

**STATISTICKÉ METODY:  
ZÍSKÁVÁNÍ INFORMACÍ Z DRUHOVÝCH  
A ENVIRONMENTÁLNÍCH DAT;  
VIZUALIZACE VÝSLEDKŮ**

# (NE)VÝHODY STATISTIKY

OTÁZKY si klást ještě před odběrem a podle nich naplánovat design, metodiku odběru (experimentální vs. pozorování), analýzy, grafy a testy.

Je důležité, aby se srovnávaly porovnatelné OBJEKTY (tj. takové, které se liší pouze, nebo hlavně studovaným jevem a v ostatních parametrech jsou si podobné).

Identifikace DRUHŮ není tolik důležitá z pohledu taxonomie, ale záleží na jednotnosti určování; pojmenovávat organismy jednotně napříč vzorky.

Možnost využití jiných taxonomických jednotek (OTU) než je druh (morfortypy, rody).

# (NE)VÝHODY STATISTIKY

Nepoužívat PROGRAMY bez dobré znalosti metod.

Nedá se určit, která z METOD je obecně lepší záleží na povaze dat; často možnost použít více vhodných analýz.

STATISTIKA není všemocná, někdy z dat “nic” nevyplývá.

Usuzování na parametry základního souboru pomocí parametrů VÝBĚRU. Spolehlivost tohoto odhadu.

Nejjednodušší závislost je LINEÁRNÍ. To neznamená, že předpokládám, že svět se chová lineárně, ale to, že jej mohu lineárním modelem aproximovat (v určitém rozsahu hodnot).

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Podíl VARIABILITY jedné proměnné vysvětlené změnami druhé proměnné.

# OTÁZKY, KTERÉ SI LZE KLÁST

otázky spojené s organismy; nenáhodnost jevů

DIVERZITA – porovnávání na různých úrovních

SPOLEČENSTVA – výskyt druhů, podobnost, abundance

MORFOLOGIE – velikost, tvar, struktury

VÝZNAMNOST FAKTORŮ – fyzikálně-chemické

parametry, vzdálenost lokalit/vzorků, sezónní změny

# TYPY DAT/PROMĚNNÝCH

druhová, morfologická a environmentální data

**KVANTITATIVNÍ** – diskrétní (např. jen určitá čísla), spojité (měření; počítání buněk druhu)

**SEMIKVANTITATIVNÍ** – odhad proměnné (procentuální; kategorie kvantit)

**KVALITATIVNÍ** – binární (výskyt/nevýskyt), vícestavové (faktory, dummy variables), rozdělení kvantitativních do skupin/kategorií

# TERMINOLOGIE

VARIANCE/VARIABILITA/KOVARIANCE – variance hodnot určité proměnné/variabilita druhových dat (změny v druzích a/nebo v abundancích), variabilita morfologických dat (mnohorozměrná data o tvaru)/kovariance: společný vliv na variabilitu dat

(NE)ZÁVISLÁ PROMĚNNÁ - nezávislá proměnná: prediktor, faktor, kovariáta (odstínění vlivu proměnné na data); závislá proměnná: response variable, sledovaná proměnná

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prediktor, faktor, kovariáta (odstínění vlivu proměnné na data); závislá proměnná: response variable, sledovaná proměnná

DISTANCE/SIMILARITA – vzdálenost v prostoru  
dat/podobnost (distance = 1-hodnota podobnosti)

SIGNIFIKANCE - pravděpodobnost sebraných dat za  
podmínky neexistence závislosti (platnosti nulové  
hypotézy)



# METODY ANALÝZ

odhad typu a intensity závislosti proměnných

**JEDNOROZMĚRNÉ** – změny nebo vztahy několika málo proměnných; popisná statistika, analýza variance (ANOVA), korelace/regrese; druhy přes indexy diverzity nebo podobnosti

**MNOHOROZMĚRNÉ** – zjednodušení mnohorozměrných dat; shlukové analýzy, ordinační metody, mnohonásobné korelace/regrese, diskriminační analýzy

**TESTOVÁNÍ** – test jen předpokladem toho, aby bylo možné se o výsledcích vůbec bavit

# TESTOVÁNÍ

Vybrat vhodný TEST (hlavně na základě znalosti o povaze dat) a rozhodnout se pro něj před provedením vlastní analýzy (nikoli zkoušet mnoho testů naslepo).

Pokud nelineární vztah hledání různých modelů (funkce).

*Parametrické* testy mají předpoklad určitého rozdělení (např. normální – není časté u menších výběrů a také obecně u biologických dat), *neparametrické testy* (permutace/randomizace, pořadí dle hodnot).

# ZOBRAZENÍ DAT

výběr uzpůsobit pro sdělnost a zvýraznění důležitých aspektů

**NĚKOLIK MÁLO PROMĚNNÝCH:** *záv. kvantitativní vs. nezáv. kvalitativní* – popisná statistika, box ploty, sloupcové grafy, xy graf průměrů objektů; *záv. kvantitativní vs. nezáv. kvantitativní* – korelace, spojnicový graf, bodový xy graf (matematický model), box ploty (rozdělení spojitě proměnné na intervaly); *záv. kvalitativní vs. nezáv. kvalitativní* – frekvenční tabulky

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MNOHO PROMĚNNÝCH: *hypotézy* – PCA/DCA, NMDS, shlukové analýzy; *vliv faktorů*: RDA/CCA, rozdělení variability, Mantelův test

# INTERPRETACE DAT

porovnávání výsledků, umět číst z grafů

**JEDNOROZMĚRNÉ** – predikce hodnot na základě pozorování; porovnání závislostí mezi skupinami z hodnot a diagramů

**MNOHOROZMĚRNÉ** – shluky interpretovat na základě vnější informace (znalost ekologie druhů, znalost stanovišť); pozor na argumentaci kruhem. Významnost parametrů, zjištění vzájemně korelovaných parametrů (spolu-působení faktorů na variabilitu druhů), rozklad celkové variability.

# REFERENCE

NÁPOVĚDA a MANUÁLY programů; wikipedia.

materiály T HERBENA <http://web.natur.cuni.cz/~herben/biostat.html> *nebo* [.../multivar.html](http://web.natur.cuni.cz/~herben/multivar.html)

BORCARD D, LEGENDRE P a DRAPEAU P (1992) Partialling out the spatial component of ecological variation.

LEGENDRE P a LEGENDRE L (1998) Numerical ecology.

LEPŠ J a ŠMILAUER P (2003) Multivariate analysis of ecological data using CANOCO.

McCUNE B a GRACE JB (2002) Analysis of ecological communities.

MARHOLD K a SUDA J (2001) Analýza multivariačních dat v taxonomii (fenetické metody).

# STATISTICKÉ APLIKACE

komunikace přes MS Excel nebo clipboard (ctrl+c – ctrl+v)

MS EXCEL – zaznamenávání dat, pouze jednorozměrné analýzy

CANOCO – mnohorozměrné ordinační analýzy

eRko – spíše přes příkazový řádek, spousta skriptů; zdarma

PAST – obyčejné grafy, tabulkové výpočty; zdarma

PRIMER – jen mnohorozm., počítá s distancemi/podobnostmi

SIGMA PLOT – pouze kreslení grafů

ZT WIN – Mantelovy testy prostorová autokorelace; zdarma

STATISTICA, ORIGIN, S-PLUS, NCSS – jednorozměrné analýzy, klikací, pěkná grafika grafů

TPS – mnohorozměrné morfometrické analýzy tvaru; zdarma

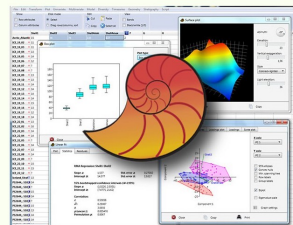
# Past 4 - the Past of the Future

Past is free software for scientific data analysis, with functions for data manipulation, plotting, univariate and multivariate statistics, ecological analysis, time series and spatial analysis, morphometrics and stratigraphy.

