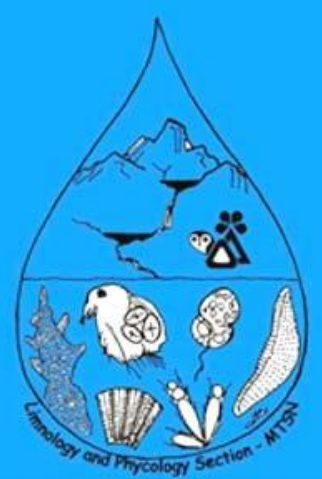


Il Progetto EBERs (*Exploring the Biodiversity of Emilia-Romagna springs*): biodiversità ed ecologia degli ambienti associati alle acque sorgive e criteri per la loro valorizzazione

Marco Cantonati (MUSE), Maria Teresa De Nardo & Stefano Segadelli (SGSS – RER) *et al.*

citati sulle slide che evidenziano il loro contributo al progetto

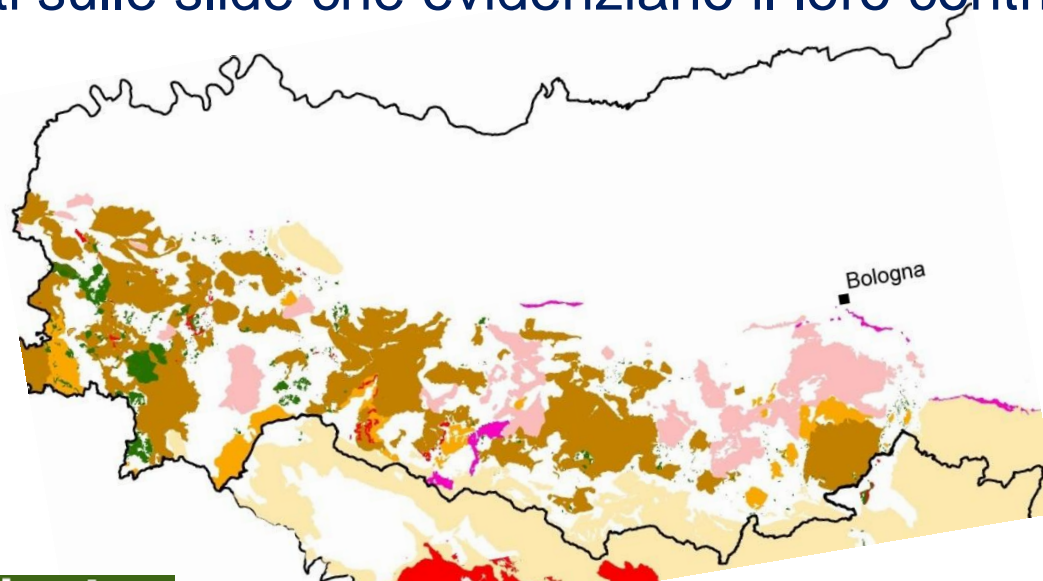


MUSE



universität
innsbruck

Adjunct Prof
Univ. Innsbruck
Austria



servizio geologico
sismico e dei suoli

Valore all'Appennino: il contributo della Geologia
Conoscenze per vivere e lavorare in montagna

Regione Emilia-Romagna

BOLOGNA
giovedì 22 ottobre 2015

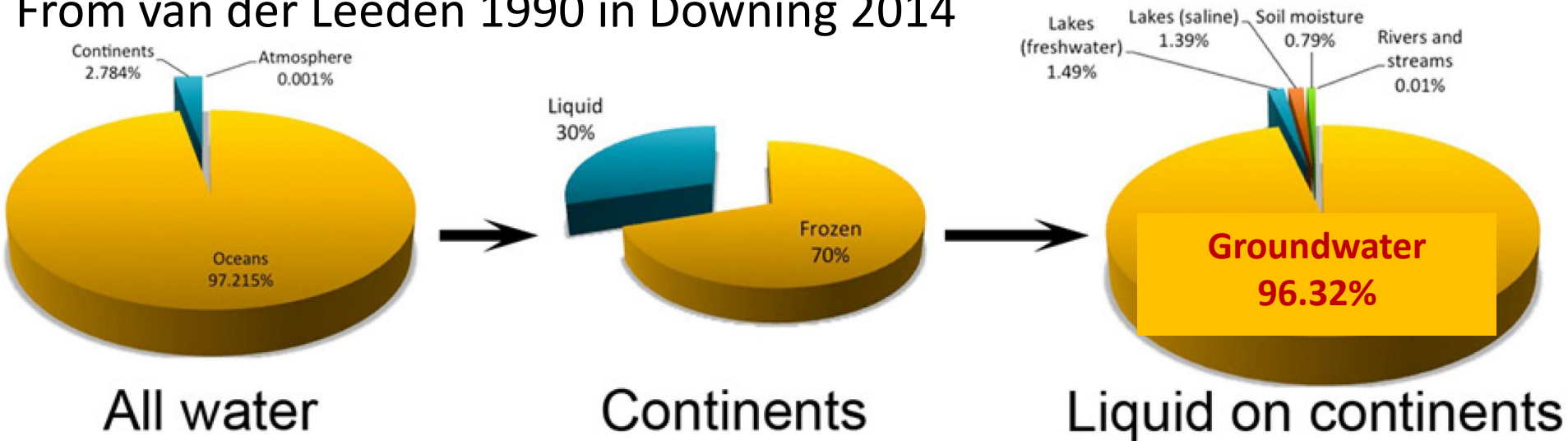


Scopo di questa presentazione

Delineare brevemente i risultati conseguiti grazie al Progetto EBERs su biodiversità ed ecologia degli habitat sorgivi dell'Emilia Romagna con attenzione alle implicazioni pratiche e gestionali e a possibili sviluppi grazie a future ricerche.

Should a freshwater ecologist care about hydrogeology?

From van der Leeden 1990 in Downing 2014



Freshwater = only 0.01% of the World's water and approx. 0.8% of the Earth's surface

