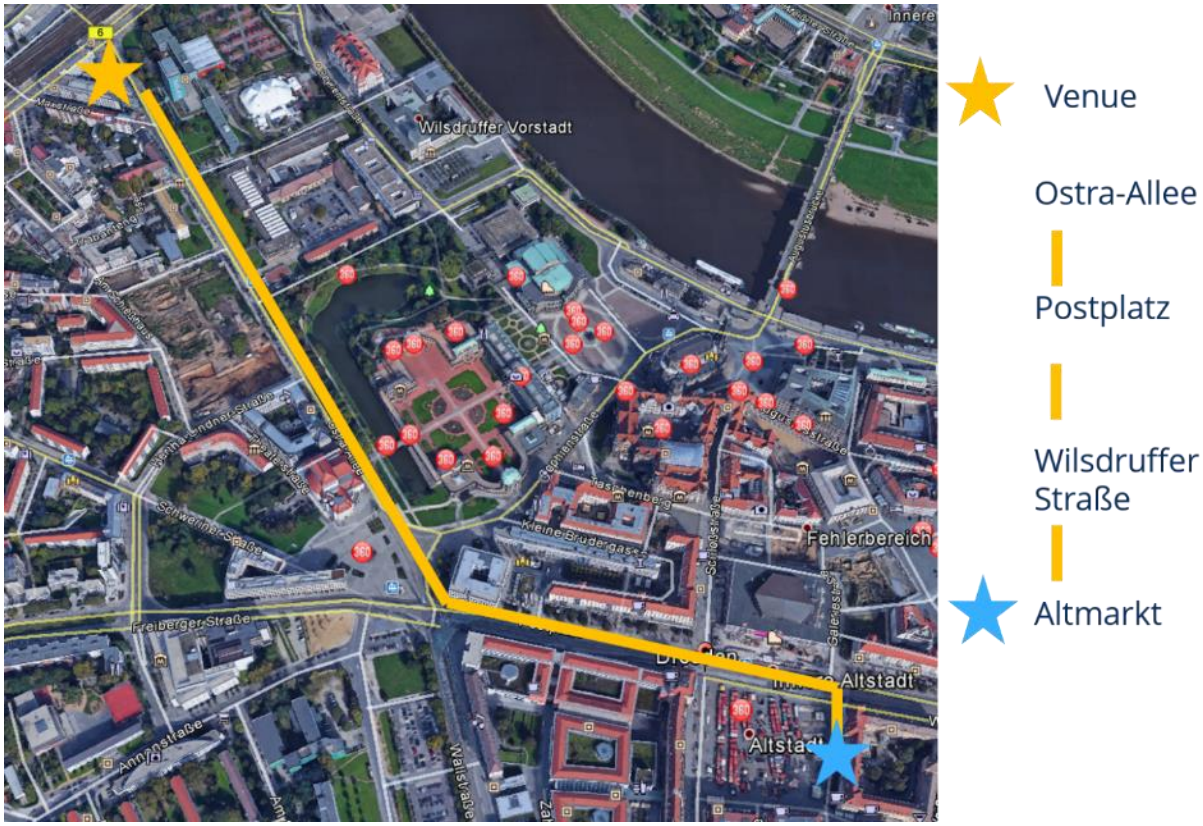
Venue:	Penck Hotel Dresden Ostra-Allee 33 | 01067 Dresden, Germany https://penckhoteldresden.de/
Local Organization Team	Jana Schneider, Thomas Schiller (Technische Universität Dresden, Germany) Franziska Jecke, Barbara Heidrich (Sächsische Landesstiftung Natur und Umwelt, Germany)
Scientific Committee	Thomas Berendonk (Technische Universität Dresden, Germany) Jürgen Geist (Technische Universität München, Germany) Marco Denic (Landkreis Passau, Germany) Frankie Thielen (natur & ëmwelt / Fondation Hëllef fir d'Natur, Luxembourg) Clemens Gumpinger (Consultants in aquatic ecology and engineering (blattfisch), Austria) Annekatrin Wagner (Technische Universität Dresden, Germany)
Contact	Technische Universität Dresden Institut für Hydrobiologie Zellescher Weg 40, 01127 Dresden, Germany Jana Schneider: E-Mail: jana.schneider2@tu-dresden.de Tel. +49 351 463 32329 Fax. +49 351 463 37108

2 Evening activities

2.1 Monday, 25th March, optional meeting in the evening

- 19:00 Reserved table for people who would like to meet, eat and talk together (reserved for “TU Dresden”)
- Restaurant (vine tavern): **Altmarktkeller Dresden,** Adress: Altmarkt 4, 01067 Dresden
- Saxon and international cuisine**,** regional beers and wine from the Saxony region
- https://www.altmarktkeller.de/

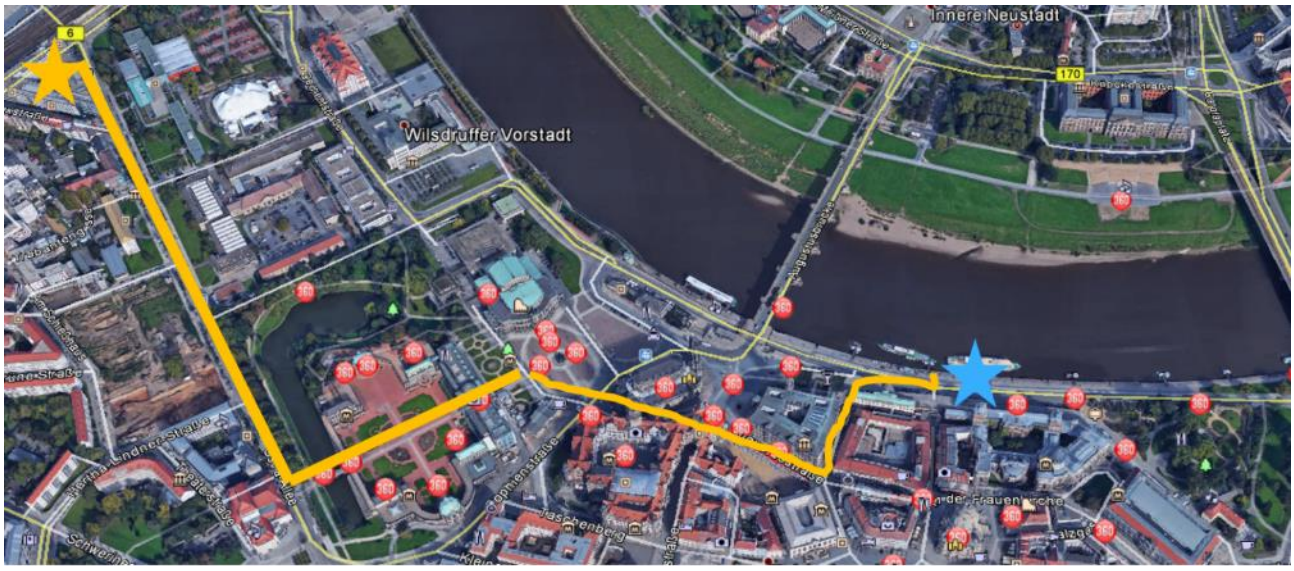
15-minutes-walk from the venue:



2.2 Tuesday, 26th March, official social evening: Steam boat tour

- **17:30 Guided walk** to the levy of the steam boat MS “August der Starke”,
- **meeting point**: reception of the venue
- **18:00 Boarding** (Adress: Terrassenufer, levy number 3F)
- **21:30 Return** to the levy
- official social evening with dinner on the boat (seasonal springtime buffet)
- all food and drinks included

25-minutes-walk from the venue:



2.3 Schedules public transport

Schedule from the airport („Flughafen Dresden“) to the venue (“Dresden Mitte”) by suburban train on weekdays:

S 2 Flughafen Dresden - Dresden Hbf - Heidenau - Pirna

		MONTAG - FREITAG																								
ZUGNUMMER		32701	32703	32705	32707	32709	32711	32713	32715	32717	32719	32721	32723	32725	32727	32729	32731	32733	32735	32737	32739	32741	32743	32743
VERKEHRSHINWEIS																							wy	W
Dresden Flughafen (Gleis 1)	ab		4.48	5.18	5.48	6.18	6.48	7.18	7.48	8.18	8.48	9.18	9.48	10.18	10.48	11.18	11.48	12.18	12.48	13.18	13.48	14.18	14.48	14.48
Dresden-Grenzstraße (Gleis 1)			4.50	5.20	5.50	6.20	6.50	7.20	7.50	8.20	8.50	9.20	9.50	10.20	10.50	11.20	11.50	12.20	12.50	13.20	13.50	14.20	14.50	14.50
Dresden-Klotzsche (Gleis 1)	an		4.53	5.23	5.53	6.23	6.53	7.23	7.53	8.23	8.53	9.23	9.53	10.23	10.53	11.23	11.53	12.23	12.53	13.23	13.53	14.23	14.53	14.53
Dresden-Klotzsche (Gleis 1)	ab		4.54	5.24	5.54	6.24	6.54	7.24	7.54	8.24	8.54	9.24	9.54	10.24	10.54	11.24	11.54	12.24	12.54	13.24	13.54	14.24	14.54	14.54
Dresden Industriegelände (Gleis 1)			4.57	5.27	5.57	6.27	6.57	7.27	7.57	8.27	8.57	9.27	9.57	10.27	10.57	11.27	11.57	12.27	12.57	13.27	13.57	14.27	14.57	14.57
Dresden-Neustadt (Gleis 2)	an		5.00	5.30	6.00	6.30	7.00	7.30	8.00	8.30	9.00	9.30	10.00	10.30	11.00	11.30	12.00	12.30	13.00	13.30	14.00	14.30	15.00	15.00
Dresden-Neustadt (Gleis 2)	ab		5.02	5.32	6.02	6.32	7.02	7.32	8.02	8.32	9.02	9.32	10.02	10.32	11.02	11.32	12.02	12.32	13.02	13.32	14.02	14.32	15.02	15.02
Dresden Mitte (Gleis 2)			5.05	5.35	6.05	6.35	7.05	7.35	8.05	8.35	9.05	9.35	10.05	10.35	11.05	11.35	12.05	12.35	13.05	13.35	14.05	14.35	15.05	15.05
Dresden Freiberger Straße (Gleis 2)			5.07	5.37	6.07	6.37	7.07	7.37	8.07	8.37	9.07	9.37	10.07	10.37	11.07	11.37	12.07	12.37	13.07	13.37	14.07	14.37	15.07	15.07
Dresden Hbf (Gleis 18)	an		5.09	5.39	6.09	6.39	7.09	7.39	8.09	8.39	9.09	9.39	10.09	10.39	11.09	11.39	12.09	12.39	13.09	13.39	14.09	14.39	15.09	15.09
Dresden Hbf (Gleis 18)	ab	4.41	5.11	5.41	6.11	6.41	7.11	7.41	8.11	8.41	9.11	9.41	10.11	10.41	11.11	11.41	12.11	12.41	13.11	13.41	14.11	14.41		15.11
Dresden-Strehlen (Gleis 2)		4.44	5.14	5.44	6.14	6.44	7.14	7.44	8.14	8.44	9.14	9.44	10.14	10.44	11.14	11.44	12.14	12.44	13.14	13.44	14.14	14.44		15.14
Dresden-Reick (Gleis 2)		4.46	5.16	5.46	6.16	6.46	7.16	7.46	8.16	8.46	9.16	9.46	10.16	10.46	11.16	11.46	12.16	12.46	13.16	13.46	14.16	14.46		15.16
Dresden-Dobritz (Gleis 2)		4.49	5.19	5.49	6.19	6.49	7.19	7.49	8.19	8.49	9.19	9.49	10.19	10.49	11.19	11.49	12.19	12.49	13.19	13.49	14.19	14.49		15.19
Dresden-Niedersedlitz (Gleis 2)		4.51	5.21	5.51	6.21	6.51	7.21	7.51	8.21	8.51	9.21	9.51	10.21	10.51	11.21	11.51	12.21	12.51	13.21	13.51	14.21	14.51		15.21
Dresden-Zschachwitz (Gleis 2)		4.53	5.23	5.53	6.23	6.53	7.23	7.53	8.23	8.53	9.23	9.53	10.23	10.53	11.23	11.53	12.23	12.53	13.23	13.53	14.23	14.53		15.23
Heidenau (Gleis 2)	an	4.55	5.25	5.55	6.25	6.55	7.25	7.55	8.25	8.55	9.25	9.55	10.25	10.55	11.25	11.55	12.25	12.55	13.25	13.55	14.25	14.55		15.25
Heidenau (Gleis 2)	ab	4.55	5.25	5.55	6.25	6.55	7.25	7.55	8.25	8.55	9.25	9.55	10.25	10.55	11.25	11.55	12.25	12.55	13.25	13.55	14.25	14.55		15.25
Heidenau Süd		4.58	5.28	5.58	6.28	6.58	7.28	7.58	8.28	8.58	9.28	9.58	10.28	10.58	11.28	11.58	12.28	12.58	13.28	13.58	14.28	14.58		15.28
Heidenau-Großsedlitz		5.00	5.30	6.00	6.30	7.00	7.30	8.00	8.30	9.00	9.30	10.00	10.30	11.00	11.30	12.00	12.30	13.00	13.30	14.00	14.30	15.00		15.30
Pirna	an	5.03	5.33	6.03	6.33	7.03	7.33	8.03	8.33	9.03	9.33	10.03	10.33	11.03	11.33	12.03	12.33	13.03	13.33	14.03	14.33	15.03		15.33

		MONTAG - FREITAG			
ZUGNUMMER		32745			
VERKEHRSHINWEIS		wy			
Dresden Flughafen (Gleis 1)	ab	15.18			
Dresden-Grenzstraße (Gleis 1)		15.20			
Dresden-Klotzsche (Gleis 1)	an	15.23			
Dresden-Klotzsche (Gleis 1)	ab	15.24			
Dresden Industriegelände (Gleis 1)		15.27			
Dresden-Neustadt (Gleis 2)	an	15.30			
Dresden-Neustadt (Gleis 2)	ab	15.32			
Dresden Mitte (Gleis 2)		15.35			
Dresden Freiberger Straße (Gleis 2)		15.37			
Dresden Hbf (Gleis 18)	an	15.39			

wy = nur 24. und 31. Dez W = nicht 24. und 31. Dez

On weekends:

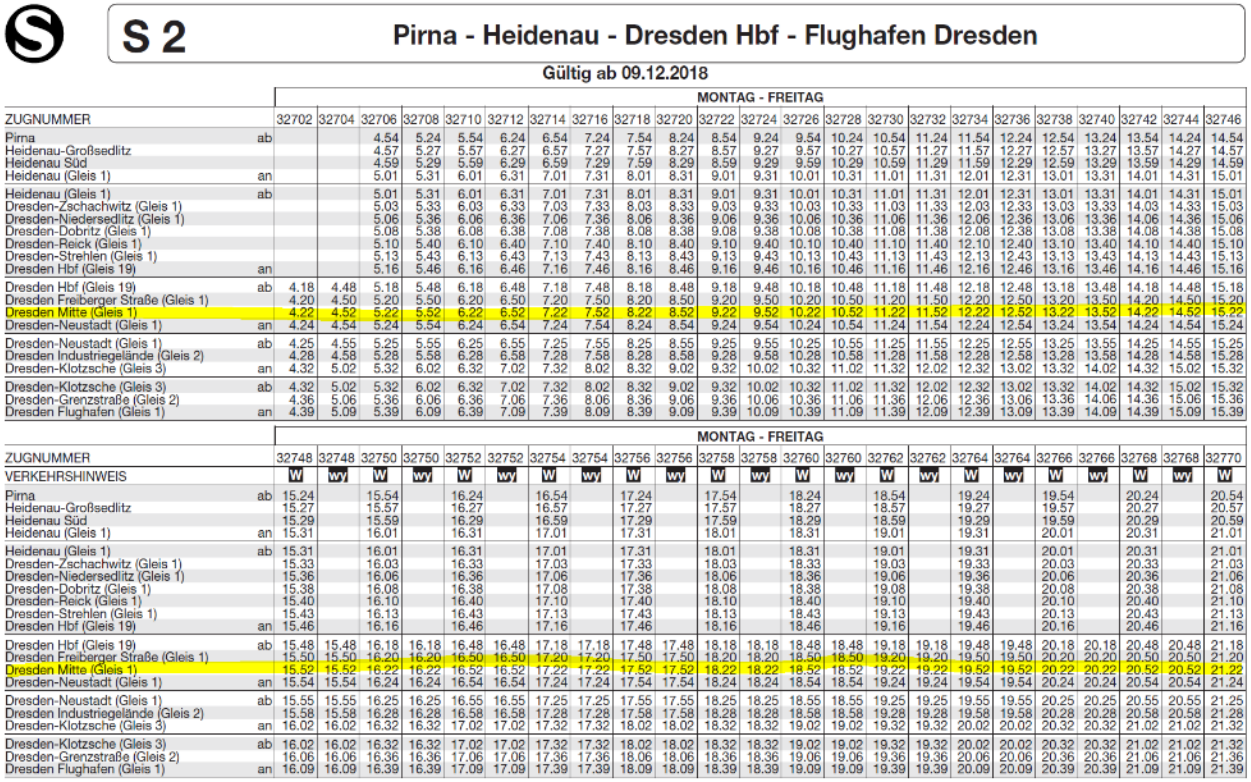
S 2 Flughafen Dresden - Dresden Hbf - Heidenau - Pirna

		SONN- UND FEIERTAG																								
ZUGNUMMER		32733	32735	32735	32737	32737	32739	32739	32741	32741	32743	32743	32745	32745	32747	32747	32749	32749	32751	32751	32753	32753	32755	32755
VERKEHRSHINWEIS		7	57	7	57	7	57	7	57	7	57	7	57	7	57	7	57	7	57	7	57	7	57	7	57	7
Dresden Flughafen (Gleis 1)	ab	12.18	12.48	12.48	13.18	13.18	13.48	13.48	14.18	14.18	14.48	14.48	15.18	15.18	15.48	15.48	16.18	16.18	16.48	16.48	17.18	17.18	17.48	17.48
Dresden-Grenzstraße (Gleis 1)		12.20	12.50	12.50	13.20	13.20	13.50	13.50	14.20	14.20	14.50	14.50	15.20	15.20	15.50	15.50	16.20	16.20	16.50	16.50	17.20	17.20	17.50	17.50
Dresden-Klotzsche (Gleis 1)	an	12.23	12.53	12.53	13.23	13.23	13.53	13.53	14.23	14.23	14.53	14.53	15.23	15.23	15.53	15.53	16.23	16.23	16.53	16.53	17.23	17.23	17.53	17.53
Dresden-Klotzsche (Gleis 1)	ab	12.24	12.54	12.54	13.24	13.24	13.54	13.54	14.24	14.24	14.54	14.54	15.24	15.24	15.54	15.54	16.24	16.24	16.54	16.54	17.24	17.24	17.54	17.54
Dresden Industriegelände (Gleis 1)		12.27	12.57	12.57	13.27	13.27	13.57	13.57	14.27	14.27	14.57	14.57	15.27	15.27	15.57	15.57	16.27	16.27	16.57	16.57	17.27	17.27	17.57	17.57
Dresden-Neustadt (Gleis 2)	an	12.30	13.00	13.00	13.30	13.30	14.00	14.00	14.30	14.30	15.00	15.00	15.30	15.30	16.00	16.00	16.30	16.30	17.00	17.00	17.30	17.30	18.00	18.00
Dresden-Neustadt (Gleis 2)	ab	12.32	13.02	13.02	13.32	13.32	14.02	14.02	14.32	14.32	15.02	15.02	15.32	15.32	16.02	16.02	16.32	16.32	17.02	17.02	17.32	17.32	18.02	18.02
Dresden Mitte (Gleis 2)		12.35	13.05	13.05	13.35	13.35	14.05	14.05	14.35	14.35	15.05	15.05	15.35	15.35	16.05	16.05	16.35	16.35	17.05	17.05	17.35	17.35	18.05	18.05
Dresden Freiberger Straße (Gleis 2)		12.37	13.07	13.07	13.37	13.37	14.07	14.07	14.37	14.37	15.07	15.07	15.37	15.37	16.07	16.07	16.37	16.37	17.07	17.07	17.37	17.37	18.07	18.07
Dresden Hbf (Gleis 18)	an	12.39	13.09	13.09	13.39	13.39	14.09	14.09	14.39	14.39	15.09	15.09	15.39	15.39	16.09	16.09	16.39	16.39	17.09	17.09	17.39	17.39	18.09	18.09
Dresden Hbf (Gleis 18)	ab	12.41		13.11		13.41		14.11		14.41		15.11		15.41		16.11		16.41		17.11		17.41		18.11		
Dresden-Strehlen (Gleis 2)		12.44		13.14		13.44		14.14		14.44		15.14		15.44		16.14		16.44		17.14		17.44		18.14		
Dresden-Reick (Gleis 2)		12.46		13.16		13.46		14.16		14.46		15.16		15.46		16.16		16.46		17.16		17.46		18.16		
Dresden-Dobritz (Gleis 2)		12.49		13.19		13.49		14.19		14.49		15.19		15.49		16.19		16.49		17.19		17.49		18.19		
Dresden-Niedersedlitz (Gleis 2)		12.51		13.21		13.51		14.21		14.51		15.21		15.51		16.21		16.51		17.21		17.51		18.21		
Dresden-Zschachwitz (Gleis 2)		12.53		13.23		13.53		14.23		14.53		15.23		15.53		16.23		16.53		17.23		17.53		18.23		
Heidenau (Gleis 2)	an	12.55		13.25		13.55		14.25		14.55		15.25		15.55		16.25		16.55		17.25		17.55		18.25		
Heidenau (Gleis 2)	ab	12.55		13.25		13.55		14.25		14.55		15.25		15.55		16.25		16.55		17.25		17.55		18.25		
Heidenau Süd		12.58		13.28		13.58		14.28		14.58		15.28		15.58		16.28		16.58		17.28		17.58		18.28		
Heidenau-Großsedlitz		13.00		13.30		14.00		14.30		15.00		15.30		16.00		16.30		17.00		17.30		18.00		18.30		
Pirna	an	13.03		13.33		14.03		14.33		15.03		15.33		16.03		16.33		17.03		17.33		18.03		18.33		

		SONN- UND FEIERTAG												
ZUGNUMMER		32757	32757	32759	32761	32763	32765	32767	32769	32771	32773	32775	32777	32779
VERKEHRSHINWEIS		57	7											
Dresden Flughafen (Gleis 1)	ab	18.18	18.18	18.48	19.18	19.48	20.18	20.48	21.18	21.48	22.18	22.48	23.18	23.48
Dresden-Grenzstraße (Gleis 1)		18.20	18.20	18.50	19.20	19.50	20.20	20.50	21.20	21.50	22.20	22.50	23.20	23.50
Dresden-Klotzsche (Gleis 1)	an	18.23	18.23	18.53	19.23	19.53	20.23	20.53	21.23	21.53	22.23	22.53	23.23	23.53
Dresden-Klotzsche (Gleis 1)	ab	18.24	18.24	18.54	19.24	19.54	20.24	20.54	21.24	21.54	22.24	22.54	23.24	23.54
Dresden Industriegelände (Gleis 1)		18.27	18.27	18.57	19.27	19.57	20.27	20.57	21.27	21.57	22.27	22.57	23.27	23.57
Dresden-Neustadt (Gleis 2)	an	18.30	18.30	19.00	19.30	20.00	20.30	21.00	21.30	22.00	22.30	23.00	23.30	0.00
Dresden-Neustadt (Gleis 2)	ab	18.32	18.32	19.02	19.32	20.02	20.32	21.02	21.32	22.02	22.32	23.02	23.32	0.02
Dresden Mitte (Gleis 2)		18.35	18.35	19.05	19.35	20.05	20.35	21.05	21.35	22.05	22.35	23.05	23.35	0.05
Dresden Freiberger Straße (Gleis 2)		18.37	18.37	19.07	19.37	20.07	20.37	21.07	21.37	22.07	22.37	23.07	23.37	0.07
Dresden Hbf (Gleis 18)	an	18.39	18.39	19.09	19.39	20.09	20.39	21.09	21.39	22.09	22.39	23.09	23.39	0.09
Dresden Hbf (Gleis 18)	ab		18.41											
Dresden-Strehlen (Gleis 2)			18.44											
Dresden-Reick (Gleis 2)			18.46											
Dresden-Dobritz (Gleis 2)			18.49											
Dresden-Niedersedlitz (Gleis 2)			18.51											
Dresden-Zschachwitz (Gleis 2)			18.53											
Heidenau (Gleis 2)	an		18.55											
Heidenau (Gleis 2)	ab		18.55											
Heidenau Süd			18.58											
Heidenau-Großsedlitz			19.00											
Pirna	an		19.03											

7 = nur 9., 16., 23. Dez 2018; 1., 8. Dez 2019 57 = nicht 9., 16., 23. Dez 2018; 1., 8.. Dez 2019

Schedule from the venue to the airport



S 2 Pirna - Heidenau - Dresden Hbf - Flughafen Dresden

Gültig ab 09.12.2018

		MONTAG - FREITAG																					
ZUGNUMMER		32702	32704	32706	32708	32710	32712	32714	32716	32718	32720	32722	32724	32726	32728	32730	32732	32734	32736	32738	32740	32742	32744	32746
Pirna	ab			4.54	5.24	5.54	6.24	6.54	7.24	7.54	8.24	8.54	9.24	9.54	10.24	10.54	11.24	11.54	12.24	12.54	13.24	13.54	14.24	14.54
Heidenau-Großsedlitz				4.57	5.27	5.57	6.27	6.57	7.27	7.57	8.27	8.57	9.27	9.57	10.27	10.57	11.27	11.57	12.27	12.57	13.27	13.57	14.27	14.57
Heidenau Süd				4.59	5.29	5.59	6.29	6.59	7.29	7.59	8.29	8.59	9.29	9.59	10.29	10.59	11.29	11.59	12.29	12.59	13.29	13.59	14.29	14.59
Heidenau (Gleis 1)	an			5.01	5.31	6.01	6.31	7.01	7.31	8.01	8.31	9.01	9.31	10.01	10.31	11.01	11.31	12.01	12.31	13.01	13.31	14.01	14.31	15.01
Heidenau (Gleis 1)	ab			5.01	5.31	6.01	6.31	7.01	7.31	8.01	8.31	9.01	9.31	10.01	10.31	11.01	11.31	12.01	12.31	13.01	13.31	14.01	14.31	15.01
Dresden-Zschachwitz (Gleis 1)				5.03	5.33	6.03	6.33	7.03	7.33	8.03	8.33	9.03	9.33	10.03	10.33	11.03	11.33	12.03	12.33	13.03	13.33	14.03	14.33	15.03
Dresden-Niedersedlitz (Gleis 1)				5.06	5.36	6.06	6.36	7.06	7.36	8.06	8.36	9.06	9.36	10.06	10.36	11.06	11.36	12.06	12.36	13.06	13.36	14.06	14.36	15.06
Dresden-Dobritz (Gleis 1)				5.08	5.38	6.08	6.38	7.08	7.38	8.08	8.38	9.08	9.38	10.08	10.38	11.08	11.38	12.08	12.38	13.08	13.38	14.08	14.38	15.08
Dresden-Reick (Gleis 1)				5.10	5.40	6.10	6.40	7.10	7.40	8.10	8.40	9.10	9.40	10.10	10.40	11.10	11.40	12.10	12.40	13.10	13.40	14.10	14.40	15.10
Dresden-Strehlen (Gleis 1)				5.13	5.43	6.13	6.43	7.13	7.43	8.13	8.43	9.13	9.43	10.13	10.43	11.13	11.43	12.13	12.43	13.13	13.43	14.13	14.43	15.13
Dresden Hbf (Gleis 19)	an			5.16	5.46	6.16	6.46	7.16	7.46	8.16	8.46	9.16	9.46	10.16	10.46	11.16	11.46	12.16	12.46	13.16	13.46	14.16	14.46	15.16
Dresden Hbf (Gleis 19)	ab	4.18	4.48	5.18	5.48	6.18	6.48	7.18	7.48	8.18	8.48	9.18	9.48	10.18	10.48	11.18	11.48	12.18	12.48	13.18	13.48	14.18	14.48	15.18
Dresden Freiberger Straße (Gleis 1)		4.20	4.50	5.20	5.50	6.20	6.50	7.20	7.50	8.20	8.50	9.20	9.50	10.20	10.50	11.20	11.50	12.20	12.50	13.20	13.50	14.20	14.50	15.20
Dresden Mitte (Gleis 1)		4.22	4.52	5.22	5.52	6.22	6.52	7.22	7.52	8.22	8.52	9.22	9.52	10.22	10.52	11.22	11.52	12.22	12.52	13.22	13.52	14.22	14.52	15.22
Dresden-Neustadt (Gleis 1)	an	4.24	4.54	5.24	5.54	6.24	6.54	7.24	7.54	8.24	8.54	9.24	9.54	10.24	10.54	11.24	11.54	12.24	12.54	13.24	13.54	14.24	14.54	15.24
Dresden-Neustadt (Gleis 1)	ab	4.25	4.55	5.25	5.55	6.25	6.55	7.25	7.55	8.25	8.55	9.25	9.55	10.25	10.55	11.25	11.55	12.25	12.55	13.25	13.55	14.25	14.55	15.25
Dresden Industriegelände (Gleis 2)		4.28	4.58	5.28	5.58	6.28	6.58	7.28	7.58	8.28	8.58	9.28	9.58	10.28	10.58	11.28	11.58	12.28	12.58	13.28	13.58	14.28	14.58	15.28
Dresden-Klotzsche (Gleis 3)	an	4.32	5.02	5.32	6.02	6.32	7.02	7.32	8.02	8.32	9.02	9.32	10.02	10.32	11.02	11.32	12.02	12.32	13.02	13.32	14.02	14.32	15.02	15.32
Dresden-Klotzsche (Gleis 3)	ab	4.32	5.02	5.32	6.02	6.32	7.02	7.32	8.02	8.32	9.02	9.32	10.02	10.32	11.02	11.32	12.02	12.32	13.02	13.32	14.02	14.32	15.02	15.32
Dresden-Grenzstraße (Gleis 2)		4.36	5.06	5.36	6.06	6.36	7.06	7.36	8.06	8.36	9.06	9.36	10.06	10.36	11.06	11.36	12.06	12.36	13.06	13.36	14.06	14.36	15.06	15.36
Dresden Flughafen (Gleis 1)	an	4.39	5.09	5.39	6.09	6.39	7.09	7.39	8.09	8.39	9.09	9.39	10.09	10.39	11.09	11.39	12.09	12.39	13.09	13.39	14.09	14.39	15.09	15.39