Past went through a complete redesign with version 3 in 2013. In 2020, version 4 was released with 64-bit support.

Past works under Windows 11, 10, 8 and 7, and Mac OSX up to and including Sonoma.

Current version (June 2024): 4.17



## GET STARTED

### 1 Shiny Basics

- Welcome to Shiny
- Build a user interface
- Add control widgets
- Display reactive output
- Use R scripts and data
- Use reactive expressions
- Share your apps

### 2 Build an App

### 3 Next Steps

Shiny Basics > Welcome to Shiny

# Welcome to Shiny

## Installation

Shiny is an R package that makes it easy to build interactive web applications (apps) straight from R. This lesson will get you started building Shiny apps right away.

If you still haven't installed the Shiny package, open an R session, connect to the internet, and run

```
install.packages("shiny")
```

Shiny comes with another package, [bslib](#), which we'll also use to build great looking user interfaces.



# VIZUALIZACE DAT

usnadnění ORIENTACE v datech: možnost najít zákonitosti, které stojí za to zkoumat více do hloubky

po explorativních analýzách se zaměřit na DŮLEŽITÉ VÝSLEDKY, které jsou jádrem našeho výzkumu

PŘEDÁNÍ POSELSTVÍ nejen textem ale i odpovídajícím obrázkem, který může zvýšit zaujetí i pochopení ostatními

# JEDNOROZMĚRNÉ ANALÝZY

# POPISNÉ TABULKY

**Table 3.** Variations of chlorophyll a (Chla), pheopigment (Pheop) concentrations, the mean density (Dm) and their standard deviation (S.D.) respectively of drifting algae according to the mean current velocity (Vm), the mean depth (Pm) and the hydraulic radius (rh)

		Group 1			Group 3	Group 2		
		1	5	6	3	4	7	8
		Taxon name						
		Adlafia bryophila						
		Chamaepinnularia australomediocris						
		Fragilaria capucina morph. 2						
		Pinnularia acidicola						
		Stauroforma exiguiformis						
		Chl. a						
		Pheop.						
		Dm						
		Vm						
		Pm						
		rh						
		$\mu\text{g} \cdot \text{l}^{-1}$						
		$\text{cell} \cdot \text{l}^{-1}$						
		$\text{m} \cdot \text{s}^{-1}$						
		m						
		m						
Station 1	Surface	0.46 ( $\pm 0.24$ )	0.84 ( $\pm 0.21$ )	42200 ( $\pm 40310$ )	0.32			
	Half depth	0.50 ( $\pm 0.20$ )	0.64 ( $\pm 0.29$ )	50660 ( $\pm 33010$ )	0.27	0.15	0.024	
	Bottom	0.93 ( $\pm 0.75$ )	1.50 ( $\pm 0.82$ )	55820 ( $\pm 44540$ )	0.17			
Station 2	Surface	0.35 ( $\pm 0.10$ )	0.23 ( $\pm 0.12$ )	17710 ( $\pm 12180$ )	0.53			
	Half depth	0.38 ( $\pm 0.12$ )	0.39 ( $\pm 0.11$ )	16430 ( $\pm 12660$ )	0.34	0.21	0.052	
	Bottom	0.40 ( $\pm 0.26$ )	0.50 ( $\pm 0.18$ )	16330 ( $\pm 14470$ )	0.22			
		Psammothidium stauroneioides						
		Diademis contenta						

**Table 3** Summary of the main ecological characteristics of the different assemblages

	Group 1			Group 3	Group 2		
	1	5	6	3	4	7	8
Number of samples	62	5	10	15	4	18	18
Mean moisture class	4.1 $\pm$ 0.9	3.9 $\pm$ 1.2	4.7 $\pm$ 0.5	3.3 $\pm$ 0.9	3.25 $\pm$ 0.29	2.8 $\pm$ 1.0	2.3 $\pm$ 0.9
Mean water pH <sup>a</sup>	6.8 $\pm$ 0.6	6.2	6.9 $\pm$ 0.4	6.8 $\pm$ 0.6	–	5.8	6.8 $\pm$ 0.6
Mean soil pH <sup>a</sup>	6.1 $\pm$ 0.6	7	6.3 $\pm$ 1.2	5.8 $\pm$ 0.4	–	5.98 $\pm$ 0.10	5.8 $\pm$ 0.5
Mean soil conductivity <sup>a</sup> ( $\mu\text{S}/\text{cm}$ )	0.17 $\pm$ 0.08	0.09	0.40 $\pm$ 0.20	0.23 $\pm$ 0.12	–	0.54 $\pm$ 0.21	0.21 $\pm$ 0.12
Mean soil salinity <sup>a</sup>	0.10 $\pm$ 0.04	0.05	0.23 $\pm$ 0.12	0.13 $\pm$ 0.7	–	0.31 $\pm$ 0.12	0.12 $\pm$ 0.08
Mean LOI (%DW) <sup>a</sup>	23 $\pm$ 16	1	41 $\pm$ 23	22 $\pm$ 12	–	14.5 $\pm$ 1.0	11 $\pm$ 8
Mean no. of taxa	32 $\pm$ 10	22 $\pm$ 4	21 $\pm$ 6	24 $\pm$ 6	19 $\pm$ 11	30 $\pm$ 11	33 $\pm$ 13
Mean diversity	2.4 $\pm$ 0.5	1.7 $\pm$ 0.4	1.7 $\pm$ 0.5	1.9 $\pm$ 0.5	1.5 $\pm$ 0.7	2.4 $\pm$ 0.5	2.3 $\pm$ 0.7
Mean evenness	0.70 $\pm$ 0.10	0.54 $\pm$ 0.12	0.55 $\pm$ 0.12	0.61 $\pm$ 0.12	0.51 $\pm$ 0.15	0.70 $\pm$ 0.12	0.66 $\pm$ 0.11

<sup>a</sup>When measured.

# MATICE

**Table 2**

Results of Mantel tests with respect to LDV and species richness and significance of the relationships. Lower left part – calculated on the whole dataset, upper right part north-western part (upper numbers) and south-eastern part (lower numbers).

	LDV <sup>a</sup>	Richness <sup>b</sup>	Age <sup>c</sup>	Forest <sup>d</sup>	N-gps <sup>e</sup>	E-gps <sup>f</sup>	Altitude	Radiation <sup>g</sup>	Precip. <sup>h</sup>	PM10s-96 <sup>i</sup>	Pollution <sup>j</sup>
LDV <sup>a</sup>		0.61*** 0.80***	-0.23* 0.45***	ns <sup>k</sup> 0.78***	-0.47*** -0.62***	-0.55*** 0.61***	0.43*** 0.42***	ns 0.21**	0.48** 0.74***	-0.77*** -0.28**	ns ns
Richness <sup>b</sup>	0.68***		ns 0.40***	-0.24** 0.61***	ns -0.61***	-0.25** 0.62***	0.26** 0.32***	0.31** 0.31***	0.25* 0.56***	-0.68*** ns	ns ns
						ns 0.28***	0.41*** 0.54***	0.27** 0.41***	-0.40** 0.56***	ns ns	ns ns
						0.19* 0.47***	-0.19* 0.55***	-0.20* 0.20**	ns 0.69**	ns -0.35***	ns ns
						0.32** -0.56***	ns ns	0.21* ns	-0.32* -0.34***	0.38*** 0.55***	ns -0.25*
							-0.67*** 0.18*	ns 0.36***	ns 0.57***	0.40*** ns	ns 0.18*
						-0.33***		0.32** 0.26***	ns 0.69***	-0.45*** ns	ns ns
						0.36***	0.14**		ns	-0.28* 0.46***	ns 0.25**
						0.61***	0.22***	0.37***		-0.41** ns	ns ns
						-0.36***	ns	-0.17***	-0.19***		ns ns
Pollution <sup>j</sup>	-0.11*	-0.17**	ns	ns	0.25***	-0.15**	ns	-0.13**	ns	0.48***	

**Table 4.** Results of linear discriminant analyses (DA,  $p < 10^{-5}$ ) based on quantitative shape characters of strains obtained from geometric morphometrics.