Freshwater biodiversity = almost **6%** of all described species

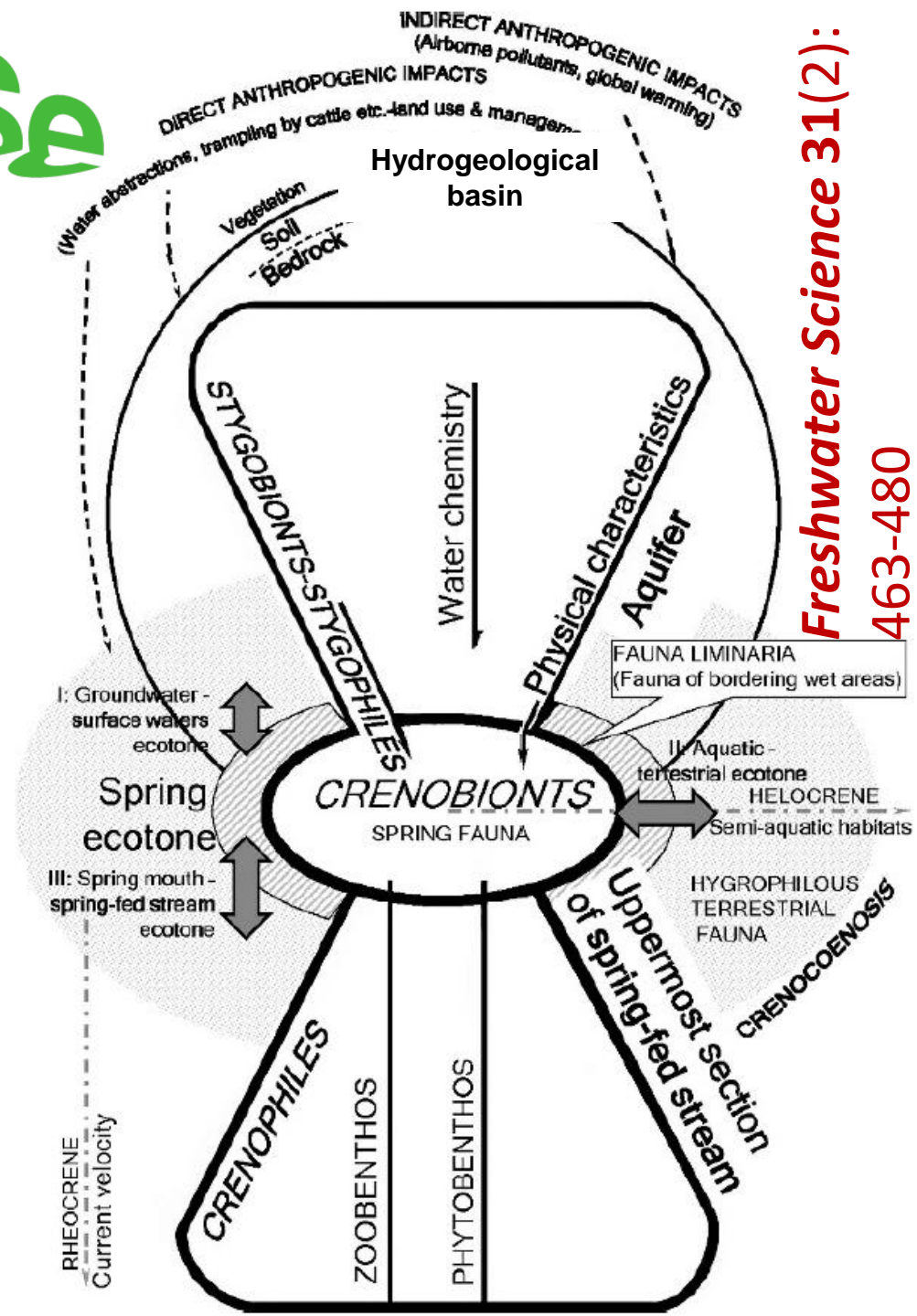
From Dudgeon *et al.* 2006



HYDROGEOLOGY



ECOLOGY

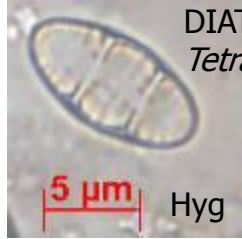


**Freshwater Science 31(2):
463-480**

RhLA

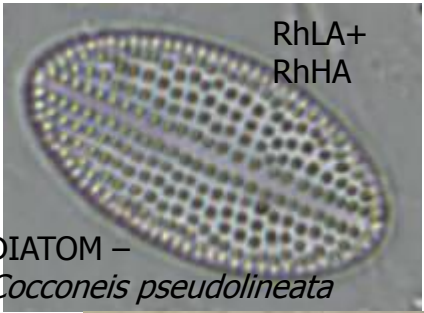
RhHA

RhL



DIATOM – *Tetracyclus rupestris*

Hyg



RhLA+ RhHA

DIATOM – *Cocconeis pseudolineata*

WATER MITE – *Atractides walterii*



RhHA+ RhS



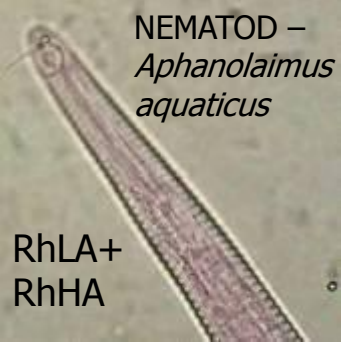
DIATOM – *Nitzschia dissipata*

RhL



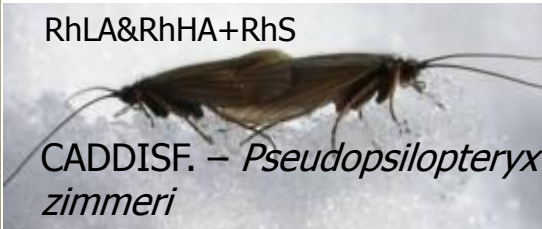
Hyg

COPEPOD - *Attheyella crassa*



NEMATOD – *Aphanolaimus aquaticus*

RhLA+ RhHA



RhLA&RhHA+RhS

CADDISF. – *Pseudopsilopteryx zimmeri*



Hyg

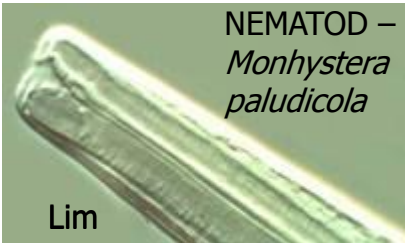
BRYOPHYTE – *Eucladium verticillatum*



Hyg

DIATOM – *Gomphonema lateripunctatum*

Freshwater Science 31(2): 563-574.



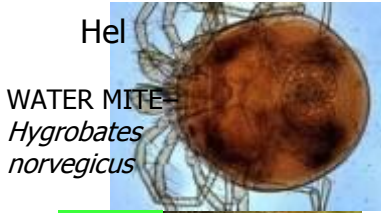
NEMATOD – *Monhystera paludicola*

Lim



DIATOM – *Tabellaria flocculosa*

Lim



Hel

WATER MITE – *Hygrobates norvegicus*

Hel



DIATOM – *Frustulia crassinervia*

BRYOPHYTE – *Scapania undulata*



NEMATOD – *Epitobrilus allophysis*

Lim

CHIRONOMID – *Prodiamesa olivacea*

Lim



VASCULAR PLANT – *Eriophorum* spp.



BRYOPHYTE – *Scapania undulata*



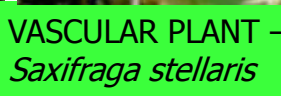
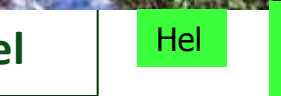
VASCULAR PLANT – *Saxifraga stellaris*



CHIRONOMID – *Diamesa zernyi* gr.