		MONTAG - FREITAG																						
ZUGNUMMER		32748	32748	32750	32750	32752	32752	32754	32754	32756	32756	32758	32758	32760	32760	32762	32762	32764	32764	32766	32766	32768	32768	32770
VERKEHRSHINWEIS		W	WJ	W	WJ	W	WJ	W	WJ	W	WJ	W	WJ	W	WJ	W	WJ	W	WJ	W	WJ	W	WJ	W
Pirna	ab	15.24		15.54		16.24		16.54		17.24		17.54		18.24		18.54		19.24		19.54		20.24		20.54
Heidenau-Großsedlitz		15.27		15.57		16.27		16.57		17.27		17.57		18.27		18.57		19.27		19.57		20.27		20.57
Heidenau Süd		15.29		15.59		16.29		16.59		17.29		17.59		18.29		18.59		19.29		19.59		20.29		20.59
Heidenau (Gleis 1)	an	15.31		16.01		16.31		17.01		17.31		18.01		18.31		19.01		19.31		20.01		20.31		21.01
Heidenau (Gleis 1)	ab	15.31		16.01		16.31		17.01		17.31		18.01		18.31		19.01		19.31		20.01		20.31		21.01
Dresden-Zschachwitz (Gleis 1)		15.33		16.03		16.33		17.03		17.33		18.03		18.33		19.03		19.33		20.03		20.33		21.03
Dresden-Niedersedlitz (Gleis 1)		15.36		16.06		16.36		17.06		17.36		18.06		18.36		19.06		19.36		20.06		20.36		21.06
Dresden-Dobritz (Gleis 1)		15.38		16.08		16.38		17.08		17.38		18.08		18.38		19.08		19.38		20.08		20.38		21.08
Dresden-Reick (Gleis 1)		15.40		16.10		16.40		17.10		17.40		18.10		18.40		19.10		19.40		20.10		20.40		21.10
Dresden-Strehlen (Gleis 1)		15.43		16.13		16.43		17.13		17.43		18.13		18.43		19.13		19.43		20.13		20.43		21.13
Dresden Hbf (Gleis 19)	an	15.46		16.16		16.46		17.16		17.46		18.16		18.46		19.16		19.46		20.16		20.46		21.16
Dresden Hbf (Gleis 19)	ab	15.48	15.48	16.18	16.18	16.48	16.48	17.18	17.18	17.48	17.48	18.18	18.18	18.48	18.48	19.18	19.18	19.48	19.48	20.18	20.18	20.48	20.48	21.18
Dresden Freiberger Straße (Gleis 1)		15.50	15.50	16.20	16.20	16.50	16.50	17.20	17.20	17.50	17.50	18.20	18.20	18.50	18.50	19.20	19.20	19.50	19.50	20.20	20.20	20.50	20.50	21.20
Dresden Mitte (Gleis 1)		15.52	15.52	16.22	16.22	16.52	16.52	17.22	17.22	17.52	17.52	18.22	18.22	18.52	18.52	19.22	19.22	19.52	19.52	20.22	20.22	20.52	20.52	21.22
Dresden-Neustadt (Gleis 1)	an	15.54	15.54	16.24	16.24	16.54	16.54	17.24	17.24	17.54	17.54	18.24	18.24	18.54	18.54	19.24	19.24	19.54	19.54	20.24	20.24	20.54	20.54	21.24
Dresden-Neustadt (Gleis 1)	ab	15.55	15.55	16.25	16.25	16.55	16.55	17.25	17.25	17.55	17.55	18.25	18.25	18.55	18.55	19.25	19.25	19.55	19.55	20.25	20.25	20.55	20.55	21.25
Dresden Industriegelände (Gleis 2)		15.58	15.58	16.28	16.28	16.58	16.58	17.28	17.28	17.58	17.58	18.28	18.28	18.58	18.58	19.28	19.28	19.58	19.58	20.28	20.28	20.58	20.58	21.28
Dresden-Klotzsche (Gleis 3)	an	16.02	16.02	16.32	16.32	17.02	17.02	17.32	17.32	18.02	18.02	18.32	18.32	19.02	19.02	19.32	19.32	20.02	20.02	20.32	20.32	21.02	21.02	21.32
Dresden-Klotzsche (Gleis 3)	ab	16.02	16.02	16.32	16.32	17.02	17.02	17.32	17.32	18.02	18.02	18.32	18.32	19.02	19.02	19.32	19.32	20.02	20.02	20.32	20.32	21.02	21.02	21.32
Dresden-Grenzstraße (Gleis 2)		16.06	16.06	16.36	16.36	17.06	17.06	17.36	17.36	18.06	18.06	18.36	18.36	19.06	19.06	19.36	19.36	20.06	20.06	20.36	20.36	21.06	21.06	21.36
Dresden Flughafen (Gleis 1)	an	16.09	16.09	16.39	16.39	17.09	17.09	17.39	17.39	18.09	18.09	18.39	18.39	19.09	19.09	19.39	19.39	20.09	20.09	20.39	20.39	21.09	21.09	21.39

Airport connections: https://www.dresden-airport.de/passengers-and-visitors/to-and-from-the-airport-parking/rail-and-bus.html?newLanguage=en

Local public transport – Dresdner Verkehrsbetriebe: https://www.dvb.de/en-gb/

3 Workshop Schedule

3.1 Monday, 25th March 2019

10:00-11:00	**Get together with coffee and tea / Workshop registration and formalities** at Penck Hotel Dresden, Ostra-Allee 33, 01067 Dresden	
11:00-11:30	Berendonk, Thomas	*Institute of Hydrobiology, Technische Universität Dresden, Germany* Welcome speech: **Conservation of freshwater mussels by a combined approach of research and implementation**
11:30-12:00	Geist, Jürgen	*Aquatic Systems Biology Unit, Technische Universität München, Germany* Opening speech: **Conservation of European Freshwater Pearl Mussel – current knowledge and future directions**
Session: Ecology of freshwater mussels		
12:00-13:00	Araujo, Rafael	*Museo Nacional de Ciencias Naturales-C.S.I.C., Spain* Keynote speech: **Conservation of freshwater mussels: taxonomy, captive breeding and wild restoration**
13:00-14:00	LUNCH	
14:00-14:20	Taskinen, Jouni	*Department of Biological and Environmental Sciences, University of Jyväskylä, Finland* **Local spatio-temporal dynamics in *Margaritifera margaritifera* / *Salmo trutta* relationship**
14:20-14:40	Zapitis, Charitos	*School of Environmental Sciences, University of Derby, Derby, UK* **Behavioural responses of the Unionids *Unio pictorum* and *Anodonta anatina* to light availability and their ecological importance**

14:14-15:00	Skujienė, Grita	*Vilnius University, Life Sciences Center, Institute of Biosciences, Lithuania* Variation of thick shelled river mussel *Unio crassus* Philipsson, 1788 in Lithuania in respect to habitat characteristics
15:00-15:20	Belamy, Tiare	*University of Bordeaux, Équipe Écotoxicologie Aquatique, France* Acute toxicity of sodium chloride, nitrates, phosphates, cadmium and arsenic to freshwater pearl mussel juveniles (*Margaritifera margaritifera*)
15:20-15:50	COFFEE BREAK	
15:50-16:10	Soler, Joaquín	*Museo Nacional de Ciencias Naturales-C.S.I.C., Spain* New advances toward the conservation of *Margaritifera auricularia* (Spengler 1793) in France
Session: Nutritional requirements of freshwater mussels		
16:10-16:40	Brauns, Mario	*Department River Ecology, Helmholtz Centre for Environmental Research GmbH – UFZ, Germany* Quantifying the diet of the freshwater pear mussel (*Margaritifera margaritifera*) using stable isotopes ($\delta^{13}C$, $\delta^{15}N$)
16:40-17:00	Lavictoire, Louise	*Freshwater Biological Association, Cumbria, UK* Feeding and filtration rates in juvenile freshwater mussels
17:00-18:00	Poster session	
From 19:00	Reserved table for people who would like to meet, eat and talk together at **Altmarktkeller Dresden** (→ wine tavern), Altmarkt 4, 01067 Dresden (just a 15-minutes-walk from the venue) https://www.altmarktkeller.de/	

3.2 Tuesday, 26th March 2019

Session: Quantitative characterisation and assessment of mussel habitats		
09:00-10:00	Moorkens, Evelyn	*Department of Zoology, Trinity College, Dublin, Ireland* Keynote speech: **Practical assessment methodologies for the evaluation and monitoring of *Margaritifera* habitats and their condition**
10:00-10:20	Kladivová, Vera	*T. G. Masaryk Water Research Institute, Czech Republic* **Chemical, hydromorphological, and other environmental parameters of optimal habitats for the freshwater pearl mussel: Czech experience**
10:20-10:40	Schiller, Thomas	*Institute of Hydrobiology, Technische Universität Dresden, Germany* **Comparison of different bioindication methods with captive-bred juvenile freshwater pearl mussels to identify suitable habitats for their release into the wilderness**
10:40-11:10	COFFEE BREAK + Poster Session	
11:10-11:30	Killeen, Ian	*Malacological Services, Greystones, County Wicklow, Ireland* **How juvenile habitat mapping can be used to assess the sustainability of a *Margaritifera* population**
11:30-11:50	Simon, Ondrej P.	Faculty of Environmental Sciences, Czech University of Life Sciences Prague, Czech Republic **Long-term catchment restoration of the Blanice River Nature Reserve - Is it possible to reverse anthropogenic eutrophication in a freshwater pearl mussel protected area?**
11:50-12:10	Höß, Rebecca	*Aquatic Systems Biology Unit, Department of Ecology and Ecosystem Management, Technische Universität München, Germany* **Impact of fish ponds on sediment deposition and habitat quality of freshwater pearl mussels**

12:10-12:30	Vandré, Robert	Schmidt & Partner GbR, Germany **The Assessment of siltation: from single stream patches to whole catchments**
12:30-13:30	Group picture of the workshop participants LUNCH	
13:30-13:50	Bayerl, Helmut	*Aquatic Systems Biology Unit, Technische Universität München, Germany* **Habitat assessment as a prerequisite in freshwater mussel conservation: methodologies and implications using the example of the Painter`s mussel (*Unio pictorum*, Linnaeus 1758)**
Session: Selection of suitable habitats		
13:50-14:40	Capoulade, Marie	*Bretagne Vivante, Brest Cedex, France* Keynote speech: **Habitat selection for freshwater pearl mussels resettlement in Brittany (France)**
14:40-15:00	Daill, Daniel	*Consultants in Aquatic Ecology and Engineering (blattfisch e.U.) – Wels, Austria* **Selection of habitats for resettlement – the strategy in the Austrian freshwater pearl mussel project**
15:00-15:30	COFFEE BREAK + Poster session	
15:30-15:50	Denic, Marco	*Landschaftspflegeverband Passau, Germany* **Freshwater pearl mussel conservation in Lower Bavaria, Germany – stories about breeding and releasing juveniles**
15:50-16:10	Ożgo, Małgorzata	*Department of Evolutionary Biology, Kazimierz Wielki University, Bydgoszcz, Poland* **Assessment of mussel relocation as a conservation and management strategy**

16:10-16:20	Explanations regarding the social evening
16:20-17:10	Poster session
17:30	Guided walk to the levy of the steam boat MS “August der Starke”
18:00	Boarding and official social evening with dinner on the boat (food and drinks included)
21:30	Return to the levy

M. margaritifera adults in Saxony, Germany (Foto: F. Grunicke)

3.3 Wednesday, 27th March 2019

Session: Evaluation of captive-bred mussel release		
09:00-09:50	Österling, Martin	*Karlstad University, Sweden* Keynote speech: **Reintroduction and the importance of mussel-host fish interactions**
09:50-10:10	Capoulade, Marie	*Bretagne Vivante, Brest Cedex, France* **Resettlement of young freshwater pearl mussels in Brittany (France)**
10:10-10:40	COFEE BREAK + Poster Session	
Session: Significance of global warming for freshwater mussels		
10:40-11:40	Bespalaya, Yulia V.	*Institute of Biogeography and Genetic Resources, Federal Center for Integrated Arctic Research, Russian Academy of Sciences, Arkhangelsk, Russia* Keynote speech: **Climate warming as a possible trigger of freshwater pearl mussel population decline in oligotrophic rivers throughout Europe**
11:40-12:00	Reis, Joaquim	*MARE - Marine and Environmental Sciences Centre Faculdade de Ciências da Universidade de Lisaboa, Portugal* **Project MUSSELFLOW: Host-dependent evolution, ecology and conservation of freshwater mussels under varying hydrological conditions: consequences of climate change.**
12:00-12:20	Wagner, Annekatrin	*Institute of Hydrobiology, Technische Universität Dresden, Germany* **Possible consequences of climate warming on survival and growth of juvenile freshwater pearl mussels in Vogtland (Germany)**

12:20-12:30	Berendonk, Thomas	*Institute of Hydrobiology, Technische Universität Dresden, Germany* Official farewell
12:30-13:30	LUNCH & Official end of the workshop	

3.4 Overview poster sessions

Monday, 25th March 2019 (17:00-18:00)
Tuesday, 26th March 2019 (10:40-11:10, 15:00-15:30 and 16:20-17:10)
Wednesday, 27th March 2019 (10:10-10:40)

Posters will be on display throughout the meeting.