	646K	O/71	460R	462R	B145	HV5	HV25	O/70	647K	27L	29L	O/26
646K	-	100	100	100	100	100	100	100	100	100	100	100
O/71	0	-	98.3	100	98.3	100	100	100	96.6	100	100	91.4
460R	10	1	-	100	93.3	98.3	100	98.3	91.5	100	100	98.3
462R	0	0	0	-	100	100	100	100	100	100	100	100
B145	0	1	4	0	-	98.3	100	94.8	94.9	100	100	100
HV5	0	0	1	0	1	-	100	98.3	100	100	100	100
HV25	0	0	0	0	0	0	-	100	100	100	100	100
O/70	0	0	1	0	3	1	0	-	100	100	100	100
647K	0	2	5	0	3	0	0	0	-	98.3	100	100
27L	0	0	0	0	0	0	0	0	1	-	100	96.6
29L	0	0	0	0	0	0	0	0	0	0	-	100
O/26	0	5	1	0	0	0	0	0	0	2	0	-

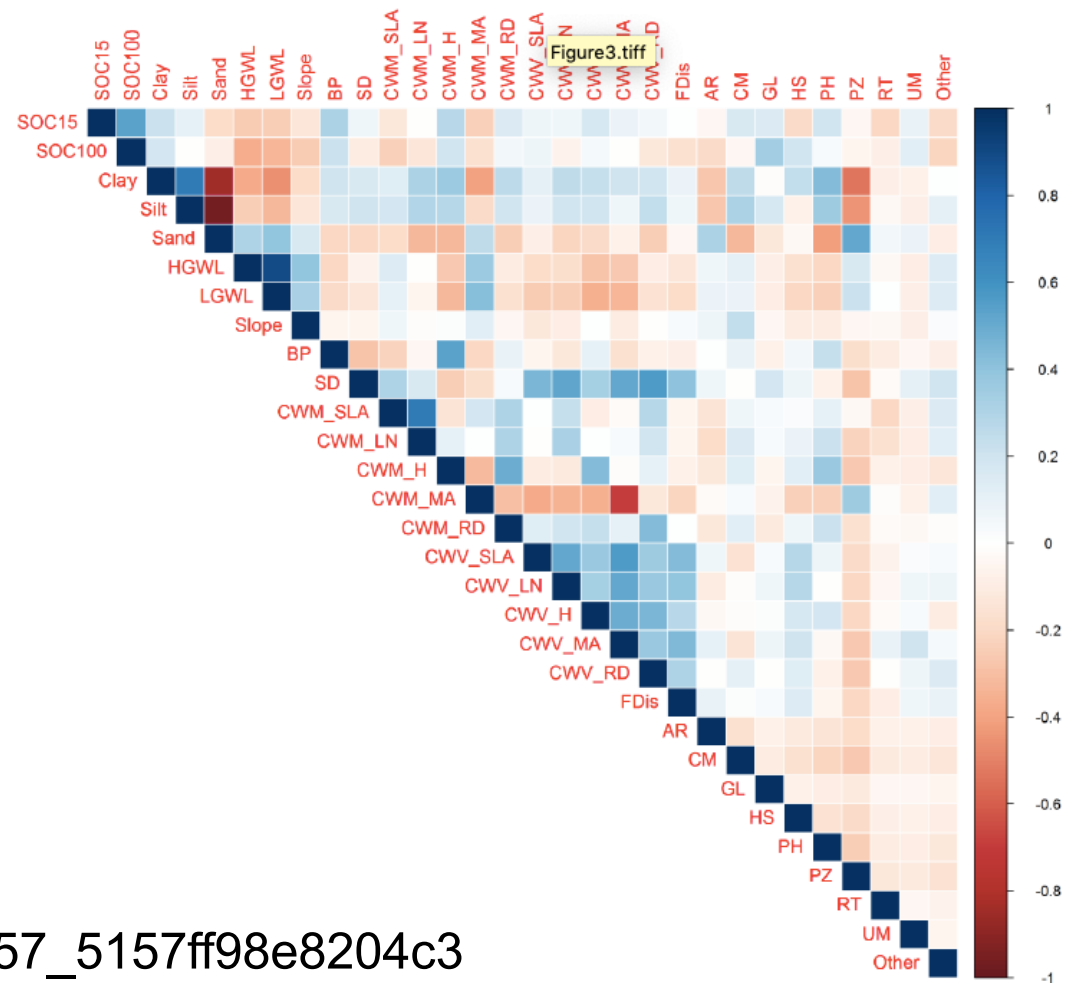
Lower part of matrix: number of displaced cells, upper part of matrix: percentage of correctly identified cells into appropriate strain. First four strains *Navicula cryptocephala* clade I, second four strains *N. trivialis* clade III, the last four strains *N. cryptocephala* clade II.

**Table 6**

Pearson correlation coefficients between targeted environmental variables for the three datasets

	pH			EC <sup>a</sup>			Cl <sup>-a</sup>			TP <sup>a</sup>			TIN <sup>a</sup>			TON <sup>a</sup>			O <sub>2</sub> %			BOD <sub>1</sub> <sup>a</sup>			
	All	pH ≤ 7	pH > 7	All	pH ≤ 7	pH > 7	All	pH ≤ 7	pH > 7	All	pH ≤ 7	pH > 7	All	pH ≤ 7	pH > 7	All	pH ≤ 7	pH > 7	All	pH ≤ 7	pH > 7	All	pH ≤ 7	pH > 7	
EC <sup>a</sup>	0.69	0.40	0.26																						
Cl <sup>-a</sup>	0.63	0.64	0.31	0.86	0.85	0.82																			
TP <sup>a</sup>	0.26	ns	ns	0.49	0.48	0.49	0.48	0.54	0.41																
TIN <sup>a</sup>	ns	ns	ns	0.26	0.34	0.29	0.19	0.31	ns	ns	0.30	ns													
TON <sup>a</sup>	0.32	0.53	ns	0.37	ns	0.39	0.45	0.45	0.41	0.62	0.76	0.58	ns	ns	ns										
O <sub>2</sub> %	0.22	-0.45	0.56	ns	-0.40	ns	ns	-0.39	ns	-0.25	-0.31	-0.29	ns	ns	ns	ns	ns	ns							
BOD <sub>1</sub> <sup>a</sup>	0.30	0.52	ns	0.28	0.36	ns	0.31	0.50	ns	0.29	0.50	0.20	ns	ns	ns	0.61	0.55	0.61	ns	ns	ns				
pGOP <sup>a</sup>	0.23	0.38	ns	0.21	ns	ns	0.20	ns	ns	ns	ns	ns	ns	ns	ns	0.53	ns	0.59	ns	ns	ns	0.70	0.46	0.74	