RhS

Lim



Hel

Hel

RhS

Communication and dissemination of information

Springs: Neglected Key Habitats for Biodiversity Conservation

Guest Editors:

Marco Cantonati, Reinhard Gerecke, Ingrid Jüttner & Eileen J. Cox

Journal of Limnology

January 2011

http://www.jlimnol.it/JL_70_sup/JL_70_sup.htm



Istituto per lo Studio degli Ecosistemi
Verbania Pallanza (Italy)

J-NABS

Journal of the
North American
Benthological
Society

2010
March
Volume 29
Issue 1

IN THIS ISSUE:

Ecology of Springs

A 50th Anniversary Issue

The Role of J-NABS in Freshwater Benthic Science

Guest Editors:

Marco Cantonati, Leopold Füreder,
Ingrid Jüttner & Eileen J. Cox

March 2012

SIL2007 Montreal, Special Session N. 47: "Springs and small streams: Understudied and under-protected key habitats for biodiversity conservation"



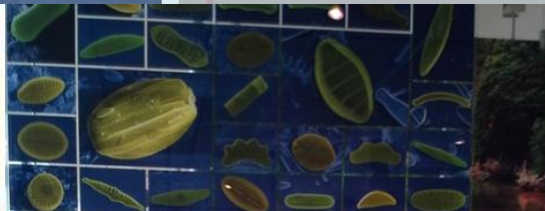
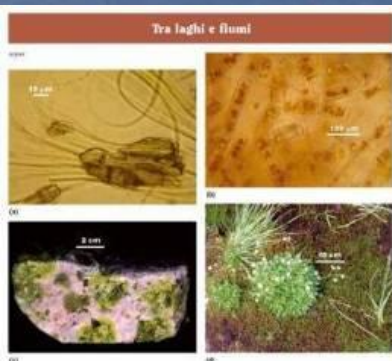
BRIDGING GENES TO ECOSYSTEMS:

AQUATIC SCIENCE AT
A TIME OF RAPID CHANGE

MAY 18-23 / OREGON CONVENTION CENTER

051 - Spring-habitats and spring-fed headwaters: biology fifty years after the definition of crenobiology

Duration: 4h, 15 talks



• Italian Edition of Smith & Smith, ecology textbook

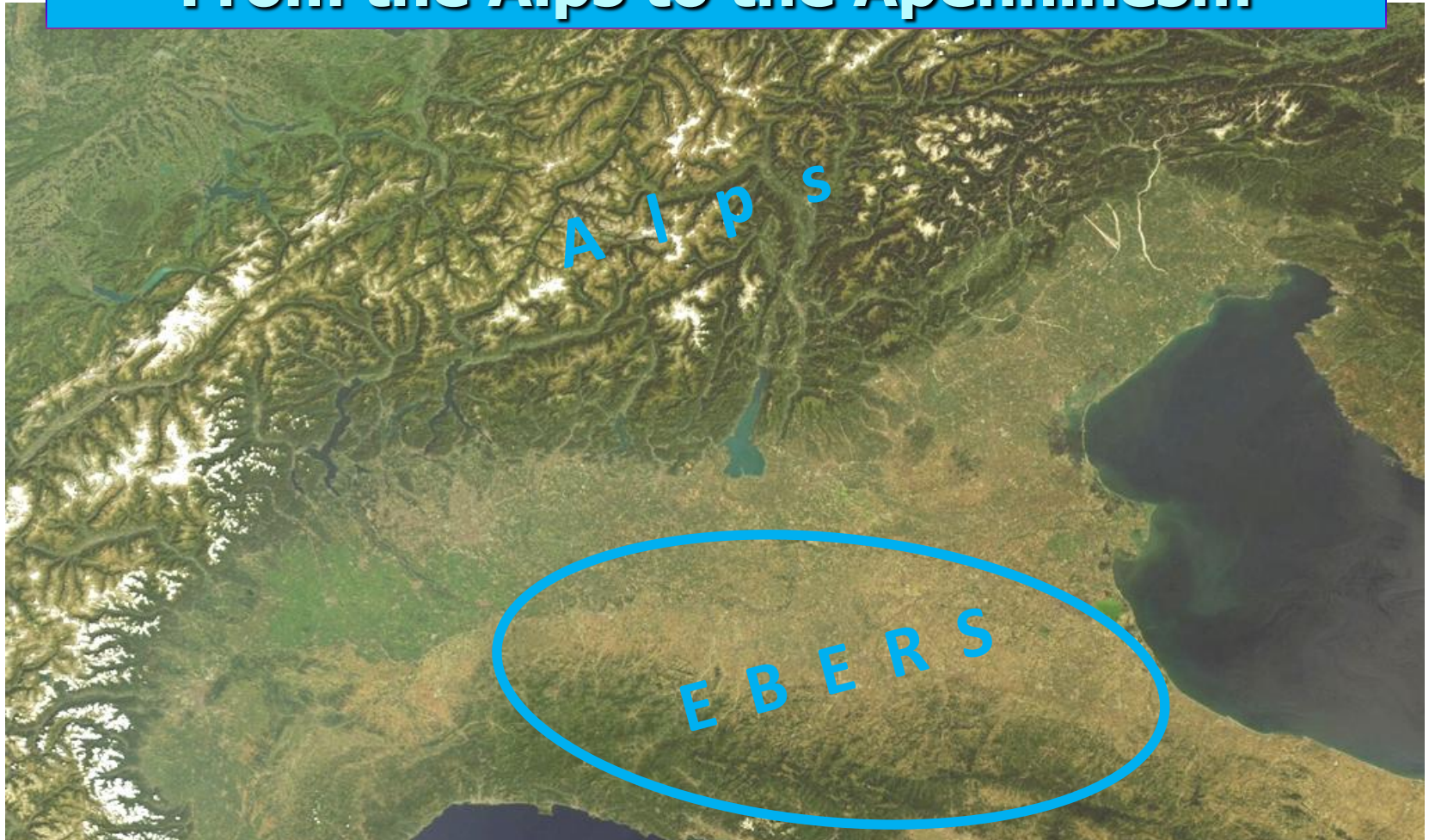


31 JULY
5 AUGUST

SPECIAL SESSION:
Springs: Well-known groundwater resources, disregarded biodiversity hotspots