First author	Title
Barak, V.	*Faculty of Environmental Sciences, Czech University of Life Sciences Prague, Czech Republic* Evaluation of suitable mussel habitats with bioindication mesh cages: Case study from three rivers in the Czech Republic
Dobler, A.	*Aquatic Systems Biology Unit, Technische Universität München, Germany* A spatial conservation prioritization approach for two endangered freshwater mussel species in Bavaria, Germany
Hasenbein, M.	*Aquatic Systems Biology Unit, Technische Universität München, Germany* The Bavarian mussel coordination office: Bridging the gap between science and applied mussel conservation
Horácková, J.	*T. G. Masaryk Water Research Institute, Czech Republic* INTERREG (Austria – Czech Republic) project "Malsemuschel": Support of the natural environment of the freshwater pearl mussel (*Margaritifera margaritifera*) and its occurrence in the upper Malše River catchment (Austria / Czech Republic)
Horická, Z.	*T. G. Masaryk Water Research Institute, Czech Republic* EU project strengthening and protection of the freshwater pearl mussel population in the Šumava National Park (Bohemia, Czech Republic)
Lavictoire, L.	*Freshwater Biological Association, Cumbria, UK* Investigations into feeding structures of juvenile freshwater pearl mussels (*Margaritifera margaritifera*) through scanning electron microscopy
Leigh-Moy, K.	*Graduate Placement- Freshwater Pearl Mussels, Scottish Natural Heritage, Scotland* Improving the status of freshwater pearl mussel in the upper River Spey: habitat & population density factors

Schmidt, C.	*Schmidt & Partner GbR, Germany* The first successful resettlement of *Margaritifera m.* in Bavaria: Evidence for the need of long-term monitoring data
Selheim, H.	*Biologische Station StädteRegion Aachen e.V., Germany* 15-year experience of saving the last freshwater pearl mussel (*Margaritifera margaritifera*) population in North Rhine-Westphalia, Germany
Vaessen, Q.	*University of Liege – LHGF, Belgium* What is a suitable microhabitat for *Unio crassus* ?

4 Welcome speech

Thomas Berendonk

Institution:
Institute of Hydrobiology,
Technische Universität Dresden, Germany

Currently research field, projects and studies:
Thomas Berendonk leads the professorship limnology since 2008 and is head of the Institute of Hydrobiology at Technische Universität Dresden.

His current research topics include for example: evolution of antibiotic resistances in anthropogenically influenced aquatic systems and generally ecology and evolution in freshwatersystems especially abiotic stressors affecting the genetic diversity of freshwater populations. The impact of (fish) neobiota and their spread and distribution. Finally, he is interested in the maintenance and reestablishment of endangered species and is therefore also the project leader of the freshwater mussel conservation project ArKoNaVera.

Interests:

Beyond the above research questions he interested in fish biology and fly fishing, but he has also a strong interest in entomology. Furthermore, he enjoys working on relevant issues in research teams and is consequently involved in several international networks and research teams throughout Europe and beyond.

4.1 Conservation of freshwater mussels by a combined approach of research and implementation

Thomas Berendonk[1], Jana Schneider[1], Annekatrin Wagner[1], Thomas Schiller[1], Sascha Krenek[1], Felix Grunicke[1]

[1]*Institute of Hydrobiology, Technische Universität Dresden, Germany*

Corresponding author: thomas.berendonk@tu-dresden.de

Freshwater mussels were previously abundant in running waters. For several decades mussel stocks decreased dramatically. Most of the current freshwater pearl mussel stocks are immediately threatened. Only due to captive breeding programs in the last 15 years the freshwater pearl mussel population of Weiße Elster River Basin was saved from extinction. More than 5000 individuals were reared to an age of at least five years and released into the most suitable stream sections.

Within the joint project ArKoNaVera advanced concepts are being developed for both, evaluation of already undertaken conservation measures and implementation of new reintroduction or resettling activities for captive-bred juvenile freshwater pearl mussels. The comprehensive goals of the joint project including in particular: the restoration of their natural life cycle, the conservation of genetic diversity and the identification of suitable mussel habitats. Particularly for the Saxony's Vogtland region captive-bred juvenile freshwater pearl mussels of different ages and genetic lines are available in this context. Recently, some of them have simultaneously been utilized as bioindicators for assessing habitat quality before their release. However, suitable reintroduction/resettlement habitat areas are urgently needed as well as short decision paths by authorities to ensure the designation of protected zones and finally to ensure the natural reproduction of these juvenile mussels because the oldest are now in a reproductive age.

For a successful freshwater mussel conservation approach, it is crucial to combine substantial research and long-term experience in practical implementation. Continuous dialogues between basic science and practice are essential to support the conservation management strategies.

5 Opening speech

Jürgen Geist

Institution:
Chair of Aquatic Systems Biology,
Technical University of Munich, Germany

Currently research field, projects and studies:
Aquatic ecology and conservation, fish and mussel biology, conservation genetics, ecotoxicology, invasion biology, effects and interactions of stressors on ecosystem functioning (e.g. landuse, hydropower)

Interests:
nature, hiking, fishing, cooking

5.1 Conservation of European Freshwater Pearl Mussel – current knowledge and future directions

Geist, Jürgen

Chair of Aquatic Systems Biology, Technical University of Munich, Germany

Corresponding author: geist@wzw.tum.de

The key roles of freshwater mussels in the functioning of freshwater ecosystems are increasingly recognized and there is a large number of projects addressing their conservation. This is particularly true for European freshwater pearl mussel (*Margaritifera margaritifera*) which is one of the main target species of mussel conservation in Europe, at the same time fulfilling the criteria of indicator, flagship, umbrella and keystone species. Restoration of mussel habitats and populations depends on accurate information concerning the habitat requirements throughout the different stages of the entire life cycle to mitigate bottlenecks most efficiently and to ensure sustainable populations in the future.

This contribution summarizes current knowledge on the ecology and genetics of freshwater pearl mussel in Europe and North America. It also suggests future directions of research and applied conservation. In contrast to most other Unionids, the distribution and the life cycle of *Margaritifera margaritifera* are well understood. The early post-parasitic phase in the streambed has been identified as the main bottleneck in most European populations. There is also an increased understanding of the importance of locally adapted fish hosts that co-evolved with freshwater pearl mussels as well as of how temperature and climate change effects may affect the fish host – mussel interaction. The recently developed European CEN standard on pearl mussel provides guidance on internationally agreed monitoring protocols as well as on assessing potential impacts of any action in the stream or catchment on populations and habitats. A large number of pearl mussel populations from the entire distribution range has already been genetically analysed revealing useful information on post-glacial colonization patterns, population history, the identification of conservation units, priority populations for conservation and captive breeding. There is also increasing experience on the captive rearing of freshwater pearl mussels and the use of juveniles as bioindicators for assessing habitat quality before their release.

In contrast, there is limited experience in successful habitat restoration in the wild, except for the Lutter in Northern Germany where holistic catchment management resulted in population recovery. Conservation of the most intact pearl mussel populations that remain and that are genetically unique should always be top priority. Second, habitat restoration and population augmentation by captive breeding need to go hand in hand, following pre-defined criteria of prioritization. Conservation management decisions need a more rigorous discussion and evaluation of the effects of population augmentation and assisted migration, both of which would in turn benefit from the development and validation of more advanced tracking methods of released mussels. Ecological niche models and spatially explicit approaches can help identify conservation conflicts with other species and help take decisions on assessing management of protected areas. Such approaches can also be useful in predicting trends in extant populations as well as in predicting the most suitable habitat areas under future climatic change. Generally, a more evidence-based conservation approach and more rigorous reporting of both failures and successes in conservation attempts of habitat restoration and rearing are essential.

6 Session: Ecology of freshwater mussels

Keynote speaker:

Rafael Araujo

Institution:
Museo Nacional de Ciencias Naturales-CSIC, Spain

Currently research field, projects and studies:
Doctor in Biological Sciences in 1995. He has published over 100 scientific articles and has collaborated or directed 20 national and international projects on biodiversity and conservation of freshwater mollusks. He has been invited to give numerous lectures on the subject of his specialty and has coordinated dozens of molluscs prospecting campaigns.
His greatest dedication in recent years has been to publicize the conservation of large freshwater bivalves. He has also directed three doctoral thesis and several video documentaries on biodiversity that have won national and international awards.
He works at the Museo Nacional de Ciencias Naturales-CSIC (Madrid, Spain) since 1985.

Interests:
Biodiversity of freshwater mussels: Conservation. Reproductive biology. Captive breeding. Taxonomy and Phylogeny.

6.1 Conservation of freshwater mussels: taxonomy, captive breeding and wild restoration

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Among the many victims of global biodiversity loss in the Anthropocene, freshwater mussels species of the world are between the most endangered fauna, due to the conservation problems affecting freshwater ecosystems.

In the West Palaearctic (Europe and the North of Africa) live two families of naiads: *Margaritiferidae*, with three native species of the genus *Margaritifera*, and *Unionidae*, with three species of *Potomida*, one of *Microcondylaea*, one of *Pseudanodonta* and, at least, two species of *Anodonta* and 15 of *Unio*. Although there are, probably, some populations out of danger, practically all these species need conservation measures in order to survive for the future.

All unionoid mussels need a host fish for the development of their glochidia. The decline of these hosts, also related with habitats changes, is already causing a drastic effect on the mussels. The implementation of corrective measures for freshwater habitats is becoming more difficult in a world in constant change; one example of this is the great changes that are now taking place in the large rivers of Morocco.

One of the more used conservation measures to help endangered mussels is captive breeding. To do this, once we have selected the mussel species, it is basic to know its reproductive strategy, glochidial release season and host fish.

Nevertheless, captive breeding is not the best help action for naiad conservation, but occasionally, it would be the only actual option. In the best cases, this measure should be completed with successful species propagation in the wild and restoration of the habitat, being the last the more important and difficult strategy. In this conference, I will review the taxonomical studies published of the different West Palaearctic freshwater mussels species, with data about their distribution and threats. Then, I will show a summary of mussel captive breeding and habitat restoration programmes, with emphasis in the problems that are still not yet solved.

6.2 Local spatio-temporal dynamics in *Margaritifera margaritifera / Salmo trutta* relationship

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We investigated seasonally the spatial occurrence of the fish host, 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 Barents Sea, Arctic Ocean. This 3 km long river was first divided into 46 sections and investigated for the occurrence of pearl mussels.

Then 12 sections with the highest mussel density (4-34 ind./m^2) were assigned as "mussel sites" and 12 non-mussel sections as "control sites". Seasonal electro fishing was performed every 3rd week from May 27 to September 22, 2009 (9 sampling points).

Highest water temperature, 16.9 °C, was observed on July 29. All sampling points combined, the mean density of trout was higher in control sites (24 ind/m^2) than in mussel sites (15 ind/m^2). In May, trout were in the lower reaches of the river, so that none of them were at the mussel sites. Then fish started to come back, and the proportion of trout caught from the mussels sites increased, reaching the highest level, 55 %, at the end of July—exactly at the time when the fully developed glochidia started to drop from the gills of trout. 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). New glochidia were released by mussels and attached to trout in early August. There was a positive correlation between mussel density and glochidia abundance in fish after the emergence of new glochidia in autumn (in mussels sites)—suggesting that the intensity of glochidia infestation 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 juvenile mussels dropped from the fish to mussel sites was 9 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.

Overall, the results indicate a fine tuned, local, spatio-temporal dynamics in the relationship between trout and pearl mussel, leading to overlap of mussel habitat and trout habitat (especially habitat of glochidia-infested trout) at the critical moment of glochidia detachment from fish, which will translate into settlement of juvenile mussels mainly to the mussel habitat.

6.3 Behavioural responses of the Unionids *Unio pictorum* and *Anodonta anatina* to light availability and their ecological importance

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Benthic bivalve filter feeders are considered to have a strong water purification potential. This potential relies on the balance of filtration, biodeposition, excretion and bioturbation. In mobile bivalves, such as unionids, locomotion results in sediment mixing and nutrient release. The environmental drivers of locomotion are highly understudied creating a gap in the knowledge associated with bioturbation. The influence of diurnal rhythm and light availability on locomotion behaviour can reveal information on unionid adaptations to their environment and species-specific purification potential. This study examines the behavioural responses of *Unio pictorum* and *Anodonta anatina* to light availability and intensity.

The diurnal rhythm of *U. pictorum* was assessed in 9 47-hour experiments each using 8 specimens with the light provided between 06:00 and 22:00 by a fluorescent tube placed on top of the tank. Vertical photographs of mussels' position were taken at 06:00, 14:00 and 22:00 before feeding with the unicellular algae Chlorella vulgaris at a concentration of 0.1 mg of Ash Free Dry Weight l-1. 29 movements were recorded. The probability theory analysis showed significant differences between locomotion activity in the two light periods (06:00- 14:00, 14:00-22:00) and the dark period (22:00-06:00) ($p < 0.01$). The locomotion distance ranged between 3.8 and 113.0 cm with linear regression showing no significant difference among the periods ($p < 0.05$) and mussel shell length ($p < 0.05$).

Light intensity was assessed or each unionid species in a 96-hour experiment. 8 specimens of each species were placed in a tank parallel to the light source in 3 rows (n=24) at high- (29.0 cm distance, ~ 1085 lux), intermediate- (80.2 cm, ~ 437 lux) and low- (115.4 cm, ~ 232 lux) intensity. From 06:00 to 22:00, light was provided by a fluorescent tube placed horizontally on the side of the tank giving an intensity range between 1630 and 170 lux. Vertical photographs were taken daily at 13:00 before feeding the mussels C. vulgaris at a concentration of 0.2 mg of Ash Free Dry Weight l-1. Mussel position was derived from image analysis. *U. pictorum* showed weak positive phototaxis—strongest negative phototaxis 14.6 cm, median 3.3 cm, mean 3.5 cm, strongest positive 18.7 cm. *A. anatina* showed prominent positive phototaxis—strongest negative 21.8 cm, median 1.3 cm, mean 11.3 cm and strongest positive 102.5 cm. In both species the low-intensity group showed the strongest and the high-intensity group the weakest positive phototaxis suggesting that a light intensity of 200-300 lux is more likely to trigger locomotion responses towards light than higher intensities.

The results show that both light availability and intensity affect mussel locomotion. The species-specific differences are discussed in relation to their ecological niche, predator avoidance strategies, monitoring, and remediation potential in eutrophic ponds.

6.4 Variation of thick shelled river mussel *Unio crassus* Philipsson, 1788 in Lithuania in respect to habitat characteristics

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The thick-shelled river mussel, *Unio crassus* Philipsson, 1788 is one of Europe's threatened mussels. The information on the growth and age of this endangered mussel is crucial to correctly asses the conservation status in particular populations.