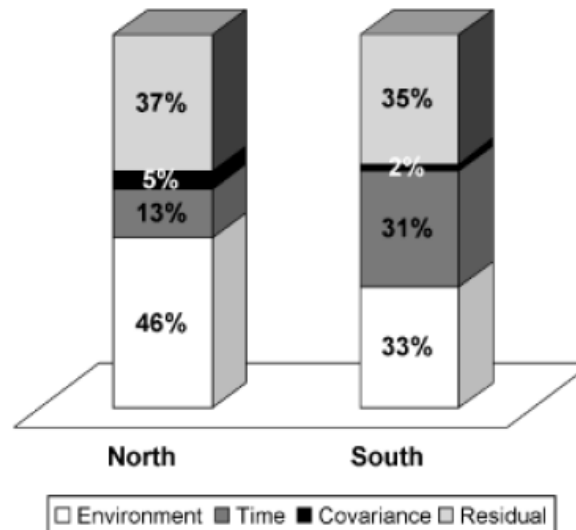
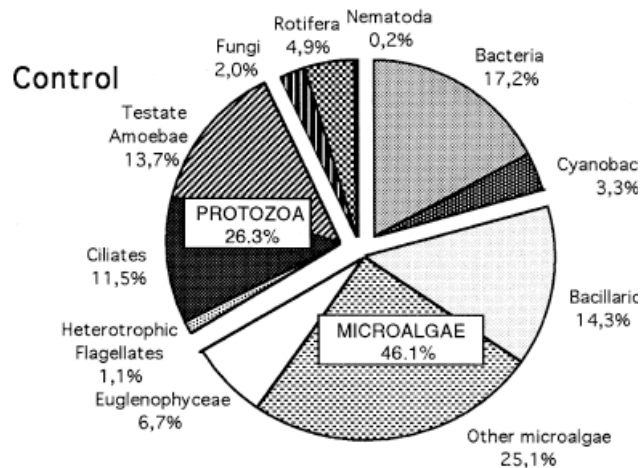
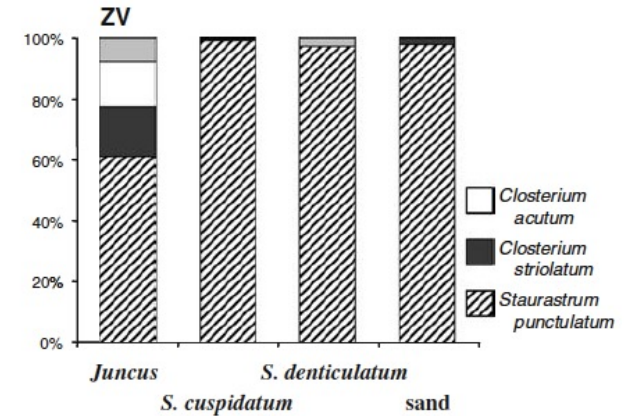
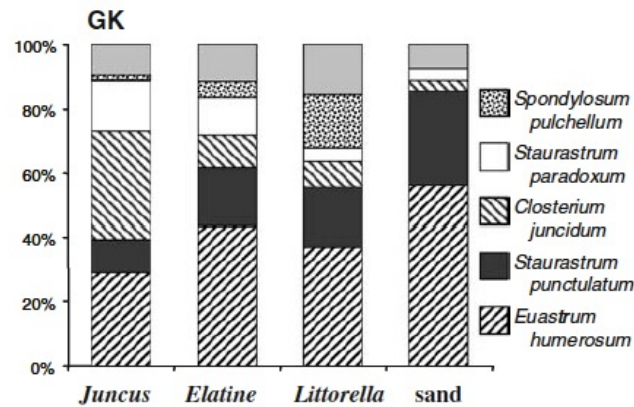
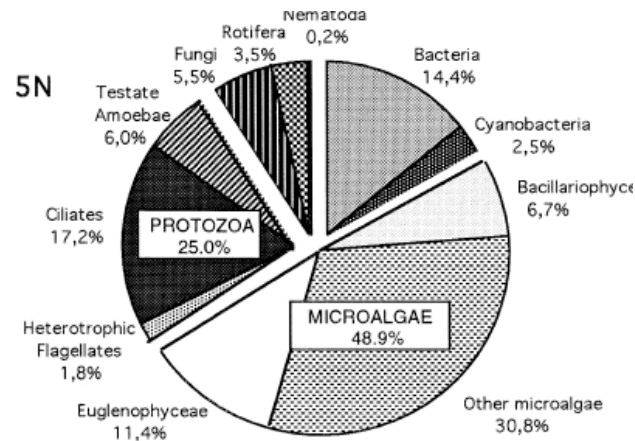
<sup>a</sup> Transformed;  $P \leq 0.05$ ; ns: not significant.



Možnosti vizualizace korelací:

[https://rstudio-pubs-static.s3.amazonaws.com/240657\\_5157ff98e8204c358b2118fa69162e18.html](https://rstudio-pubs-static.s3.amazonaws.com/240657_5157ff98e8204c358b2118fa69162e18.html)