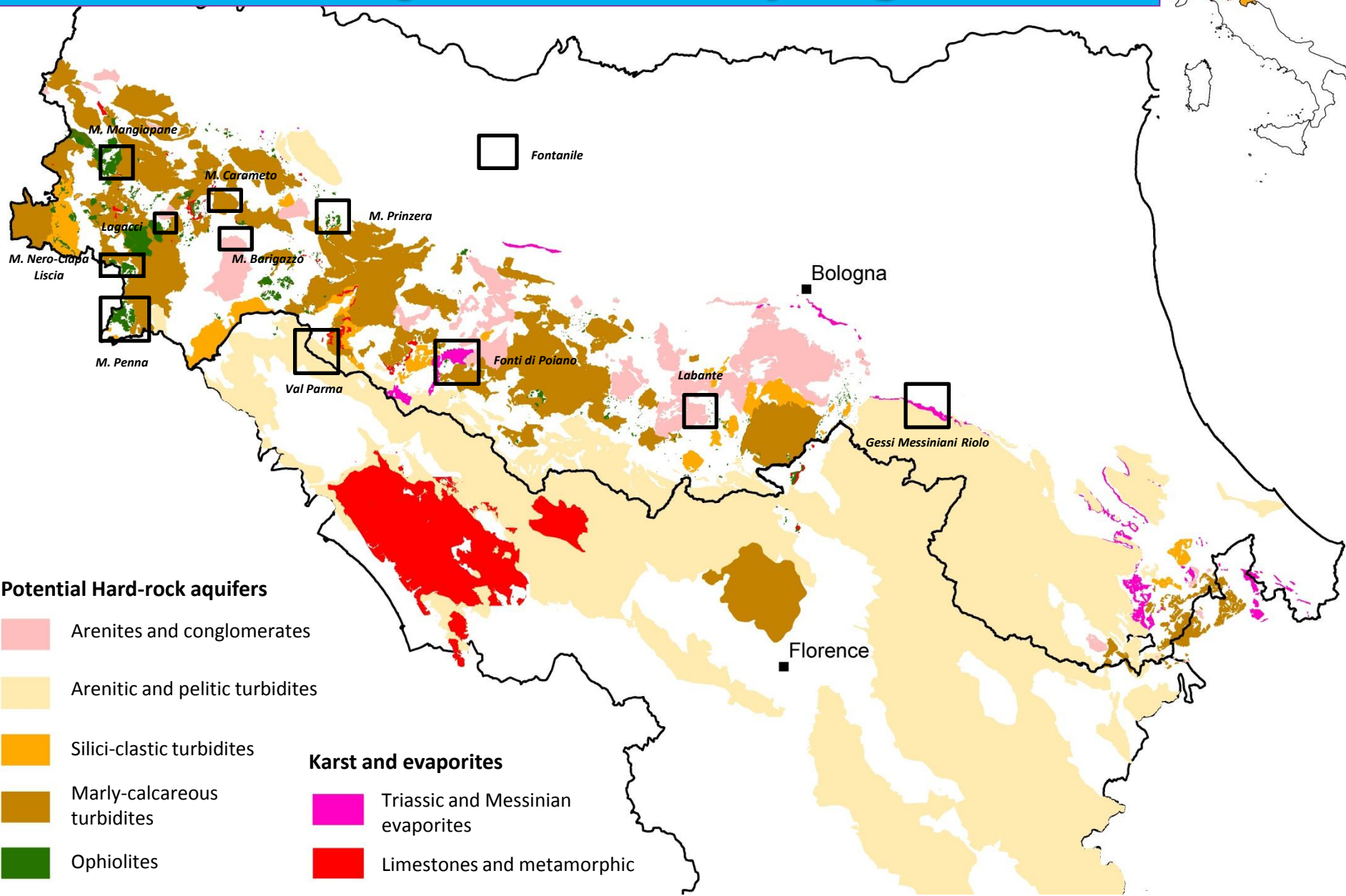
www.sil2016.it

From the Alps to the Apennines...



The EBERs Project - EBERs (*Exploring the Biodiversity of Emilia-Romagna springs*) is a three-years-lasting (2011-2013) Project fostered and funded by the Geological Survey of the Emilia-Romagna Region. Its main goal is an exploratory investigation on the biota of selected springs of the Emilia-Romagna Region with a multidisciplinary approach.

The EBERs Project and the springs studied



0 5 10 15 20 25 30 Kilometers

The EBERs springs: Ecomorphology (I)

**Low conductivity
seepage (1):** Elo_L_S



Low cond. flow. spr. (2): Cap_L_S, Font_Ve



Hygropetric (1):
Ciap_Li



**Shaded flow. spr.
with *Hild.* (4):** Mt_Nero



**Shaded flow. spr. ,
high pH (1):** Prinzer



**Shaded flow. spr. ,
med. cond. (1):** Barigaz



The EBERs springs: Ecomorphology (II)

SAL springs (2 + 1 spring stream): Labante, Caramet, Tor_Ooc
- small, near-natural:



Pool springs (2): F_VR_Su, F_VR_Sh
- sun-exposed:



Mineral springs (2): Ges_Rio, PoianoS
- sodium, chloride:



- large, exploited:



- shaded:



- sulphates:



Grouping of the majority of the EBERs springs according to hydrogeological types: **Groundwater flow systems in hard rock aquifers** involved by **fracturing** and **gravitational processes**.

a Elo_L_S
Cap_L_S
Font_Ve

b Ciap_Li

Mt_Nero
c Prinzer

Mt_Penn
d Lagacci
Man_Pan
Barigaz

e Caramet

Benthic algae including cyanob.

M.C. (MUSE, Trento)

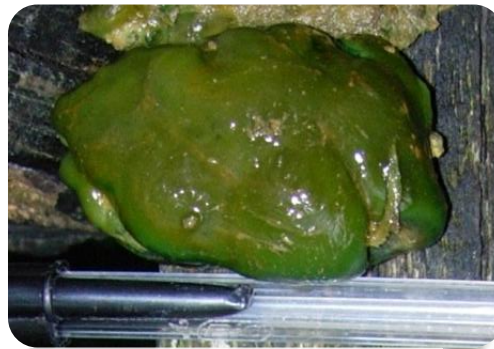
Colourings and different types of thalli formed by benthic algae were found in the majority of the springs. The most important groups were cyanoprokaryotes, green algae, and rhodophytes.

The red alga *Hildenbrandia rivularis*, recently shown in the southeastern Alps to be a characteristic species of 'Low-altitude, mostly shaded, slightly N-enriched rheocrenes with carbonate chemistry' (Cantonati *et al.* 2012), was found in 4EBERs springs.

Hildenbrandia rivularis



A macroscopic, large and abundant species of *Rivularia* found in the Poiano saline springs was sent to Prof. Marina Aboal, Spain, for phylogenetic analyses.



A *Chamaesiphon* s.s. species (*C. fonticola* was the target, *C. investiens* was sampled) of the F_VR_Sh is being cultivated and has been sequenced by Prof. Eugen Rott & Doz. Dr. Reiner Kurmayer, Univ. Innsbruck.



Green algae

Elliot Shubert (The Nat. Hist. Mus., London, UK)

Rhizoclonium

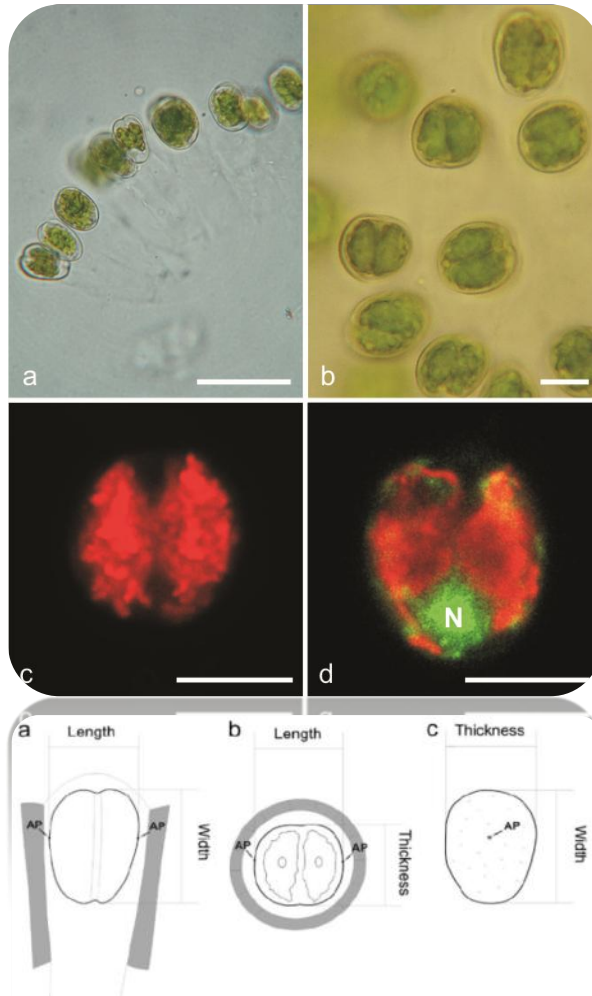
Cladophora glomerata



Interesting
epiphytic
green algae:

- *Characium*
- *Epipyxis*

Biocalcification



From Rott *et al.*
(2009) – *Protoplasma*

From Linhart &
Schagerl (2015) – *J.*
Phycol.

**The desmid *Oocardium stratum*
& L.P.S.**

Freshwater Science **31**(2): 610-624

Stoneworts

Dietmar Jäger (Hohenems, Austria)

In the artificial pond fed by the saline **Poiano springs**, 2 Characeae were recorded:

- ***Chara*** sp. – a brackish-water dioecious species;
- ***Tolypella*** sp.