In 2016 *Unio crassus* Philipsson, 1788 was observed in 58 rivers in Lithuania and we selected 15 of studied rivers based on the available data of the hydrochemical parameters from the Environmental Monitoring of The Environmental Protection Agency of Lithuania, choosing the ones with a large amount of data including the latest years. The hydrochemical data of the nearest Environmental Monitoring points to molluscs' observation sites were analysed. Growth determination consisted on taking measurements of the length, width and height, while the age determination was carried out firstly by counting the annual shell growth increments by eye, and secondly in thin shell cross-sections made with a diamond blade from the umbo to the ventral margin of the dextral valve of each specimen. Cross-sections were done in the Department of Geology and Mineralogy of Vilnius University.

Fig. 1. Bright coloration of shells. From the left: U. *tumidus, U. pictorum* and *U. crassus*.
Photo by Remigijus Karpuška.

The studied rivers have a varied character, with sections potentially meeting the habitat requirements of *U. crassus*. It was hard to assess populations' trends of species as *U. crassus* lived in short sections of the river, separated from each other at different distances from a few hundred meters to a few or a few dozen kilometers. The best ecological status of rivers was established in the areas of eastern and south-eastern and western Lithuania as at least affected by human activity in Minija, Jūra, Saria, Širvinta (Šventoji), Merkys rivers. Most of the water quality problems in surface water bodies were found in intensive agricultural areas of north, central and south-western Lithuania: in Širvinta (Vilkaviškis), Mūša, Pyvesa, Tatula rivers. The

maximal abundance of molluscs in studied rivers ranged from 16 to 105 ind./m^2, but molluscs' populations were fragmented. Mean flow velocities was 0,44 m/s but it very variated in different sites of rivers and ranged even from 0.08 to 5.43 m/s. In the slowest sections of the rivers U. crassus was absent but in general it showed a very high toleration to environmental conditions: the water was alkaline (pH varied between 7.2 and 8.4, mean 7.9); dissolved oxygen reached 9 mg O_2/l (from 6.74 to 11 mgO_2/l), the biggest nitrogen concentrations were found in Mūša (NH4 till 3.043 mg N/l, NO_2 till 0.157 mg N/l, NO_3 till 5.821 mg N/l) where it was found the biggest shells (83 x 33 x 44 mm).

Although usually references state that *U. crassus* shell is very dark, almost black, it was found quite bright colorations (Fig.1) of shells and it was observed that majority of dark shells after gently cleaning of the surface by worm water and sponge presented lighter colours that it seemed in the beginning, dark colour was caused by a deposit of sediment in the shell surface. Majority of the youngest shells were the brightest and the oldest ones were the darkest. Sediment amount on the shells depends on the river chemical parameters.

Acknowledgement. We thank for the help in the monitoring performance D. Augutis, R. Karpuška, A. Gintaras, D. Bastytė, G. Vaivilavičius, J. Skuja, G. Švitra, R. Staponkus. Monitoring was financed by the European regional development Fund of the Republic of Lithuania and the State budget, by the European Union's program of investment funds 5 priority "Environment, sustainable use of natural resources and adaptation to climate change"
05.5 .1-EPMA-V-018 instrument for biodiversity protection. N. Sanía Ibáñez study was supported by the ERASMUS+ fund.

6.5 Acute toxicity of Sodium Chloride, Nitrates, Phosphates, Cadmium and Arsenic to Freshwater Pearl Mussel juveniles (*Margaritifera margaritifera*)

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Margaritifera margaritifera is one of the most endangered mollusk species in Europe. The population of this freshwater pearl mussel has been declining since the 20th century due to pearl fishing, alteration of the water quality, habitat degradation, decline of the fish host or pollution. Several programs have been set up in order to preserve this species by restoring habitats and by the application of captive breeding techniques. However, there's a lack of knowledge on the sensitivity of this species to environmental and contamination factors. As part of the European LIFE Project (LIFE 13 NAT/FR/000506) which aims to preserve the most important French population of *Margaritifera margaritifera* (Dronne River – Dordogne), a part of the production from captive breeding facility is used for ecotoxicological studies.

This work deals with the acute toxicity of Sodium Chloride (NaCl), Nitrates (NO^{3-}), Phosphates (PO_4^{3-}), Cadmium (Cd) and Arsenic (As) to juveniles of this species. Acute toxicity tests were carried out on 10 to 21 months old juveniles in order to assess the toxicity thresholds of those toxicants and to compare the sensibility according to age. First, the experimental protocol has been developed using Sodium Chloride as reference toxicant. After that, the use of a substrate (silicate sand) for experiments has been studied compared to conditions without any as preconized by the American Society for Testing and Materials (ASTM) Standard guide for conducting laboratory toxicity tests with freshwater mussels. The toxicity threshold obtained for NaCl reveals a greater sensibility of *M. margaritifera* juveniles than for some other species of freshwater mussels. Also, results showed that juveniles aged from 10 to 21 months were tolerant to high concentrations of NO^{3-}, PO_4^{3-}, Cd and As. Moreover, the comparison of sensibility in function of age reveals that younger juveniles were more sensitive than older individuals. The use of sand for acute toxicity tests has no impact on water quality, toxicants concentrations and results, validating our method of exposure in more realistic conditions for burrowing mussels. This study allowed us to improve our knowledge about this endangered species and showed that ecotoxicological studies could be a complementary approach for helping conservation strategies since it gives us useful data for targeting reintroduction areas.

	Toxicants	Age of organisms (months)	Substrate	Total number of organisms	LC_{50} 48h	LC_{50} 96h	Units
NaCl	Sodium Chloride	10	Yes	120	1,1 (0,87 - 1,33)	ND	g/L
NaCl	Sodium Chloride	21	No	120	> 1,6	1,19 (1,11 - 1,28)	g/L
NaCl	Sodium Chloride	21	Yes	120	1,5 (1,35 - 1,66)	1,33 (1,24 - 1,42)	g/L
NO_3^-	Nitrates	13	Yes	120	> 2290	1000 - 1500	mg/L
PO_4^{3-}	Phosphates	13	Yes	120	> 5,01	> 5,01	mg/L
$CdCl_2$	Cadmium	15	Yes	120	> 112	> 112	µg/L
$CdCl_2$	Cadmium	21	No	120	> 147	> 147	µg/L
$CdCl_2$	Cadmium	21	Yes	120	> 110	> 110	µg/L
As_2O_5	Arsenic	16	Yes	96	> 127	> 127	µg/L

Median lethal concentrations for survival of juvenile mussels (*M. margaritifera*) in different toxicity tests. The use of substrate, the age of organisms and the total number of organisms used are also describe in this table. Numbers in parentheses represent 95% confidence intervals.

6.6 New advances toward the conservation of *Margaritifera auricularia* (Spengler 1793) in France

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Margaritifera auricularia is considered one of the rarest and the most imperilled freshwater bivalve species in Europe. The population decline in the last two centuries has been estimated to be over 90%, and today, it is nearly extinct with only a few remaining populations in Spain (Ebro Basin) and France (Loire, Charente, Garonne and Adour basins).

Despite harboring approximately 90% of the world population, the species has not been enough studied in France and there are still important knowledge gaps that hinder their effective conservation. Here we summarize some of the most significant advances that have been achieved within the framework of the LIFE project 'LIFE13 BIO/FR/001162 Conservation of the Giant Pearl Mussel in Europe' between 2015 and 2017, including the identification of the reproductive period, new host species and the results of the first experiences of captive breeding of juveniles of *M. auricularia* in France.

7 Session: Nutritional requirements of freshwater mussels

7.1 Quantifying the diet of the freshwater pear mussel (*Margaritifera margaritifera*) using stable isotopes ($\delta^{13}C$, $\delta^{15}N$)

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The freshwater pear mussel (FPM) is one of the most threatened freshwater species in Europe. Despite this status, surprisingly little is known about its feeding ecology. We compared resource use of two populations of FPM using stable isotopes of carbon (δ13C) and nitrogen (δ15N). For that, FPM and its potential food resources were sampled from two headwater streams in Saxony (Germany). Stable isotope data were analysed using a nested Bayesian mixing model with 'tissue type' and 'individual' to examine which factor explains more of the variation in FPM's diet. Similarly, we used Bayesian mixing models to analyse FPM's diet of the two populations. Nested models showed that up to 5-times more variation in FPM's diet was explained by 'tissue type' than by 'individual' suggesting that tissue has to be taken into account when isotopes are used to estimate FPM's diet. Mixing models showed that 50% of the FPM's diet originated from terrestrial sources whereas autochthonous sources contributed on average 12% to FPM's diet. Given the significant contribution of terrestrial subsidies to FPM's diet, our results demonstrate the importance of terrestrial-aquatic linkages for the food supply of FPM.

Detritus for captive breeding of *M. margaritifera* juveniles (Foto: F. Grunicke)

7.2 Feeding and filtration rates in juvenile freshwater mussels

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Little is known about natural diet of endangered freshwater mussel species although propagation programmes both in the USA and in Europe are utilising both commercially available algae e.g. Shellfish diet, *Nanno* sp. (Reed Mariculture, California, USA) and 'home-grown' cultured algae to grow juvenile mussels destined for reintroduction e.g. Gatenby et al., (2003).
Following the findings that juvenile mussels begin to undergo the transformation from pedal- to filter-feeding around 1.1 mm shell length (Araujo et al., 2018; Lavictoire et al., 2018), the authors investigated whether gill transformation affected the filtration rate of North American juvenile freshwater mussels. Here we describe a method to analyse the filtration rate of individual mussels using different sized fluorescent microspheres (6 and 10 µm). We found that filtration rates between individual mussels varied widely, particularly in individuals <1 mm shell length, but there was no step-change in filtration rate following the onset of gill transformation. The largest individual studied (7.8 mm) had a clearance rate of 27 ml/hour, which equated to the removal of almost 34,000 6 µm particles per hour.
Additionally, the gape limitation (i.e. maximum particle size individuals could consume) was investigated in several species of newly-metamorphosed (excysted) juveniles to inform decisions about the size of particles which are suitable for the smallest juveniles. All species investigated could consume particles up to 10.2 µm diameter, and preliminary evidence suggests small juveniles cannot consume particles measuring 20 µm diameter (Durzan, unpublished).
These studies help inform breeding programmes utilising artificial feeding techniques and can help improve survival in the smallest and most vulnerable juvenile stages.

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8 Session: Quantitative characterization and assessment / evaluation of mussel habitats

Keynote speaker:

Evelyn Moorkens

Institution:

University of Dublin, Trinity College, Ireland

Currently research field, projects and studies:

Evelyn has completed over 30 years of research on FPM requirements for flow, food and river bed condition, and produced guidance for practical management, including condition and impact assessment and standard survey methods.

Interests:

Catchment management, hydrological requirements, research to fill gaps in knowledge of *Margaritifera* requirements

8.1 Practical Assessment methodologies for the evaluation and monitoring of *Margaritifera* habitats and their condition

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Understanding the requirements of freshwater pearl mussels, the specific conditions in each population that support their sustainable function, and the level, frequency and methodologies of investigations required to undertake condition assessment of each population within a limited budget is a challenging task for the specialist and their funding body.

EU guidance, the FPM CEN Standard, and national protocols dictate our approach to data gathering, but choices regarding the number of site locations and the intensity of investigation will determine the balance of value from gaining a spread of data versus its level of detail.

In Ireland, systematic monitoring of FPM began in 2004. The results of medium-term surveillance are presented, with examples that highlight the information gained from a range of methodologies. The results demonstrate that each population assessment poses a series of questions that must be answered in their own unique way, and that an understanding of the entire catchment is essential to making the correct choices of measures needed to rehabilitate populations in unfavourable condition.

8.2 Chemical, hydromorphological, and other environmental parameters of optimal habitats for the freshwater pearl mussel: Czech experience

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In the Czech Republic, as elsewhere in Europe, the populations of the freshwater pearl mussel (*Margaritifera margaritifera*) became extinct on most sites of the species historical occurrence, and their numbers decreased alarmingly on the remaining locations during the last several decades. In Czechoslovakia / the Czech Republic, much attention has been payed to this problem since the early 1970s. It was namely Jaroslav Hruška who contributed substantially to understanding the biology of the species and its environmental needs, and developed methods of its semi-natural breeding. All the knowledge and experience of J. Hruška and his followers were published as Action Plan methods for the freshwater pearl mussel by Simon et al. (2017) in Czech* (an English version will be published in 2019).

In the Freshwater Pearl Mussel Action Plan, started in 1993, protection of the remaining populations as well as of the biotope (including adjacent parts of catchments) of the critically endangered species has been involved. The Action Plan gives a list of basic parameters, including value ranges for them, of the species biotope requirements. These optimal conditions (water temperature and chemistry, a watercourse hydromorphology, and other – drainage, river regulations, agriculture and forestry practices in catchments, etc.), based on our empirical knowledge, and several case studies from South Bohemia will be presented.

While hydrochemical parameters were suitable for freshwater pearl mussels only in upper reaches of several watercourses in the 1990s, they have improved a lot since the beginning of the century on many locations of historical and current occurrence of the species. This improvement is related to a change of the landscape management as well as to a stricter protection of the freshwater pearl mussel. Further improvement of the catchments status could bring revitalization and spontaneous renaturation of watercourses, regulated in the past. In the Czech Republic, the freshwater pearl mussel survived the “bad years” on the upper edge of its natural area. In rivers such as the Vltava (Moldau), the Blanice (Flanitz), and the Malše (Maltsch), optimal conditions in terms of hydromorphology, water temperature, food supply, and other parameters would be found downstream. However, these areas, densely populated by people, are more risky for the freshwater pearl mussel due to a worse water quality and a possibility of direct damage by people.

8.3 Comparison of different bioindication methods with captive-bred juvenile freshwater pearl mussels to identify suitable habitats for their release into the wilderness

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Since the beginning of the 21st century many efforts have been undertaken to stabilise endangered freshwater pearl mussel (*Margaritifera margaritifera*) populations by the semi-natural breeding program in Saxony's Vogtland region, Germany. Essential protection measures and actions to improve catchment area and wastewater management have been implemented already. Sufficient host fish populations are present in almost all streams of the former pearl mussel distribution of the river system "Weisse Elster". Nevertheless, establishment of self-reproducing mussel populations has not been successful so far.

Within the joint project ArKoNaVera advanced concepts for reintroduction/resettlement of captive-bred juvenile freshwater pearl mussels as well as long-term objectives for establishing self-sustaining mussel populations will be developed. These activities include in particular: analysis of causes for the prevention of natural reproduction, conservation of genetic diversity and identification of suitable mussel habitats. Furthermore, captive-bred juvenile freshwater pearl mussels of different ages and genetic lines are available for Saxony's Vogtland region. New suitable habitats are currently needed because the oldest captive-bred mussels are now in an age of first reproduction.