# SLOUPCOVÉ a VÝSEČOVÉ GRAFY



DIATOMS

185

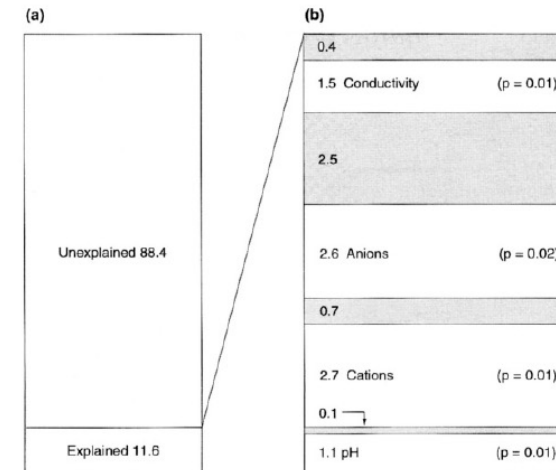
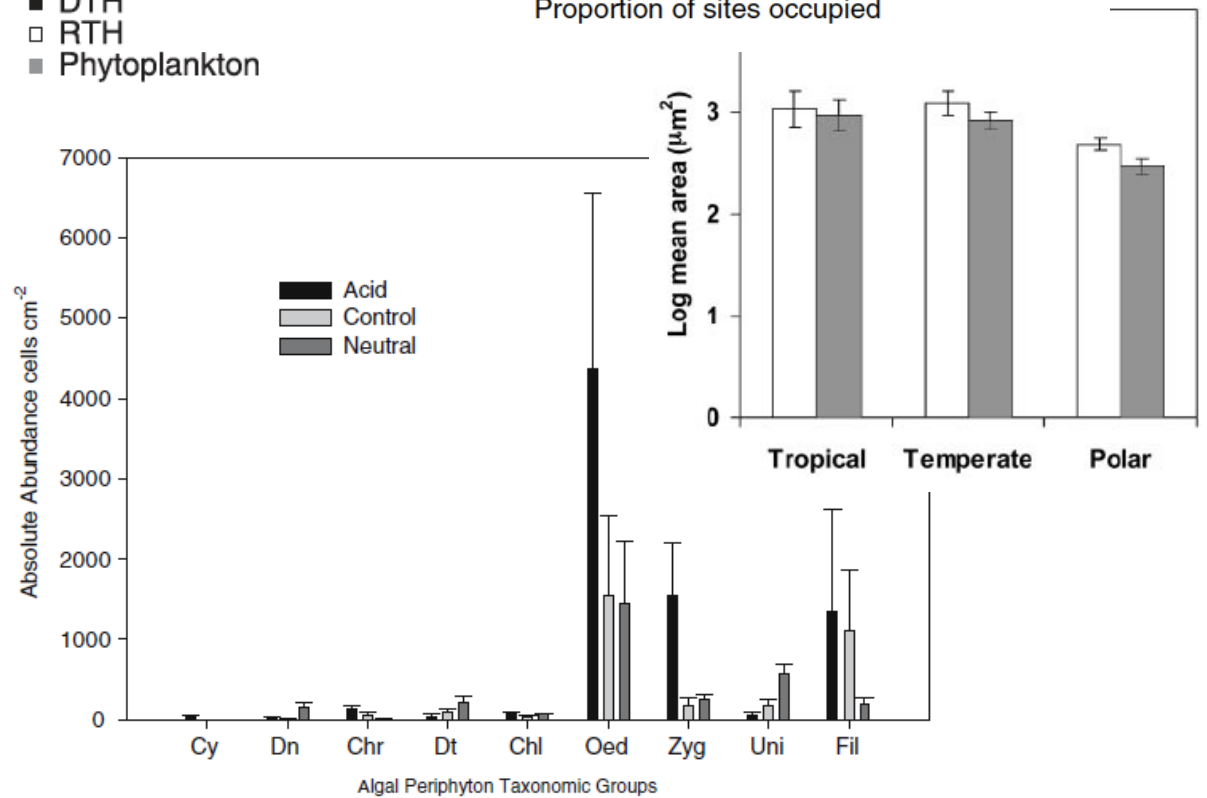
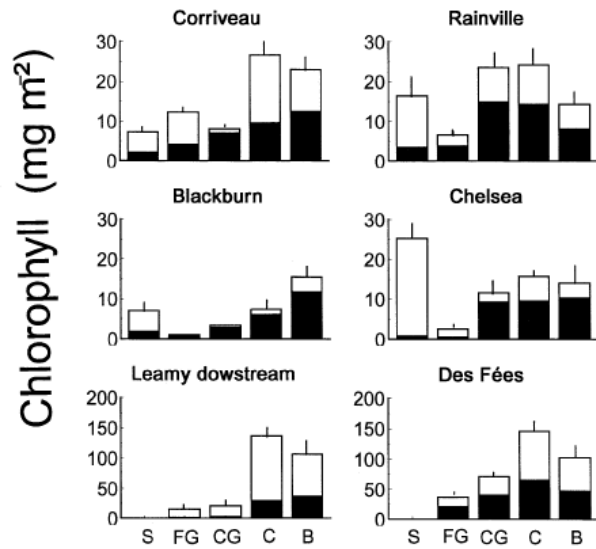
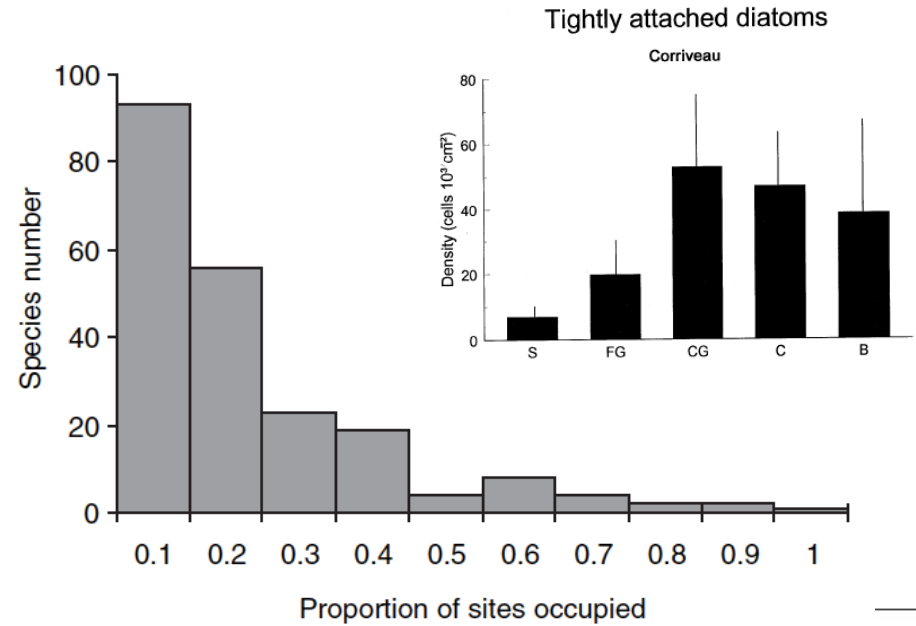
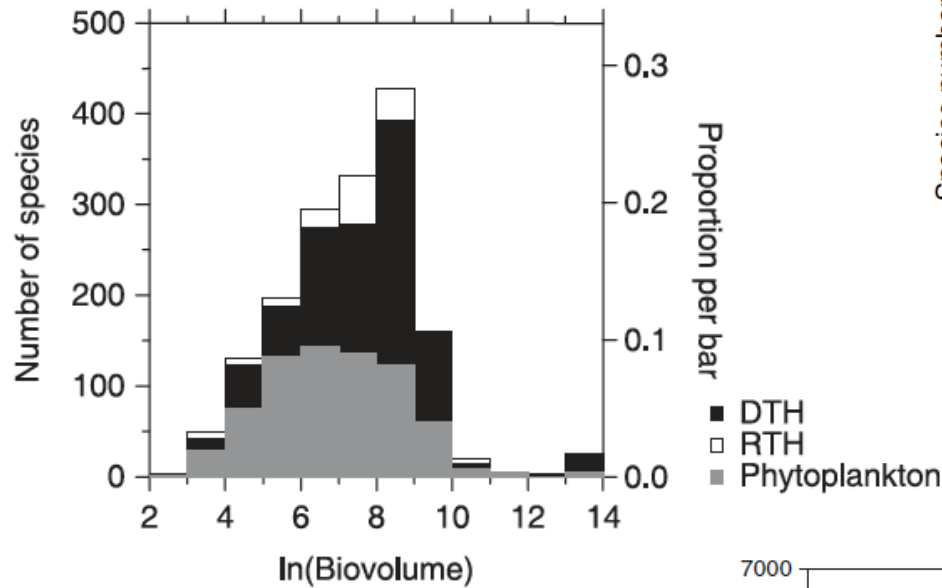
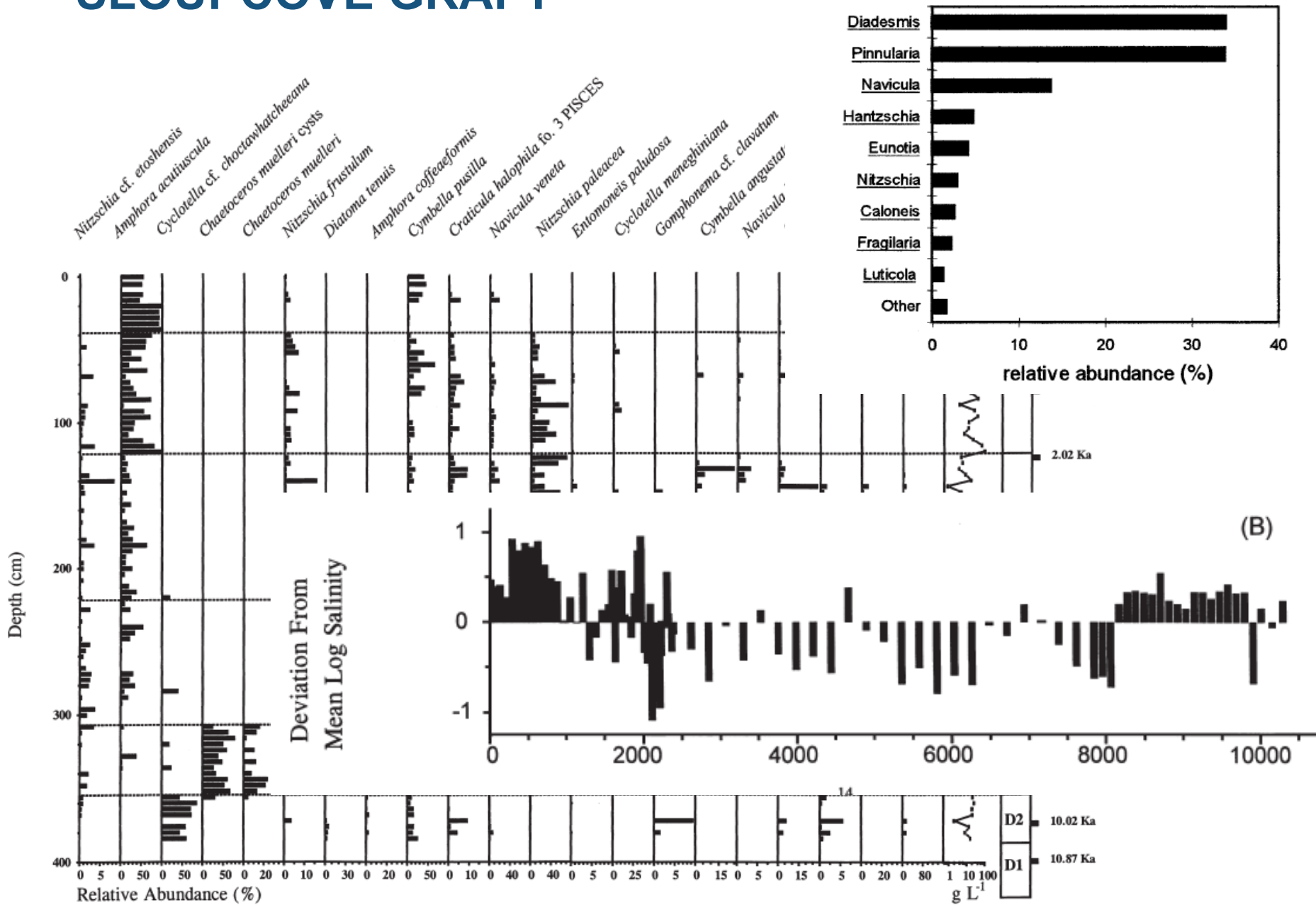


Figure 9. Results of partial CCAs of the training set shown in Figure 8, partitioning the total variance in the diatom a into (a) explained and unexplained portions, and (b) components representing the unique contributions of variables representing the conductivity, pH, cation and anion gradients (open), and correlations between gradients (aded). Significance (p) values are based on 99 random Monte Carlo permutations.