In the two large **pool springs** (both exposed and shaded), ***Nitella mucronata*** was found.

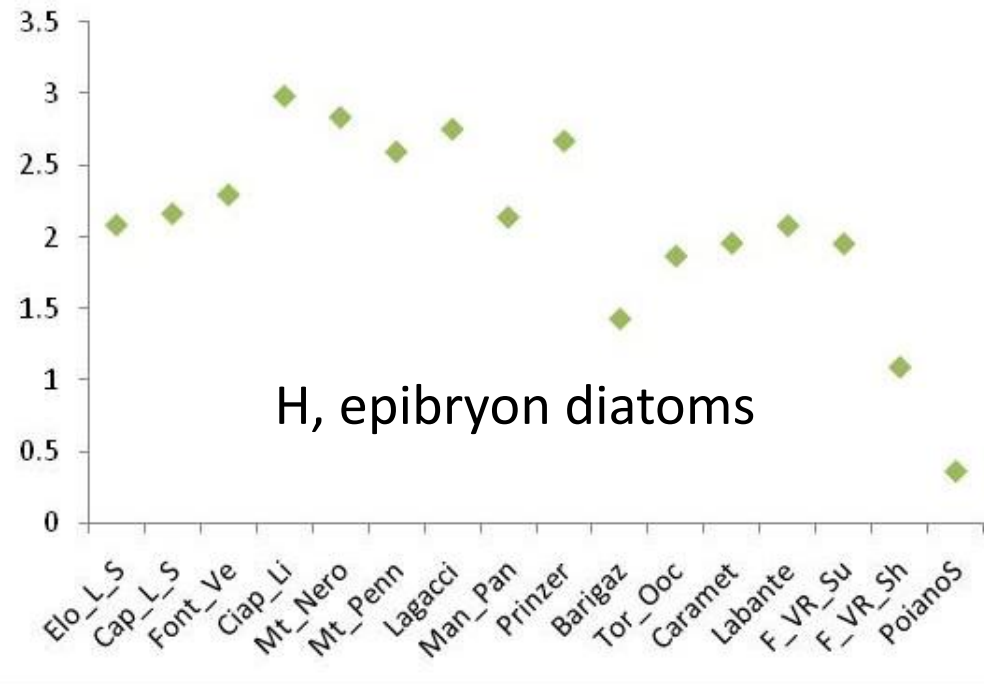
Diatoms: Diversity

M.C. & Nicola Angeli (MUSE, Trento)
H. Lange-Bertalot (Un. Frankfurt, DE)

This incredibly diverse group of microalgae can provide a wealth of useful information on water quality in most types of habitats, including springs (**Cantonati *et al.* 2012**).

Biodiversity: More than three-hundred (301) taxa belonging to **60 genera** were identified. EBERs confirmed **seepages** to be the spring type **richest in species** (60 taxa found in the Lago Scuro helocrenic spring).

Shannon-Wiener diversity of the epibryon diatoms is significantly correlated with **conductivity** (negative association) and with **altitude** (positive association).



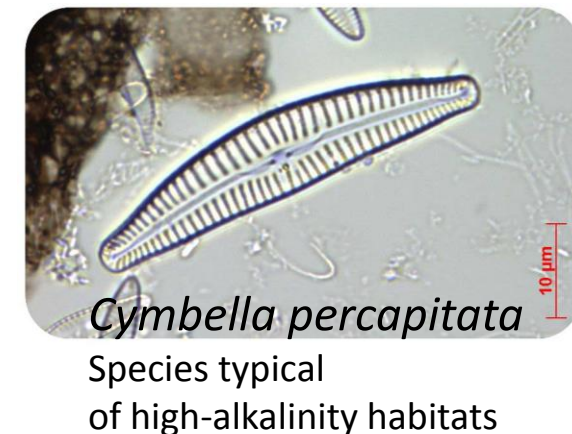
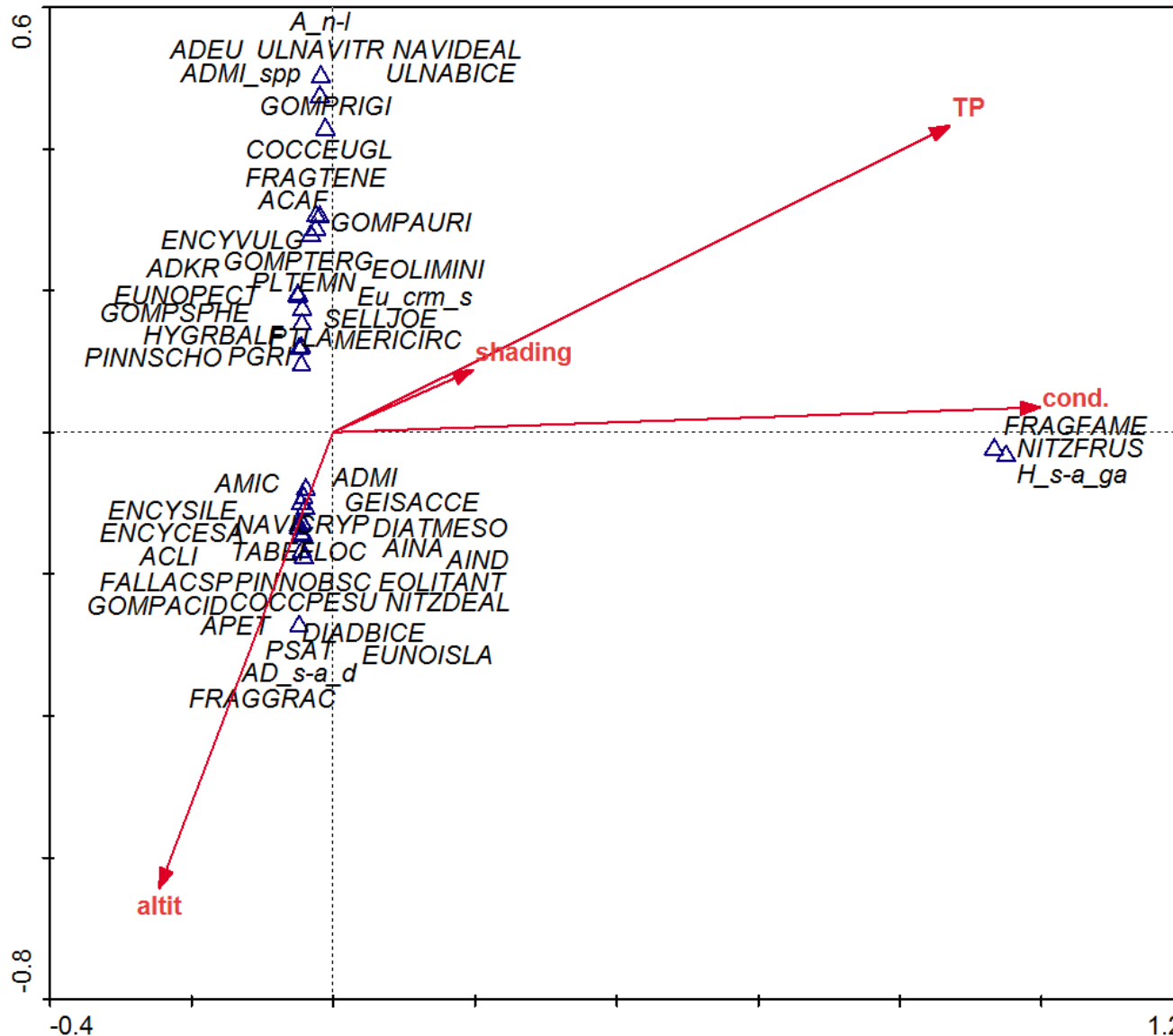
Diatoms: species of special interest

Four species (in the genera: *Halamphora*, *Delicata*, *Eunotia*, *Navicula*) are **new to science**.