Comprehensive analyses have been conducted to identify suitable mussel habitats. In addition to physical, chemical, biological and hydrological parameters, the quality of stream sediments was also subject of investigation. However, results of different bioindication methods are the decisive criteria for identification of suitable habitats. The bioindication tests were realised with post-parasitic as well as semi-adult mussels exposed in flowing water and in the interstitial in seven small streams from 2016 to 2018. Survival and growth rates are a major step towards the identification of optimal habitat requirements for freshwater pearl mussels at certain life stages.

8.4 How juvenile habitat mapping can be used to assess the sustainability of a *Margaritifera* population

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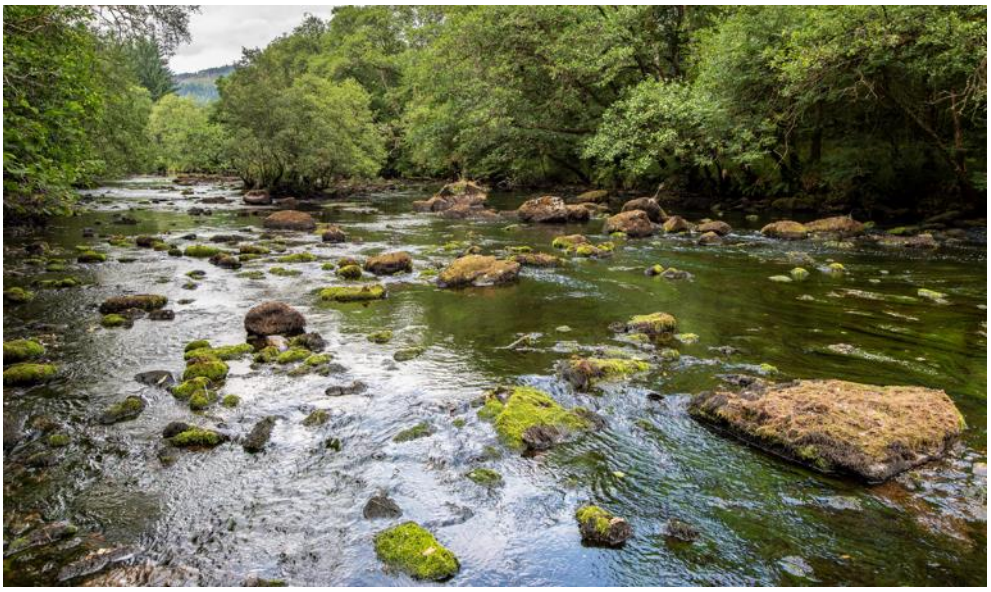
Juvenile habitat mapping provides an assessment of adult mussel distribution within the context of the ability of the river bed habitat to sustain the recruitment of juvenile mussels into a new generation of adults. While this technique can be used to compare reaches of good and bad habitat in a wide range of rivers, a full 4 km of continuous *Margaritifera* habitat has been surveyed and analysed in the Ehen River in England. This has provided a unique opportunity to look at the hydromorphological, riparian, land use and juvenile recruitment function of this population in very great detail.



Margaritifera margaritifera habitat in Scotland (Foto: F. Grunicke)

8.5 Long-term catchment restoration of the Blanice River Nature Reserve - Is it possible to reverse anthropogenic eutrophication in a freshwater pearl mussel protected area?

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The Blanice River nature reserve (63 km^2, 350 residents) originated in 1989 to protect the whole catchment of pearl mussel rivers and give an opportunity to manage water quality processes. The main goals of the management plan were to protect the river against village sewage waters, convert intensively drained fields, eliminate intensive pastures, support sustainable (organic) agriculture and realize active support for local pearl mussel (*Margaritifera margaritifera* L.) populations. A specific, mandatory water quality limit table (NH_4, NO_3 , P_{tot} conductivity) was an important tool to protect river network against anthropogenic eutrophication.

Long-term monitoring (1988 – 2018) enables the opportunity to analyze changes in water quality in the catchment. A critical level of nitrogen and organic pollution caused massive deaths of pearl mussels in 1992. Reproduction in the reserve has been absent since the 70's, presumably due to poor water quality and low calcium content in the detritus. There was accelerated conversion of all arable land to extensive pastures in the catchment before 1993. Since then, there has been a gradual decrease of nitrogen and phosphorus concentrations, but this process is very long.

Organic or extensive farming now persists in some parts of catchment, but many small, important floodplain meadows are not used and are being converted into sedge (*Carex sp.*) communities which are not producing useful detritus for juvenile mussel nourishment. Four main point sources of sewage water were eliminated by a combination of water treatment plants, infiltration or low treated biological ponds systems. Channel restoration took place on one highly modified stream, but systematic drainage persists in approximately 3km2 of meadows and pastures. Decreased NO3 and NH4 concentrations were a success and highly-polluted streams, such as Zbytinský and Tetřívčí stream, are now chemically suitable biotopes. Phosphorus concentration is still slightly high within some parts of river network, partially due to old gold mining waste, but not from agriculture. Ion concentrations (conductivity) are still high in tributaries with functional drainage systems. Natural mussel reproduction is still absent, but water quality in the main channel is probably not the reason and survival of mussels older than two years is good. It is possible to improve the water quality within the nature reserve over a long-time period, but control processes in all catchment are needed.

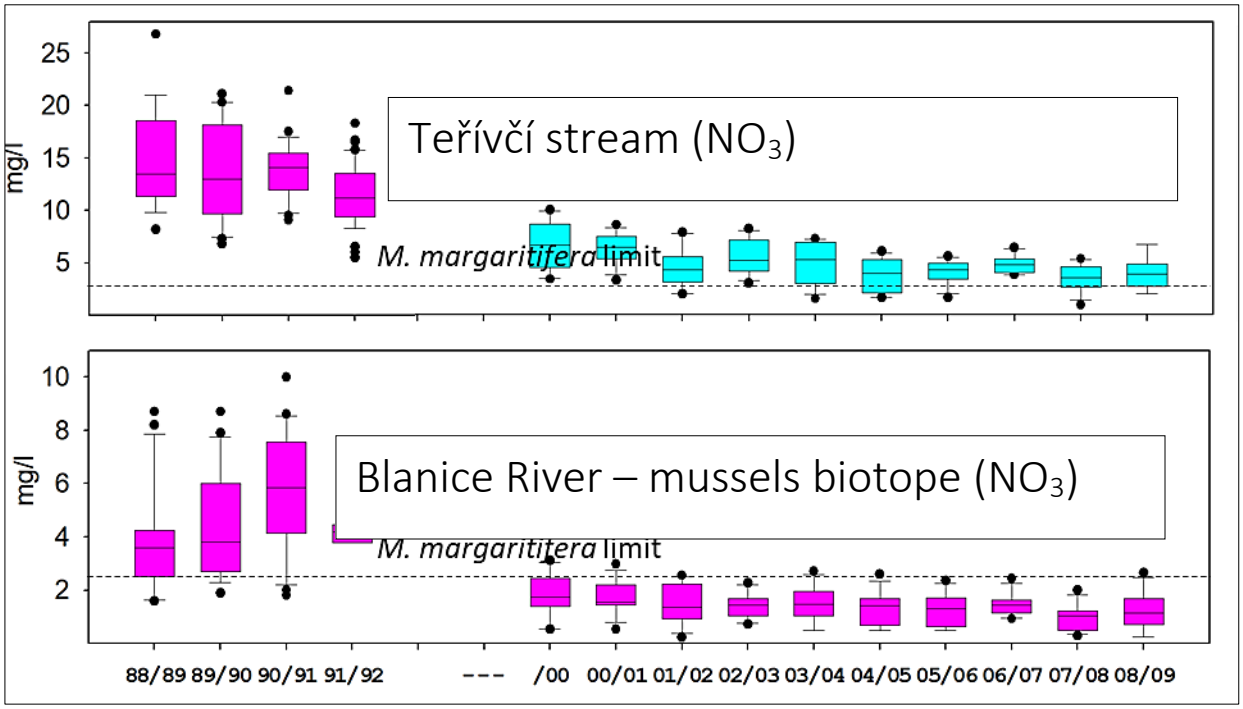

Fig 1: Partial picture of the data from one tributary as well as the main river (Blanice River, Blanice nature reserve, Czech Republic) in a period of rapid decrease of NO3 concentrations between 1990 –2009. In the catchment of Tetřívčí stream, all fields were converted to meadows before 1991.

8.6 Impact of fish ponds on sediment deposition and habitat quality of freshwater pearl mussels

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An oxygenated stream bed and high exchange rates between open and interstitial water are considered key requirements for successful recruitment of the highly endangered freshwater pearl mussel *Margaritifera margaritifera*. Understanding the processes of fine sediment deposition and colmation are therefore essential both in conservation of intact sites as well as in restoration of degraded sites inhabited by this species. In this contribution, we examined the spatio-temporal patterns of stream bed quality and fine sediment deposition in pearl mussel habitats in the border area between Bavaria, Saxony and the Czech Republic with a focus on analysing the effects of fish ponds which are hypothesized to result in degradation of habitats for juvenile mussels.

Redox potentials, substrate surface compaction, as well as differences in physicochemical variables between open and interstitial water were measured throughout the year and in high spatial resolution as indicators of habitat suitability throughout the catchments as well as in areas below fish ponds. In addition, sediment traps and temperature loggers were employed to test for possible sediment and temperature regime modifications by the ponds. The first results reveal a deficient stream bed quality at the majority of sites, particularly during low-flow conditions. Also, high spatio-temporal variation of substrate quality and fine sediment deposition within and among streams was evident. Even during low flow conditions in summer, higher mean fine sediment deposition rates were found at pond outflows compared to upstream and downstream sites. Our findings suggest that conservation of freshwater pearl mussel populations in this area should focus on improving stream bed habitat quality. Based on a better understanding of the processes and management practices that affect stream bed conditions, this project aims at developing management guidelines that minimize conflicts between fish farming and pearl mussel conservation.

8.7 The Assessment of siltation: from single stream patches to whole catchments

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Siltation of stream gravel leads to oxygen depletion in the interstitial zone. It is considered one of the main factors impairing the quality of juvenile mussel habitats of *Unio crassus* and *Margaritifera margaritifera*. The degree of siltation in a single patch of stream bottom is directly indicated by the grain-size distribution of the substrate. The availability or depletion of oxygen is related to the redox environment in the substrate, which is characterized by a choice of methods.

As a rule, attempts to solve the siltation problem by flushing out the silt from river substrates only have had short-term effects. Often the unfavourable conditions are soon restored by renewed siltation. Thus, for sustainable restoration of mussel habitats the process of siltation itself and the sources of the fine sediments have to be addressed.

The process of infiltration of silt into the stream bottom is governed by channel morphology and flow regime. The silt may derive from stream bank erosion or, most often, from soil erosion throughout the whole catchment. In the latter case, soil erosion and the transport of eroded soil to the river are the main processes to be dealt with.

When it comes to conservation and restoration measures, siltation has to be viewed on all scales, from substrate patches, stream sections and channels to whole catchments. Based on a number of field surveys, we present methods to assess siltation, addressing the different scales involved.

8.8 Habitat assessment as a prerequisite in freshwater mussel conservation: methodologies and implications using the example of the Painter`s mussel (*Unio pictorum*, Linnaeus 1758)

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Freshwater bivalve mollusks provide a number of valuable ecosystem services, including turbidity reduction by filtration, nutrient recycling and storage, substrate and food web modification, and their use as environmental indicators. However, many species recently have experienced dramatic declines and freshwater mollusks worldwide are among the most endangered taxa. Habitat restoration and mussel propagation are two ways to mitigate this situation but they require a profound understanding of habitat requirements of individual species in order to take the appropriate measures. In Europe, research has so far been mainly focused on two highly endangered freshwater bivalves, the freshwater pearl mussel (*Margaritifera margaritifera*) and thick shelled river mussel (*Unio crassus*), but much less is known about habitat preferences of species like the painter's mussel (*Unio pictorum*). This species is classified as species of national responsibility in Germany and is found in stagnant as well as in flowing waters.

The spectrum of different habitat types, where it occurs, suggests a wider tolerance towards environmental conditions than that of highly specialized species as the freshwater pearl mussel. We assessed density and age structure of *U. pictorum* in relation to substrate and water quality in 10 water bodies (rivers, backwaters, and lakes) in the catchment area of the Danube in Bavaria. Sediment quality was characterized by penetration resistance, texture analysis and redox potential measurements in 5 and 10 cm depth compared to the free flowing water. Water quality was assessed by measuring temperature, oxygen concentrations, pH, specific conductivity, current velocity and depth. Physicochemical measurements were conducted for free flowing water and interstitial water from 5 and 10 cm depth.

Our results indicate that *U. pictorum* tolerates high proportions of fine sediment and that the species is associated with low current velocity. They also suggest that the species has a comparatively broad ecological niche. Analyses will be continued for additional catchment areas to cover the greatest possible range of ecological tolerance, and to compare the results to current data which were mostly collected during the exceptionally warm and dry summer 2018. Findings of this study will help to characterize the range of habitat parameters which is needed for the development of conservation measures, management plans, and river restoration action related to *U. pictorum*.

9 Session: Selection of suitable habitats

Keynote speaker:

Marie Capoulade

Institution:
Bretagne Vivante, SEPNB, Brest Cedex, France

Currently research field, projects and studies:
Management of knowledge's actions and of conservation programmes of the association in Brittany: naturalistic studies, ecological monitoring, nature reserves.

Interests:
Nature conservation and protection, music, aïkido

9.1 Habitat selection for freshwater pearl mussels resettlement in Brittany (France)

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Freshwater pearl mussel (*Margaritifera margaritifera*) is a critically threatened freshwater bivalve in Europe. Since several years, ex-situ conservation actions have been developed in different European countries. Their objectives are to solve the lack of juveniles in wild populations and to carry out actions to improve habitat. The success of resettlement actions is determined, in part, by the selection of sites where young mussels are released. Indeed, they need food, oxygen, the possibility to burrow, especially to resist to high flow, and also substrate stability.

How to find habitats combining these different conditions?

First, this can be done by expert opinion. If sites with juveniles are already known nearby, it is possible to identify similar ones in rivers where resettlement is planned. However, in most cases, this method remains difficult to implement because areas with juveniles are rare. Moreover, in case of new programs, operators experience is not sufficient.

Then, it is possible to select resettlement sites from a series of micro-habitat scale measurements: red-ox potential, penetrability, intra-sediment water quality, near-bed flow velocity, granulometry, water depth or near-bed shear stress. On one hand, more studies seem necessary to clarify guide values for all of these parameters. On the other hand, other factors at the scale of the watercourse section could also influence these parameters: presence of riparian forest, slope of the watercourse, presence of an artificial flow regulation infrastructure…

The use of in-situ rearing systems and the measurement of different parameters is another possible method. Several in-situ breeding techniques can be used: Buddensiek cages, meshed tubes, concrete silos, plastic or wooden boxes. Assessment of the survival and growth rate of young mussels may indicate the most favorable areas. It can also be used to refine guide values for some parameters.