# SLOUPCOVÉ GRAFY

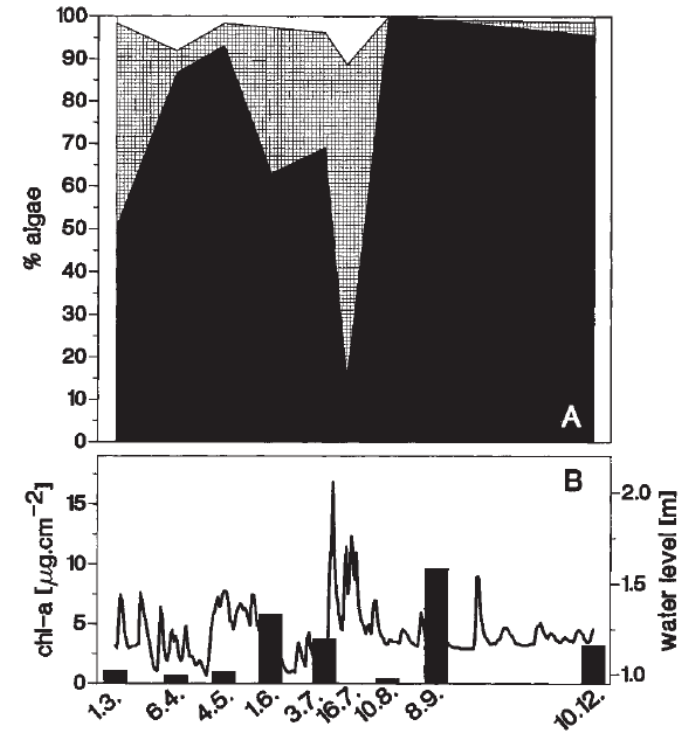
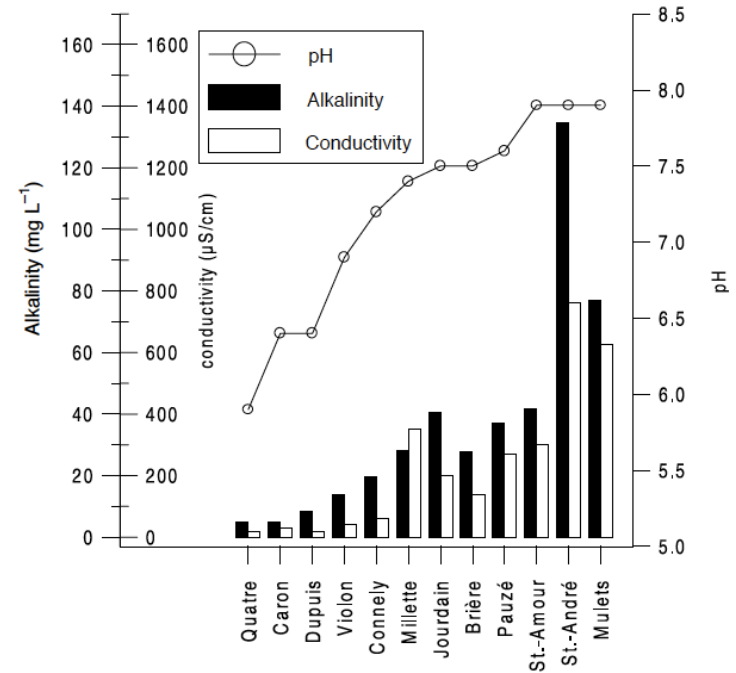
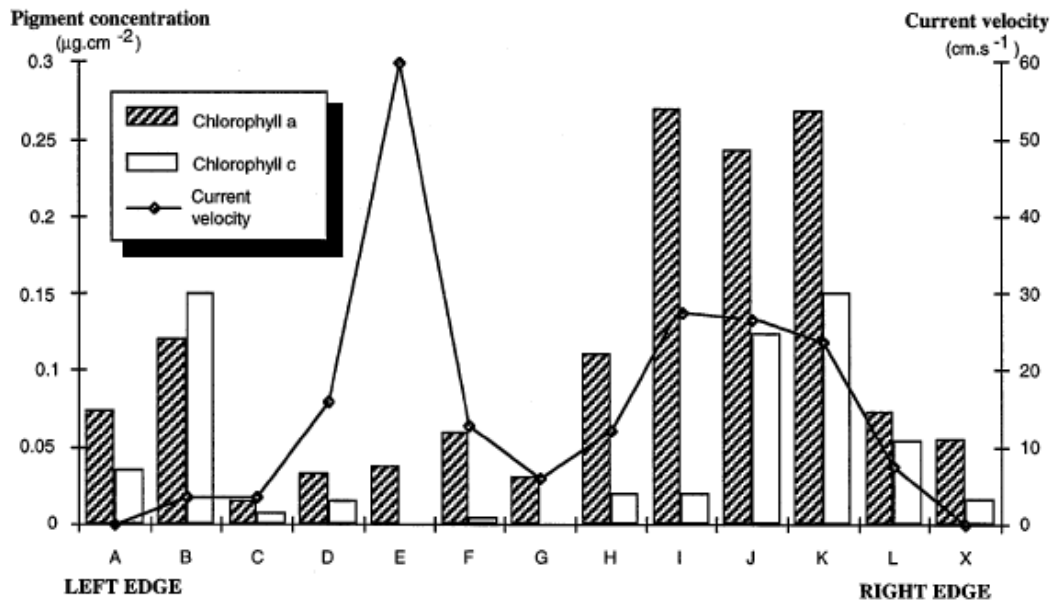
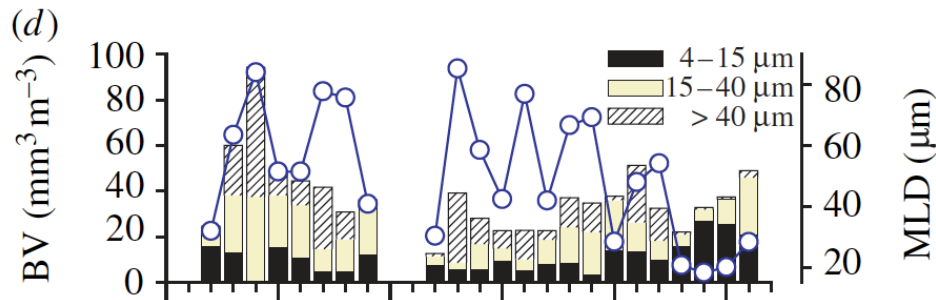
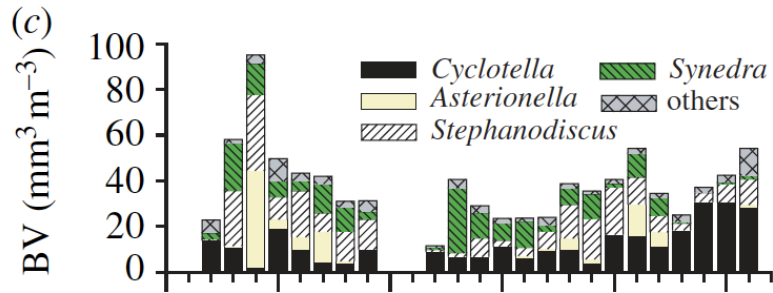