In-depth studies on their LM morphology (variability etc.), chromoplast shape and arrangement, SEM ultrastructure, and ecology and distribution are being completed to characterize them. Further several other taxa (7) are putative new species, and observations and extensive literature research is being performed to confirm these hypotheses.

Diatoms: Correlations with the environmental variables

Daniel Spitale & Marco Cantonati, Science Museum – MUSE, Trento)



Diatom assemblages in the different spring types

Transform: Square root
Resemblance: S17 Bray Curtis similarity

2D Stress: 0.14

NMDS

Low
conductivity

F_VR_Sh
Pool spring -
shaded

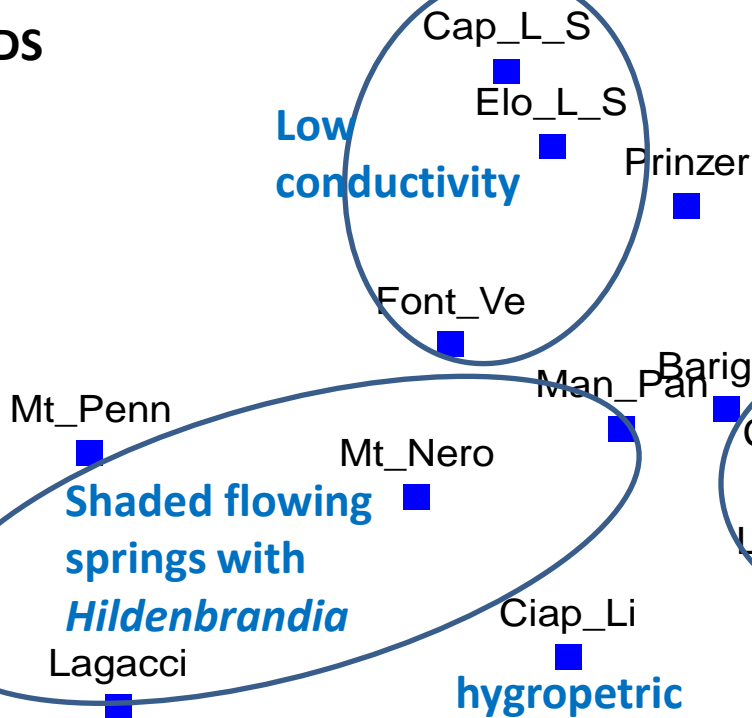
PoianoS
saline
spring

Shaded flowing
springs with
Hildenbrandia

SAL
springs

hygropetric

Pool spring -
exposed
F_VR_Su



Hydrochemistry

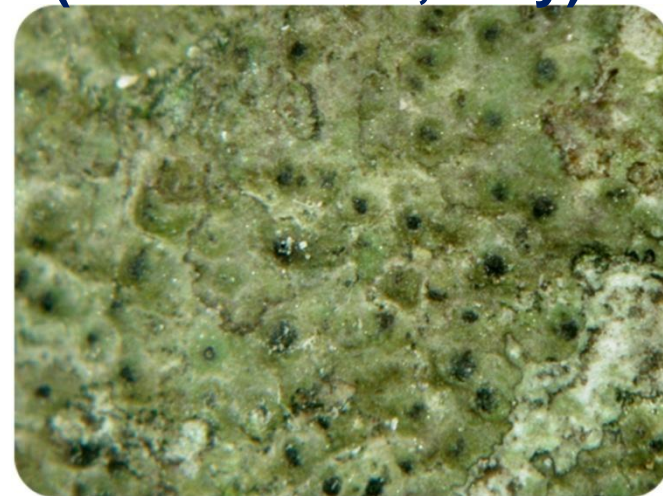
Jacopo Gabrieli (IDPA-CNR, Univ. Venice)

The **conductivity gradient** of the springs studied ($13\text{-}11560\ \mu\text{S cm}^{-1}$) extends over **three orders of magnitude**. In spite of its strikingly high (11.2) pH value, the Monte Prinzero spring just appears to be enriched with sodium and chloride. The two mineral springs (**Poiano**, and **Riolo**) are characterized by high **sodium, chloride, and sulphate** values. They also showed **high total phosphorus (TP) values**. TP enrichment is otherwise rare, even in the agricultural **lowland Fontanili** that are contaminated by **nitrate and chloride**. The Monte Nero and Ciapa Liscia springs, both coming to daylight on **ophiolithic rocks**, are enriched with sodium, magnesium, **chromium, nickel, arsenic, uranium, molybdenum, cadmium, antimony, titanium**.

Aquatic lichens

Juri Nascimbene (Univ. Trieste, Italy)

Biodiversity: 5 species identified, almost all highly interesting: **two are new reports for Italy**, and two are new for the Emilia-Romagna Region.

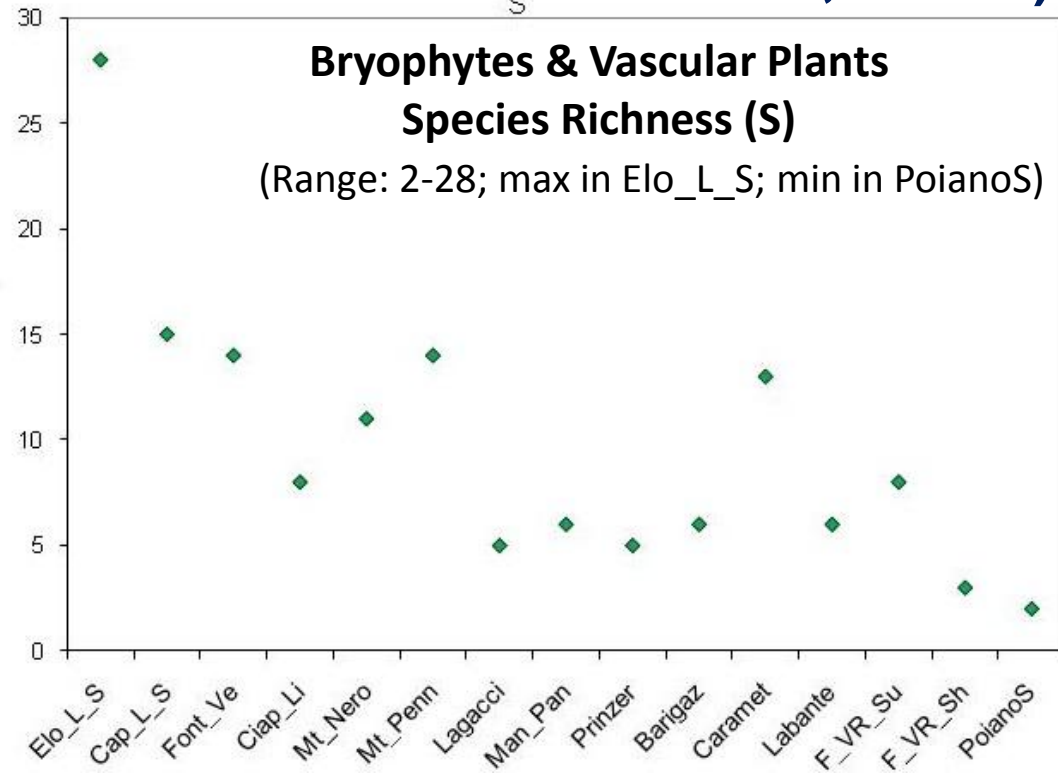


Bryophytes and vegetation

Daniel Spitale (Science Museum – MUSE, Trento)

A total of 93 species were found (**43 bryophytes** and **49 vascular plants**). Average richness was 9.6.