In Brittany, north-west of France, Bretagne Vivante and its partners have been leading a conservation program for the freshwater pearl mussel since 2010. A rearing station was built. Three mussel populations from Brittany are reared in this facility. Using meshed tubes and plastic boxes, we have resettled young mussels in their original rivers and measured survival rate and growth rate. The results of this experimentation will be presented.

Reference :

BEAUME N., PASCO P.-Y., CAPOULADE M., RIBEIRO M., DURY P., ROSTAGNAT L. & BEAUFILS B., 2016. *Freshwater Pearl Mussel Conservation in the Rivers of Brittany and Normandy: LIFE+ Nature «Freshwater Pearl Mussel Conservation in the Armorican Massif» Programme Report, 2010–2016*. Bretagne Vivante / CPIE des Collines / FDPPMA 29 / SIAES / PNRNM. Brest. 72 p. https://goo.gl/u8MjqM

9.2 Selection of habitats for resettlement – the strategy in the Austrian freshwater pearl mussel project

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In the framework of the Austrian conservation project "Vision Flussperlmuschel" juvenile mussels have been reared since 2011. The aim of the project is to establish reproductive populations in selected river systems. To reach this goal it is crucial to choose suitable habitats that provide favourable conditions not only in the short term, but over a long period. Such areas have to feature several key properties including a rich structural equipment with heterogeneous water flow velocities and proper substrate conditions that remain stable even after extreme situations like major flood events.

For the assessment of these parameters various working steps are carried out. Initially, potential project rivers are mapped to gain a first impression and promising sites for further analysis are selected. Next a biomonitoring in the open water is carried out using juvenile mussels. Results from previous surveys indicate that the choice of the proper rearing system depending on the runoff characteristics of the selected river is essential. Since 2016 an additional biomonitoring in the interstitial has been performed to evaluate the availability of oxygen and nutrients. For this purpose, custom-built substrate boxes were filled with substrate and buried within the interstitial. Previous results at promising sites yielded a mussel survivability of 80 % to 100 % after an exposure of four months.

To assess the stability of a potential site, continuous observations over a certain period are necessary. Furthermore, we aim to use a hydrodynamic model to calculate relevant parameters like the shear stress situation during flood events and thereby draw additional conclusions on the long-term stability of a potential site. Finally, it is planned to use GIS based analysis to identify potential threats and favourable areas for improvement measures.

9.3 Freshwater pearl mussel conservation in Lower Bavaria, Germany – stories about breeding and releasing juveniles

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As in many other parts of its distribution area, the freshwater pearl mussel (*Margaritifera margaritifera*) is critically endangered in Lower Bavaria due to a lack of recruitment. The latter is caused by the strong sensitivity of juveniles to adverse habitat conditions, especially to increased levels of fine sediments. As a consequence, a semi-natural rearing program is carried out in the course of the project "ArKoNaVera – Rescue of the Freshwater Pearl Mussel in Lower Bavaria". For early life stages, different types of rearing devices have been established by several research groups, of which we compared Buddensiek cages and sediment boxes. Of each rearing device we exposed three replicates, each filled with 30 1+ juveniles, at 10 sampling sites for one year. Overall, survival of juveniles was higher in Buddensiek cages than in sediment boxes with 40–93% compared to 0–87%. Growth was comparable in both field cages. The site specific variation indicates that suitability of field cages is determined by environmental conditions and that successful use of sediment boxes might be restricted to habitats with higher water quality.

The purpose of each breeding program is the stocking of juveniles to declining native populations as a short term compensation of the lack of natural reproduction. The choice of optimal release sites is decisive for the long term success of stocking measures, especially in case of the freshwater pearl mussel with its long breeding cycles and low individual mobility. Here, the stocking protocol used in lower Bavaria is presented with a special emphasis on investigation of local hydraulic conditions.

9.4 Assessment of mussel relocation as a conservation and management strategy

Małgorzata Ożgo [1], Maria Urbańska [2], Urszula-Biereżnoj Bazille [3], Karolina Tarka [3], Piotr Marczakiewicz [3], Andrzej Kamocki [4]

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Freshwater mussel translocation is increasingly used in conservation programmes, but experimental evidence documenting the success of this strategy remains limited. This study was carried out in response to the plans of deepening a 75 m long channel in the Biebrza National Park in norht-eastern Poland in 2015 inhabited by *Anodonta anatina, A. cygnea, Unio pictorum* and *U. tumidus*. Prior to the excavator works, we divided the channel into 15 equal-length sections, and from each section we collected all mussels we were able to find. We individually marked all the mussels, took measurements of shell dimensions and body weight and released them to the same sections of the deepened channel. We monitored mussel survival, migrations and recruitment in 2016, 2017, and 2018. The overall survival in the first year after relocation was 49%, and increased to approximately 60% in the following years. The highest survival was in *A. anatina* and *U. tumidus*. First juveniles were observed in 2017: they contributed to 67% of collected *A. anatina* and 40% of *A. cygnea*; no juvenile *Unio spp*. were found. Spatial distribution of the juveniles indicates that habitat connectivity plays a crucial role in the recovery of mussel populations.

This study was supported by the Polish Minister of Science and Higher Education, under the program "Regional Initiative of Excellence" in 2019 - 2022 (Grant No. 008/RID/2018/19).

10 Session: Evaluation of captive-bred mussel release

Keynote speaker:

Martin Österling

Institution:
Karlstad University, Sweden
Department of Environmental and Life Sciences

Currently research field, projects and studies:
Conservation of freshwater mussels and their host fishes, dam removal, winter ecology, aquatic-terrestrial interactions, river connectivity.

Interests:
Outdoor activities and music

Juveniles of *Margaritifera margaritifera* (Foto: F. Grunicke)

10.1 Reintroduction and the importance of mussel-host fish interactions

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The conservation of species with complex life-cycles is not always straightforward. This may be particularly problematic for a species with a life cycle that includes a parasitic stage on a host because there is also a need to examine the ecology of the host population. For the threatened unionoid mussels with their parasitic life stage on fish, eco-evolutionary relationships between the mussel and the fish need to be considered. For many unionoid species, much effort has been directed towards captive breeding of juvenile mussels. Perhaps, less focus has been directed towards the interactions between mussels and their host fish. Yet, the suitability and ecology of the host fish can differ manifold between strains and species, but also between age classes. Such aspects can also affect the passive movement of mussels on the host fish, given that different fish species and life stages differ in their suitability, movement and migration patterns. Fish also differ in their sensitivity to the infestation of mussel larvae, with potential effects on growth and survival of the fish. In this presentation, I will talk about suitability, local adaptation, infestation techniques, fish tolerance, fish ecology, patterns of infestation of wild fish populations and reintroduction of mussel-infested fish.

10.2 Resettlement of young freshwater pearl mussels in Brittany (France)

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Since 2010 in Brittany, north-west of France, the association Bretagne Vivante and its partners have been leading a conservation program for the last population of freshwater pearl mussel (*Margaritifera margaritifera*).A rearing station was built in 2011 and first glochidias were collected at the same time. The first young mussels were obtained in May 2012. Currently, three mussel populations from Brittany are reared in this installation. Several thousand young mussels are released each year in their original watercourses.

Since 2012, we have conducted experiments to choose the most favourable places to release young mussels. By a lack of space at the rearing station, thousands of young ones from 400 to 500 µm were directly resettled, after their excystment (0+). As the mussels grew up at the rearing station, the cohorts were split in two, one half released in their original watercourse (size from 1 to 5 mm), the other half kept in the facility.

To assess effectiveness of direct resettlements, in-situ breeding systems were set up nearby. We have tested successively or simultaneously Buddensiek cages, concrete silos, meshed tubes and boxes. A first attempt to research young ones in sediment was conducted in 2018, unsuccessfully. Two other rivers have to be investigated. However, we have observed individuals in all the in-situ breeding systems. Currently, the last system contains mussels between 8 and 18 mm. The initial size of the mussels put in the in-situ breeding systems is important: the bigger they are, the better their survival rate seems. The interest of the rearing station is then essential in order to protect young mussels during their first year of life.

Reference:

PASCO P.-Y., BLAIZE C. & CAPOULADE M., 2018. *Rapport d'activité 2017.* Déclinaison régionale Bretagne du Plan National d'Actions en faveur de la mulette perlière 2016-2021. Rapport Bretagne Vivante. 44 p. + annexes. http://k6.re/ChULU

11 Session: Significance of global warming for freshwater mussels

Keynote speaker:

Yulia V. Bespalaya

Institution:
N. Laverov Federal Center for Integrated Arctic Research of Russian Academy of Sciences, Russian Federation

Currently research field, projects and studies:
Yulia Bespalaya´s research focuses on the ecology, taxonomy, biogeography and phylogeography of freshwater molluscs, including invasive species.
Grants: «Biological invasions of alien species of molluscs in freshwater ecosystems the watercourses of the basin of the White Sea», «Phylogeography and ecology of freshwater aquatic organisms in Arctic lakes of different origin»

Interests:
Species Diversity, freshwater molluscs, ecology, biogeography, adaptation, life cycles, reproduction, phylogeny, extreme habitats, environmental factors, invasive species.

11.1 Climate warming as a possible trigger of freshwater pearl mussel population decline in oligotrophic rivers throughout Europe

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The effects of climate change on oligotrophic rivers and their communities are almost unknown, albeit these ecosystems are the primary habitat of the critically endangered freshwater pearl mussel (*Margaritifera margaritifera*) and its host fishes, salmonids. This species exclusively inhabits cold running waters with low mineralization and organic content and is unique because of its very high longevity (up to 280 years) and narrow host specialization (Bauer 1988; Schöne et al., 2004; Lopes-Lima et al. 2017). The distribution and abundance of *M. margaritifera* have drastically decreased throughout Europe over the last century, particularly within the southern part of the range (Bauer, 1986; Buddensiek, 1995; Sousa et al., 2015) and the majority of its populations has lacked successful reproduction for last 30–50 years (Gumpinger et al., 2002; Geist, 2010). The indirect effects associated with anthropogenic transformations, such as habitat degradation, alteration and fragmentation as well as salmonid host overfishing, are considered the most important factors for the decline of the species (Quinlan et al., 2015; Cosgrove et al., 2016). However, little attention has been paid to global climate change as a possible factor in population decline (Hastie et al., 2003; Santos et al., 2015).

On 8 January 2018, a paper co-authored by 20 scientists from six European countries (Austria, Finland, Latvia, Norway, Russia and Sweden) has been published in Scientific Reports (Bolotov et al., 2018; https://www.nature.com/articles/s41598-017-18873-y). In this study, 3279 shells of freshwater pearl mussels (*Margaritifera margaritifera*) from 50 rivers across Europe were investigated. The shells were collected during historical (~1840-1940) and recent (1984-2013) time intervals. Under the framework of this long-term project, a novel integrative approach combining morphometric, ecological and climatic data sets into a series of spatiotemporal models has been developed. This approach was applied to the morphometric data set of freshwater pearl mussels. The results support the hypothesis of possible warming-driven freshwater pearl mussel decline throughout Europe during the last 100 years. The principal new findings of this study are as follows:

(1) Climate changes may trigger hidden extinction processes in freshwater animals such as freshwater pearl mussels in oligotrophic rivers and streams at the continental scale.

(2) The mean shell convexity in freshwater pearl mussel populations reflects shifts in summer temperatures and is significantly different in viable and declining populations. This parameter may be considered an easy-to-obtain and low-cost indicator of population-level thermal effects in freshwater pearl mussels under warming climate.

(3) The significant latitudinal trend in shell convexity of freshwater pearl mussel populations throughout Europe results from the recent warm climatic episode (since 1960-1970s) and was lacking in historical samples collected in 1840-1940. Spatial and temporal modelling of the relationship between shell convexity and population status show that global climate change could have accelerated the population decline of freshwater pearl mussels over the last 100 years through rapidly decreasing suitable distribution areas. Simulation predicts future warming-induced range reduction, particularly in southern regions.

(4) In southern areas, high-altitude rivers and streams will represent local but important refugia for cold-adapted species such as freshwater pearl mussel under future climate warming scenarios.

In summary, our new results highlight the importance of large-scale studies of keystone species, which can underscore the hidden effects of climate warming on freshwater ecosystems.

The study has been supported by the program of the Presidium Ural Branch of RAS (no. 0409-2018-0148) and Russian Foundation for Basic Research (nos. 17-45-290066, 18-44-292001 p_mk and 17-44-290016).

Flooding after a heavy rain period in a pearl mussel habitat in Saxony, Germany
(Foto: F. Grunicke)

11.2 Project MUSSELFLOW: Host-dependent evolution, ecology and conservation of freshwater mussels under varying hydrological conditions: consequences of climate change.

Joaquim Reis1, Pedro Anastácio2, Carla Sousa Santos3, João Pedroso de Lima[4], Isabel Pedroso de Lima[4], João Abrantes[4], José Almeida[4], Filipe Banha[2], Mafalda Gama[2], Cristina Lima[3], Daniel Pires[5]

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Freshwater mussels are amongst the most endangered fauna in the world, presenting several unusual life history traits that include high longevity and an obligatory parasitic larval stage. The specificity of the parasite-host relation depends on the species. Being sessile adults, freshwater mussels depend on their hosts movements and on the hydrological patterns of the rivers for their dispersal, and hence to maintain connectivity within and between populations. Although much information has been collected about the host-parasite relation of many species, almost nothing is known about its influence or that of hydrology on their dispersal. Therefore, the fundaments of population dynamics and evolutionary paths of each species are largely unknown. The aim of this project is to clarify this issue with a multi-disciplinary approach that tackles population genetics, reproductive biology and hydrology. The population genetics design will consider species with different host-parasite relations and living in hydrologically distinct habitats, so that different structures may be related to differences in these factors. A combination of observational and experimental studies will be set in place to clarify the role of hydrology. Finally, results will be integrated with other environmental factors to model the species current distribution and future distribution affected by climate change. The results of this project should be directly usable for conservation purposes, helping us to anticipate threats to the populations caused by hydrological changes in the systems.

11.3 Possible consequences of climate warming on survival and growth of juvenile freshwater pearl mussels in Vogtland (Germany)

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The endangered freshwater pearl mussel, *Margaritifera margaritifera* (L.), decreased dramatically for several decades in the Vogtland region (Germany). One of the factors implicated in this decline might be the climate warming and corresponding changes in habitat quality. Climatic forcing is increasingly recognized as a potential factor, which changes both aquatic and terrestrial ecosystems. However, there remain large gaps in our understanding of how climate warming may affect the distribution, timing of life cycle as well as survival and growth of freshwater pearl mussels. The objective of this study is to highlight which aspects need to be considered for predicting consequences of climate warming on freshwater pearl mussels.