# SLOUPCOVÉ GRAFY





# KOMBINOVANÉ GRAFY



# SPOJNICOVÉ GRAFY

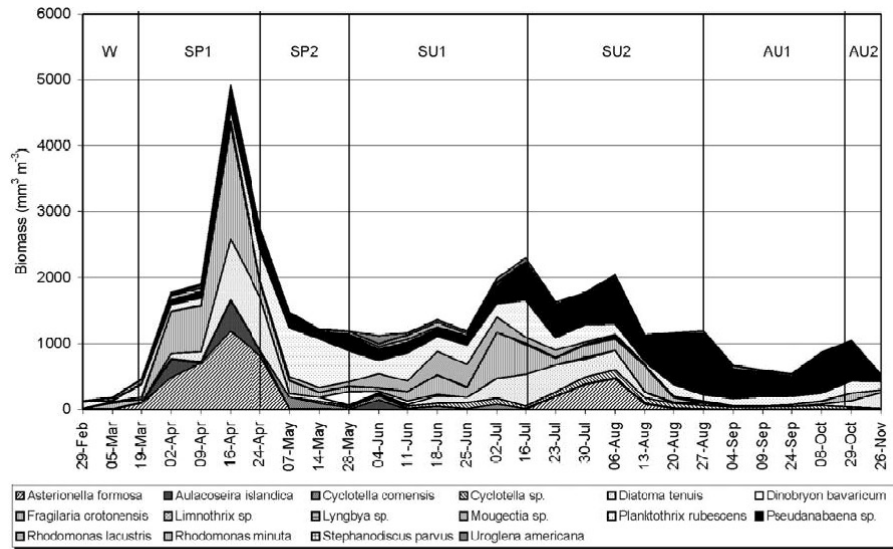
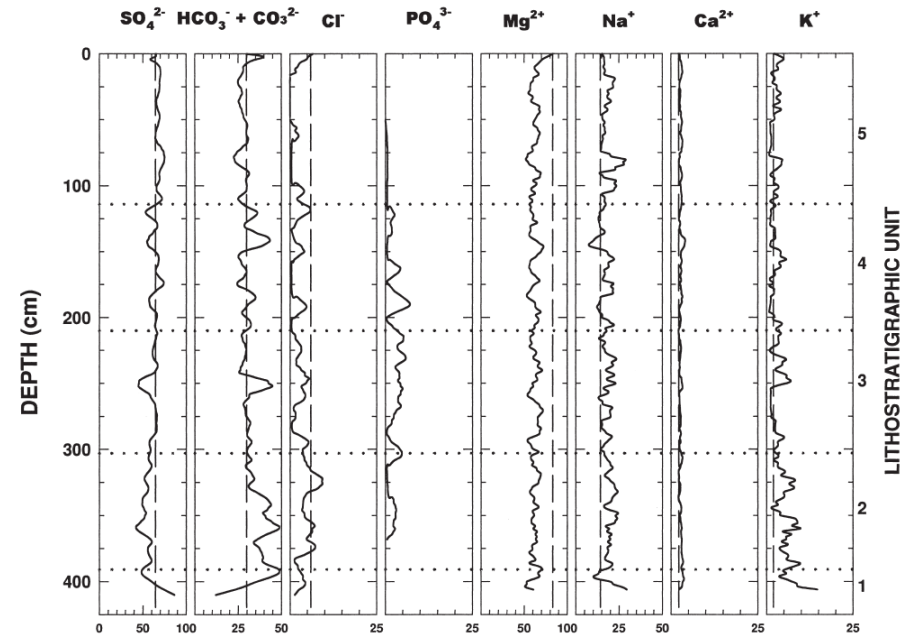
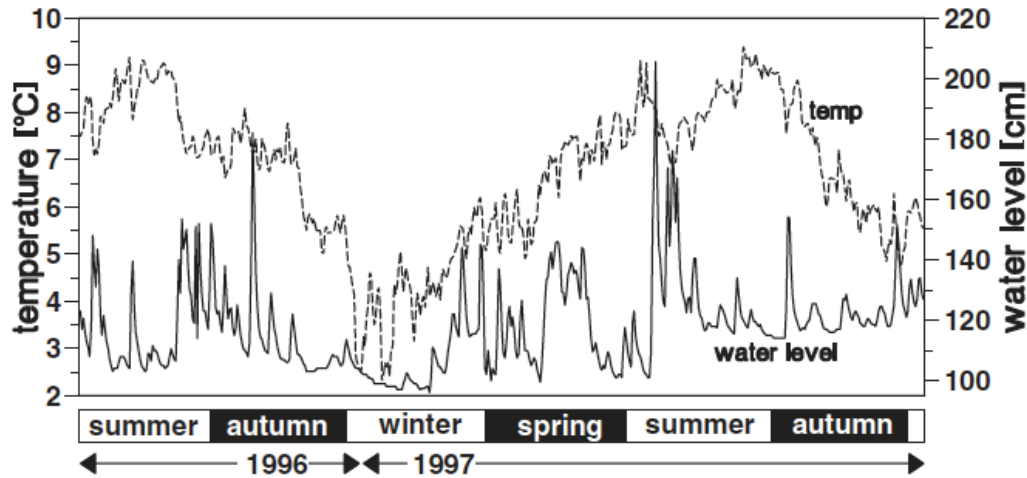
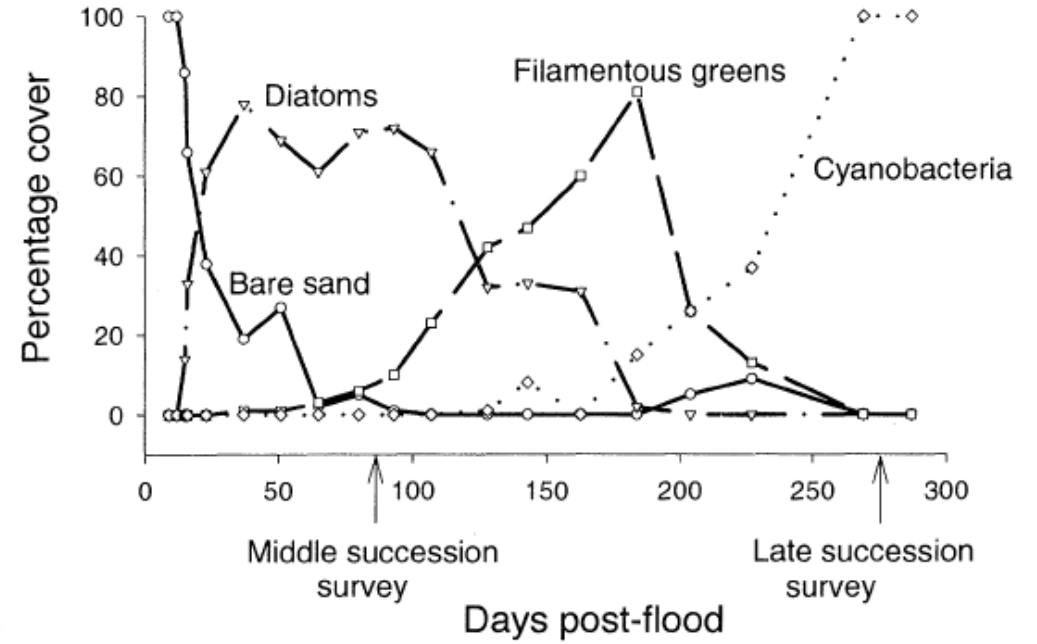


Figure 8. Seasonal changes of the biomass of the dominant species (the species contributing to build up 80% of the total biomass at least once during the year). The groups of samples are divided according to the cluster analysis.