The most interesting findings were: - a second record for Italy; - two species that were not found in Emilia-Romagna after 1950 .

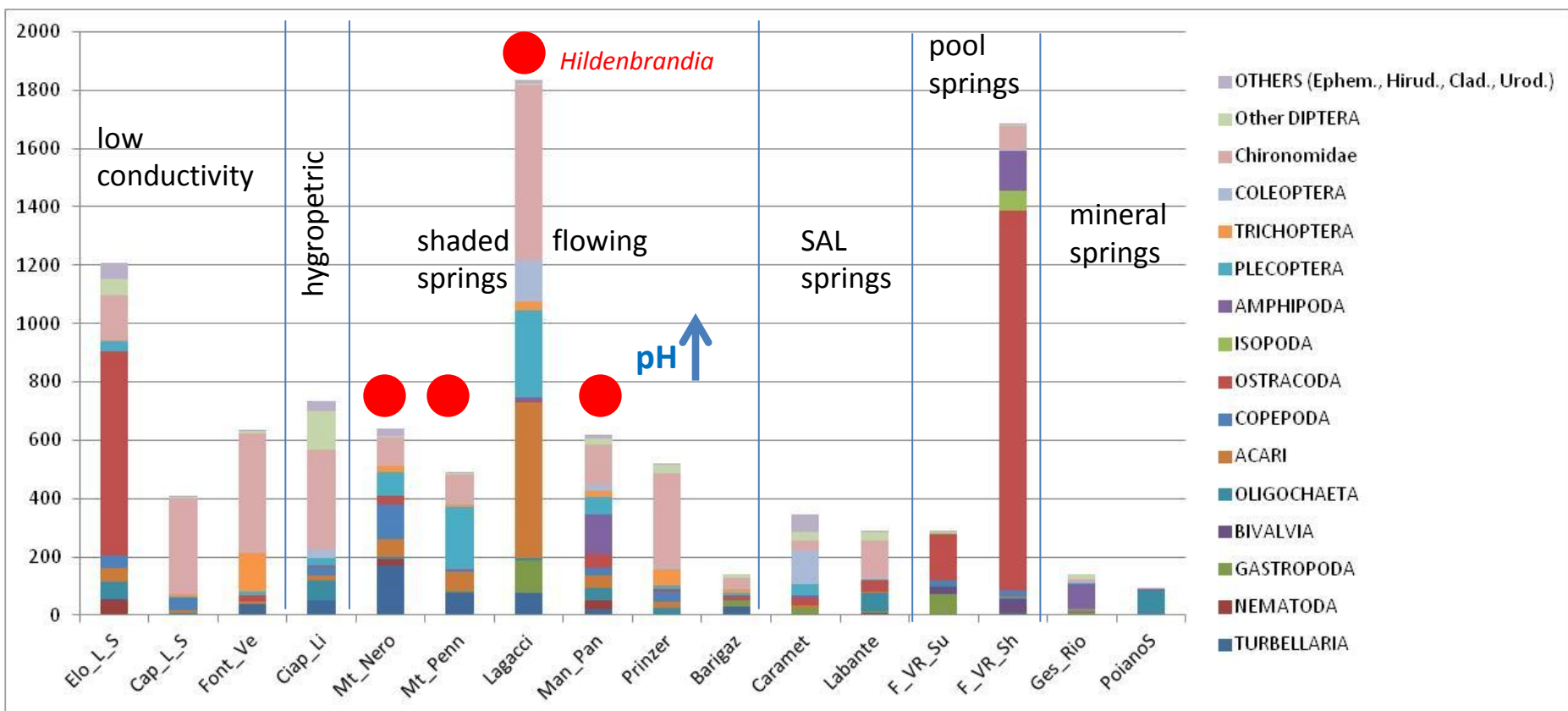


Zoobenthos

Reinhard Gerecke (Univ. Tübingen, Germany)

TURBELLARIA 473	NEMATODA 124	GASTROPODA 241	BIVALVIA 70	OLIGOCHAETA 393	HIRUDINEA 7	ACARI 827	COPEPODA 331
OSTRACODA 2356	CLADOCERA 58	ISOPODA 76	AMPHIPODA 385	EPHEMEROPTERA 150	PLECOPTERA 805	TRICHOPTERA 286	URODELA 1
COLEOPTERA 41	Dytiscidae 5	Elmidae 250	Haliplidae 3	Hydraenidae 12	Hydrophilidae 7	Psephenidae 1	Scirtidae 20
DIPTERA 4	Athericidae 14	Ceratopogonidae 124	Chironomidae 2780	Culicidae 1	Dixidae 9	Empididae 61	Limoniidae 24
	Psychodidae 94	Ptychopteridae 6	Stratiomyidae 19	Tabanidae 1			