Within the joint project ArKoNaVera, we analysed survival and growth of post-parasitic and semiadult freshwater pearl mussels using both Buddensiek- and sediment cages exposed to the flowing water in seven small streams from 2016 to 2018. According to the results of water temperature measurement by data loggers we concluded that both post-parasitic and semiadult freshwater pearl mussels survival and growth are strongly controlled by water temperatures. Additionally, we examined long-term trends for meteorological values (1950-2018) which may affect the performance of freshwater pearl mussels directly via temperature or indirectly via precipitation. As temperature remained relatively cool through the 1960s and into the 1970s, during the last 50 years the mean surface temperatures has become warmer by 0.5 °C/decade. During the same period, annual rainfall and precipitation during winter period did not change significantly from 1950 to 2018. A significant decrease in monthly rain was observed only during the month April (by 3.1 mm/decade). Additionally, the probability of summer periods with less than 60 mm/month rain increased significantly from 1950 to 2018.

Combining results from field experiments with controlled laboratory investigations and long-term data series are crucial to identify effects of increased water temperature as well as extremes of low and high water flow. Such analyses are an important requirement in the search for suitable reintroduction/resettlement habitats and to predict potential effects for conservation management of freshwater pearl mussels.

12 Posters

12.1 Evaluation of suitable mussel habitats with bioindication mesh cages: Case study from three rivers in the Czech Republic

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The Freshwater Pearl Mussel (FWPM*, Margaritifera margaritifera; Unionida, Bivalvia*) is a critically endangered bivalve occurring in oligotrophic streams. Their numbers have fallen drastically during the 20th century across the occurrence area. The current decline in species reproduction in the majority of the central European populations is probably caused by very low to zero survival of juveniles during the first few years of their life.

Within the Czech Action Plan for Freshwater Pearl Mussel, there are thousands of juveniles rising every year from a semi-natural breeding program. Nevertheless, there is a question of which habitats are suitable for successful population support by these juveniles or for eventual species reintroduction. In situ bioindication presents a way of finding the answer. Exposure methods were gradually modified and expanded over more than 15 years of application within the Czech Action Plan for Freshwater Pearl Mussel, and verified by a set of experiments.

In our case study, we focused on three Czech FWPM rivers (Vltava, Blanice and Malše River) which can be divided into stretches with different environmental conditions. Juvenile individuals were kept in mesh cages and exposed in free-flowing water of rivers. Their survival and growth rates were quantified after several weeks of exposure.

We found suitable mussel localities in each river. However, it is necessary to point out that used experiments have their limits. Firstly, simplified habitat does not correspond with real hyporheic zone for juvenile life. Thus, we can use mentioned tests for evaluation of mussel growth potential and effect of temperature, water quality and food availability. Secondly, it is obvious that bioindication tests can help to select “good” and “poor” localities or habitats without evidence of causality. Finally, field data should be collected during long-term testing. Only in this way, we will be able to use this information for management in protected areas and releasing captive-bred juveniles.

12.2 A spatial conservation prioritization approach for two endangered freshwater mussel species in Bavaria, Germany

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Freshwater mussels are among the most imperilled species worldwide and strong population declines were detected in the last decades. An implementation of effective conservation strategies also requires an accurate determination and management of protected areas to minimize possible adverse effects on remaining populations and their habitat. The goals of this study were to model the potential distribution of two endangered mussel species (*Margaritifera margaritifera* and *Unio crassus*) in Bavaria, Germany, and to assess how well these areas are currently under some sort of legal protection status.

Ecological niche models (ENMs) were calculated for both mussel species based on presence-only data using MaxEnt. Binary maps served as species distribution layers for a subsequent GIS-based gap analysis in which we distinguished between different categories of protected areas of different level of protection, including 'nature conservation areas' and 'special areas of conservation' and 'protected landscapes'.

Results of the ENMs show that *M. margaritifera* has a spatially restricted distribution whereas the distribution of *U. crassus* is wider, extending to calcareous areas. Calculation of the protection state showed, that a high percentage of suitable habitat of *M. margaritifera* is already under protection, although mainly at low protection level. In contrast, only half of the suitable habitats of *U. crassus* are under any sort of protection.

In conclusion, our results suggest that different priorities in the management of protected areas for *M. margaritifera* and *U. crassus* should be set: *M. margaritifera* requires an increase in protection status of already protected areas, whereas *U. crassus* may mostly benefit from expansion of protected areas along its distribution.

12.3 The Bavarian mussel coordination office: Bridging the gap between science and applied mussel conservation

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The Bavarian office of freshwater mussel conservation at the Aquatic Systems Biology Unit, Technical University of Munich, bridges the crucial gap between scientific knowledge on freshwater mussels and applied conservation aspects. It is financed by the Bavarian Environment Agency and the Bavarian State Ministry of Environmental and Consumer Protection. The aim of this poster is to present examples of this work, giving insights to applied mussel conservation spanning all work levels of conservation, ranging from volunteers in the field to policies and decision makers on a governmental level.

Important is the increase of awareness related to freshwater mussels and their ecosystem services as well as the transfer of knowledge to policy makers, governmental agencies, non-governmental organizations, and private people with conservation aims. In addition, education and publicity work is conducted to sensitize groups of interest. Further the education of trained assistants who function as experts on the local level is performed in order to build a network of volunteers helping with conservation efforts in the field. Together with ANL, the mussel coordination office also organizes an annual information conference on actual topics with an audience of 100-150 people.

Another crucial task is consultation work, where the coordinator functions as an independent expert to help resource managers making informed decision in favour of mussel conservation. In this role the coordinator is the main go-to person regarding all freshwater mussel relevant questions for communities, associations, agencies, as well as private fishermen and pond owners. Along with that the coordinator helps to develop concepts and reviews proposals for freshwater mussel conservation efforts. This is often combined with reviewing and drafting proposals for crucial research questions. The involvement in research is another essential part. Due to the applied type of work and the strong connections to the volunteers in the conservation network, emerging problems and research questions can be identified very early on and furthermore can be easily transferred into research projects. Thus questions to open problems can be addressed quickly and the knowledge gained from the research project can be directly communicated to the application level.

Since there is still a great lack of data on distribution and autecological aspects of multiple freshwater mussel species in Bavaria and Germany, the coordinator aims to gather and archive the data on mussel populations. Overall the conservation of freshwater mussels takes place at multiple levels that need to be coordinated which will remain a major challenge in the future. The main aim is to create a network of all stakeholders, who work together in order to address major challenges in mussel conservation and achieve major long term goals.

12.4 INTERREG (Austria – Czech Republic) project "Malsemuschel": Support of the natural environment of the freshwater pearl mussel (*Margaritifera margaritifera*) and its occurrence in the upper Malše River catchment (Austria / Czech Republic)

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It had been known that the critically endangered freshwater pearl mussel (*Margaritifera margaritifera*) still occurs somewhere in the upper parts of the Malše River in South Bohemia, on the border between the Czech Republic and Austria. The fact that the Malše forms a state border here was hampering a detailed biological survey for a long time, and thus the knowledge about the pearl mussel population and its condition has been incomplete. For that reason, an Austrian-Czech INTERREG project was started in 2017 to enhance and support the pearl mussel population in the upper Malše River catchment. The main objectives of the project (2017 – 2020) are: (i) to find out the recent state of the freshwater pearl mussel population, (ii) to strengthen the population by reintroduction of indigenous semi-naturally bred juveniles into the river, (iii) to describe the reasons why the species cannot reproduce here, and (iv) to prepare materials for improving the water quality and reducing erosion throughout the international river basin, in cooperation with Austrian project partners.

12.5 EU project strengthening and protection of the freshwater pearl mussel population in the Šumava National Park (Bohemia, Czech Republic)

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Big Czech rivers – the Vltava River (in German: Moldau) and its tributaries the Malše (German: Maltsch) and the Otava (G.: Wottawa) – used to be very rich in freshwater pearl mussels (*Margaritifera margaritifera*). Since ca 1850, their numbers decreased dramatically due to the water pollution and land use changes in the catchment area. In the Moldau, the species inhabited the river as far as below the town of České Budějovice in the past but now, it occurs strictly in the upper parts of the Moldau river basin on the Šumava National Park territory. To enhance a chance to maintain this population and restore natural reproduction, the Šumava National Park authorities coordinate this project, funded by the European Union.

The main purpose of the project (2017 – 2022) is to strengthen and stabilize the existing overaged population, which does not reproduce despite a very well preserved biotope. The main goals of the project are:
1. To increase the number of genetically indigenous pearl mussels in the river by semi-natural rearing and releasing the juveniles into the best possible river transects (tested beforehand);
2. to cover monitoring of the current population and to ensure rescue transfers or biotope improvements, if needed;
3. to consider a possibility of a rearing river branch construction in order to support natural reproduction;
4. to minimize the risk of die-back due to water pollution and erosion;
5. to create and evaluate environmental education activities focused on the freshwater pearl mussel conservation.

The project follows long-term (mainly monitoring) activities in the area, and might continue as a cooperation with the Bavarian Forest National Park – some tributaries flow from the Bavarian side, and there is no or very limited information about their water quality.

12.6 Investigations into feeding structures of juvenile freshwater pearl mussels (*Margaritifera margaritifera*) through scanning electron microscopy

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Very little is known about the morphological changes juvenile freshwater mussels undergo during their first few years and how these affect growth and survival and therefore success in culture systems. Of particular interest is the stage when juveniles transform from pedal- to filter-feeding and the morphological changes of the gills and associated feeding apparatus at this time. This investigation provides an insight into biological development in three different age classes of the freshwater pearl mussel, *Margaritifera margaritifera*: newly excysted (pre-transformation), 10-20 months old (around the time of transformation) and 3 years old (post-transformation).

Using scanning electron micrographs the ultrastructural features of juveniles is described at these different developmental stages, focussing particularly on features of the gills such as overall structure of lamellae/gill buds, formation of the inner and outer demibranchs, development of cilia and cirri, gill reflection and development of the oral groove. Structure of the mouth, labial palps, foot and mantle were also considered.

More information on the timing and type of morphological changes during this period is required to understand not just the basic biology of juvenile mussels but also how changing morphology can affect dietary requirements, juvenile growth and survival and ultimately how we deliver captive rearing activities for conservation of this mussel species.

12.7 Improving the status of freshwater pearl mussel in the upper River Spey: habitat & population density factors

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Several large recruiting populations of freshwater pearl mussel are present in the middle and lower River Spey, Scotland. However, the species is largely absent from the upper river and the few small populations present are not recruiting. It is suspected that high levels of historic pearl fishing is the main force behind this distribution, as the upper river has shallower water which is likely to have greater accessibility for pearl fishermen. However, the reasons behind the lack of recolonization and recruitment of the small remaining populations remain unknown and may be due to a deterioration in habitat quality. This poster presents the methodology developed from published literature that will be implemented to assess the suitability of the habitat in the upper river, in order to understand potential barriers to recruitment and potentially identify suitable reintroduction sites. In addition, data is presented that suggests that less dense populations may have greater difficulty successfully recruiting- a possible contributing factor to the lack of recruitment in the upper River Spey where only small widely dispersed populations remain.

12.8 The first successful resettlement of *M. margaritifera* in Bavaria: Evidence for the need of long-term monitoring data

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The continuing and unabated decline of the pearl mussel *Margaritifera margaritifera* in Central Europe has justified long-standing efforts to sustain the populations in various streams and rivers. A number of projects try to rejuvenate mussel stocks by the release of juvenile mussels. In a very successful resettlement project two different methods have both resulted in the growing up of juvenile mussels. Either the mussels were propagated artificially and released after the parasitic stage into seemingly suitable stream substrates, or they were introduced by artificial infestation of resident trout. In this “bank side infestation” the trout are caught by electrofishing, treated with mussel glochidia and released again immediately.

After these methods had been applied for 10 years a mussel population of at least 3.400 mussels was established. This is an outstanding success: In a number of other streams it has not been possible to verify the presence of juvenile mussels even after long lasting resettlement efforts. The poster presents the resettlement project as a case study with data on habitat quality and on the development of the mussel population in the time from 2005 until 2018.

12.9 15-year experience of saving the last freshwater pearl mussel (*Margaritifera margaritifera*) population in North Rhine-Westphalia, Germany

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The last freshwater pearl mussel population of North Rhine-Westphalia can be found in the Perlenbach, a small brook within the Eifel, a low mountain range southern of the city of Aachen. During the 18th century up to 500,000 mussels had been counted here. First efforts to protect the endangered species took place in the 1980s. Back than the number of individuals were just up to 300. After more than 20 years of research stagnation, work has been resumed within the EU financed framework for the LIFE project (LIFE03 NAT/000003) – 'Living brooks in the Eifel" with an overaged population of 30 remaining mussels.'

During the habitat's restoration within the LIFE-project a captive breeding program funded by the NRW-Stiftung (a foundation of the federal member state of north Rhine Westphalia) and the LANUV (an authority associated with the member states` ministry of environment) has been set up. In 2006 the infestation of brown trouts (*Salmo trutta fario*) with glochidia has been taken place for the first time.

For two following years it has been possible to infest hostfishs with glochidia from the Perlenbach's population until in 2009 the last five autochthonous donor mussels died in a dry and hot summer. As part of EU Interreg-project 'Habitat Euregio' in 2010 the breeding of a mussel population in Belgium closely related to the 2006th revived archetype started improving the genetic pool of the small local stock. Now remaining caged offspring counts up to ~ 200 mussels ranging from 9 to 11 years of age.

In about 5 years a new reproduction cycle of freshwater pearl mussels from the Perlenbach can be expected. Until then some further tasks regarding e.g. the substrate and the host fish population must be done.

12.10 What is a suitable microhabitat for *Unio crassus* ?

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In order to characterise preferences of *Unio crassus* in terms of microhabitats, we studied 3 sites along the Sûre River in Belgium (catchment: 118 km², 122 km² and 163 km²). All 3 sites were formerly largely colonised by thick-shelled river mussels. For each site, depths, flow velocity and bed grain-size were measured following an adapted method of microhabitats. The results are presented as maps, on which the exact location of all *Unio crassus* found during the inventory period is reported. In total, nearly 2000 m² have been mapped. Moreover, lab grain-size analyses were performed on samples taken at the same location than *Unio crassus* individuals. In the meantime (Spring 2018), we also studied bedload mobility and sediment transport. We used marked pebbles (PIT-Tags), scour chains and sediment traps. In our study, in the Sûre River and for a median flow, *Unio crassus* are mainly found in lentic zones with depths higher than 0.3 m. Individuals are usually located at the base of banks, and in areas of sediment deposition in convex riverbanks. They inhabit gravel-type substrate with sandy matrix (D50 = 2.6 mm; D90 = 11.3 mm). This sediment is well sorted and results from graded suspension transport and deposition. The most colonised site was also the one with the highest heterogeneity in substratum. This grain texture could be used in *Unio crassus* habitats restoration projects involving bedload recharge.

13 Your personal notes