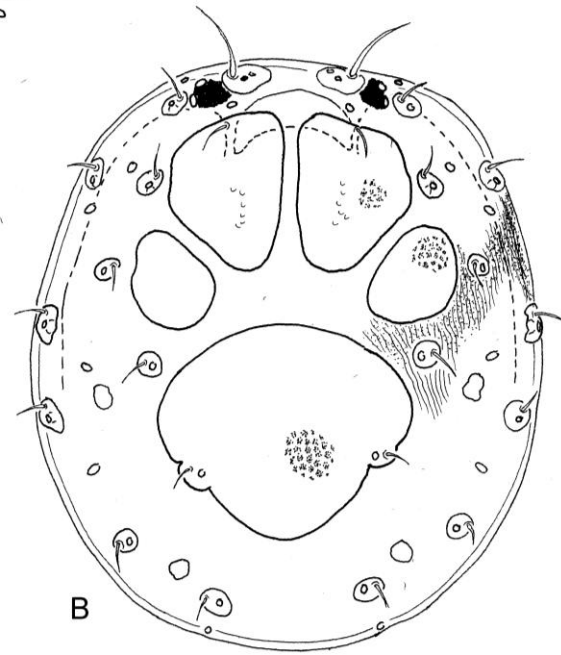
Decreasing abundance →



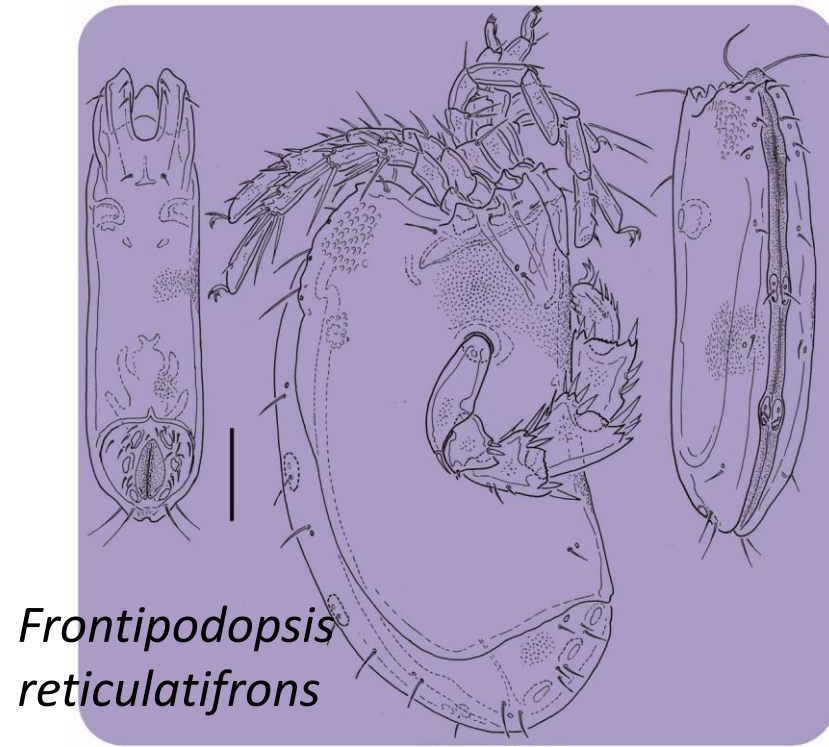
Water mites

Reinhard Gerecke, Univ. Tübingen, Germany)

This is the group of organisms that includes the highest number of species exclusive to springs (so-called **crenobionts**). Biodiversity: A **species new-to-science** (*Pseudofeltria aemiliana* Gerecke 2014); relatively-high number of species found (about 25); 2 new records for Italy, and a very-recently described species (*Hygrobates psammocrenicus* Gerecke & Di Sabatino). With reference to **stygobiotic species**, the most striking result was the finding of large population of the typical interstitial, laterally compressed water mite *Frontipodopsis reticulatifrons*. This species is normally strictly bound to interstitial water.



Pseudofeltria aemiliana Gerecke 2014, this species is more distinct in females (with 5 dorsal plates)



Frontipodopsis reticulatifrons

Copepods, Gammarids & Niphargids

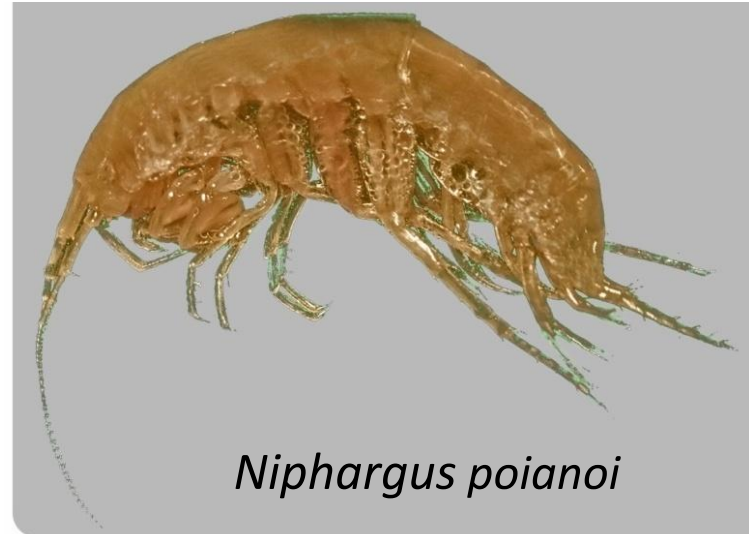
Fabio Stoch, University of l'Aquila, Italy

Biodiversity: **23** taxa found, several of special interest.

Bioindicator copepod species, typical of Alpine springs of medium-high elevation (such as *Attheyella wierzejskii*, *Bryocamptus -Rheocamptus-zschokkei*, *Bryocamptus -Arcticocamptus- cuspidatus*, and *Moraria alpina*), reveal an unexpected, and so far undemonstrated, **ecological resemblance between Emilia-Romagna and Alpine mountain springs**. These microcrustacean assemblages should therefore be considered as a glacial relict fauna in the Aemilian Apennines.

A relevant finding refers to the genus *Niphargus*, that finely splits up in a series of **endemics** (all new to science). Each of these species marks a hydrographic basin (e.g., the stygobiotic species *Niphargus poianoi* is restricted to the gypsum waters of the Upper Secchia Valley.

Echinogammarus veneris, a brackish water gammarid, was found in the spring emerging from the Riolo Gypsum.



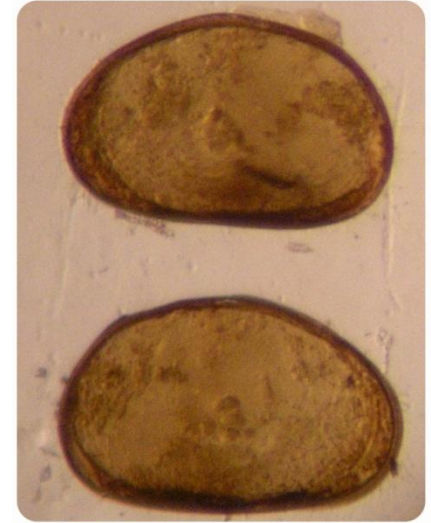
Niphargus poianoi

Ostracods

G. Rossetti & M. Rosati, Univ. Parma, Italy

Biodiversity: Relatively-high number of species found (about twenty), with **five new records for Northern Apennines' springs** (the most relevant is *Cyclocypris helocrenica*, a species, that, as the name suggests, is typical of seepages).

Most of the species found are crenobiontic but only few are stygophylous.



Cyclocypris helocrenica

Molluscs

F. Decet, Environ. Ag., Chem. Dept., Belluno

Biodiversity: **18** species identified; 8 aquatic and 10 terrestrial, as it might be expected for transitional (**ecotonal**) environments such as springs. *Bythinella schmidtii* was the most common species. ***Vertigo angustior*** is a species included in the Appendix of the European Union **Habitat Directive** (EU-HD 1992).



Bythinella schmidtii

Closing Discussion

1• Springs are confirmed by the EBERs Project to be **habitats of special relevance for nature conservation**. They are species rich, host **relevant amounts of species new to science** and of characteristic, **rare, and threatened Red-List species**. Spring habitats can moreover be **refugia** for the most sensitive taxa, in particular in densely inhabited and exploited areas.

2• Springs are **heavily-exploited water resources** but **hardly known as biodiversity hotspots** and complex groundwater-dependent ecosystems.



3• The regional pools of spring organisms tend to be **very rich** whilst **individual spring habitats** are **sometimes species poor**. Therefore, springs can be **natural treasure houses of biodiversity** only if, at the regional level, **entire pools of springs** (including different **morphological types**) **can be protected**.

4• Helocrenes and **hygropetric rheocrenes** are the **spring types on which conservation efforts should concentrate** because of their vulnerability and their relevance for several taxonomic groups.

5• The biodiversity detected in the relatively **small number** of springs studied is **remarkable** both from the quantitative and qualitative standpoints. This is likely to be due to several **reasons**: 1) **extreme heterogeneity** of environmental situations available in the study area; 2) **ecotonal character** of spring habitats that allow to encounter organisms that range from stygobiontic to rheobionthic and from strictly-aquatic to pseudaaerial; 3) spring habitats in Emilia-Romagna still relatively **unexplored**; 3) **high-resolution taxonomic approach**.

Acknowledgements



Regione Emilia-Romagna



servizio geologico
sismico e dei suoli

MuSe