# BOX PLOTY (krabicové diagramy)

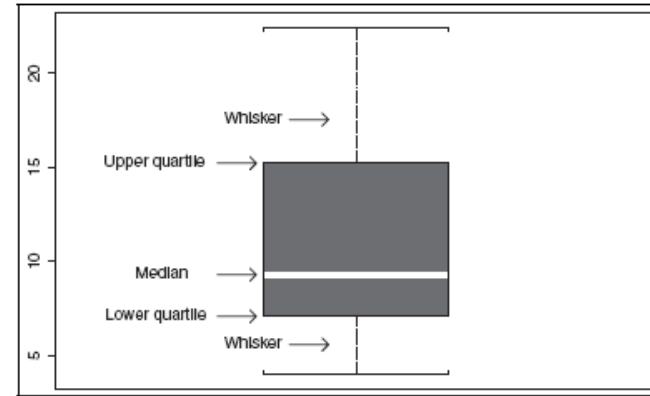
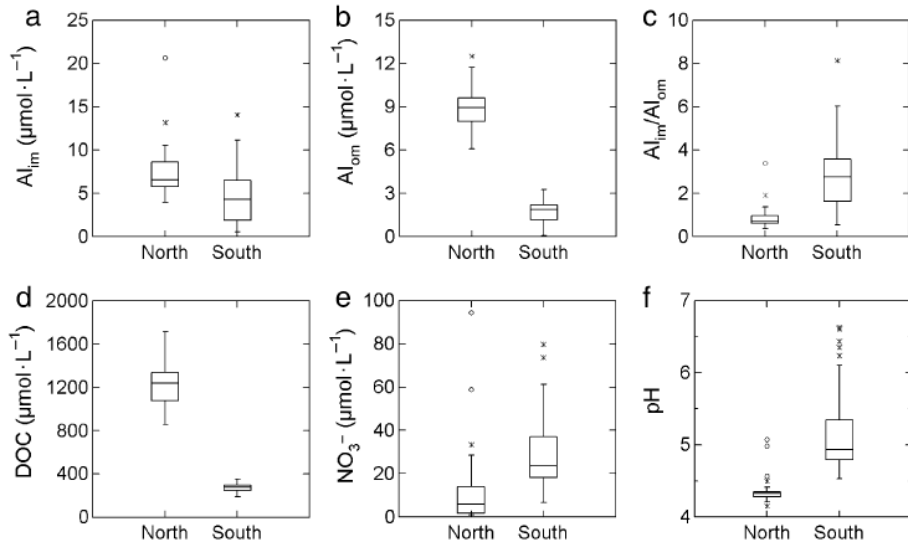


FIGURE 3.2 Example of a boxplot with no outliers.

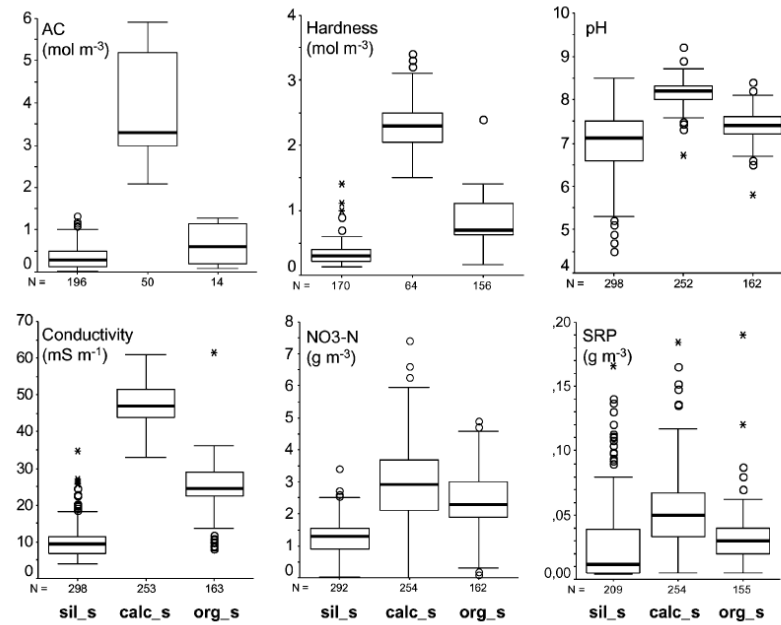
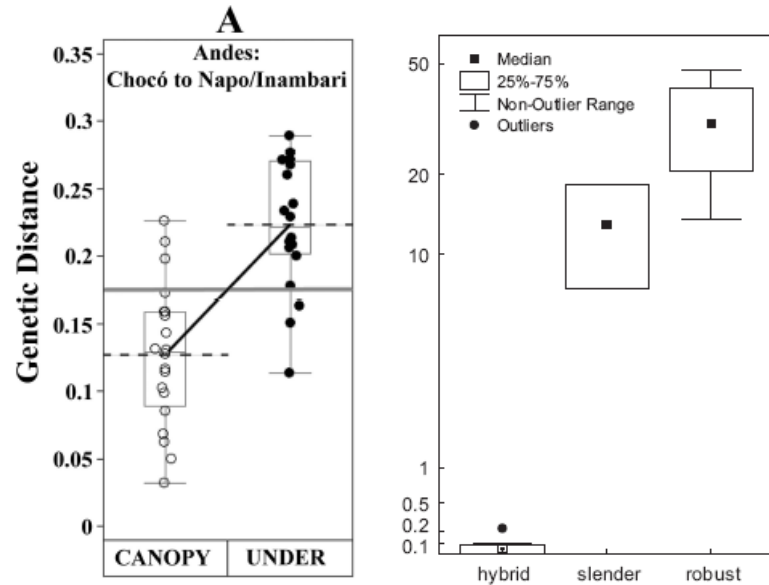
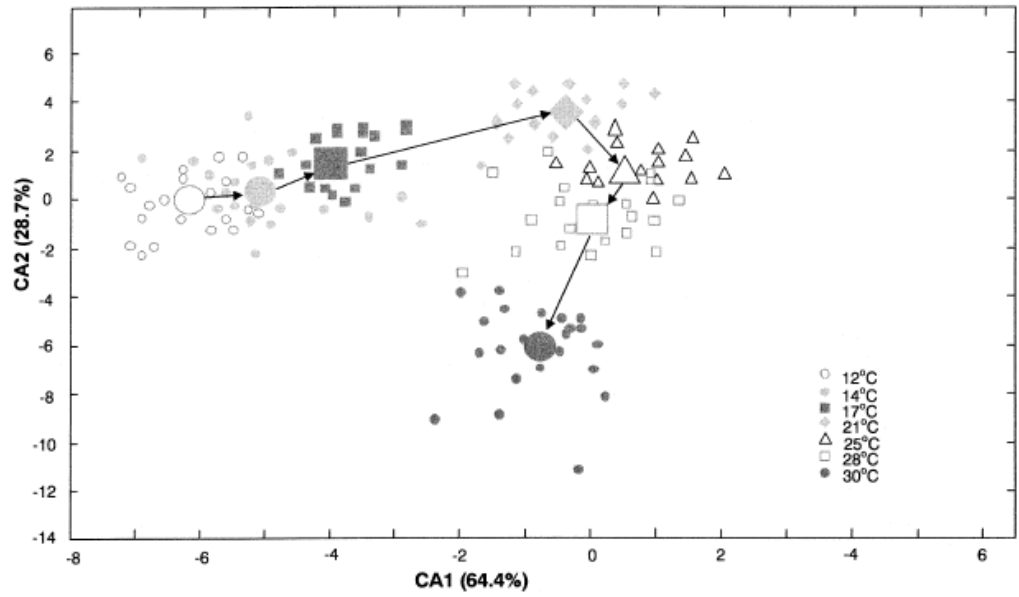
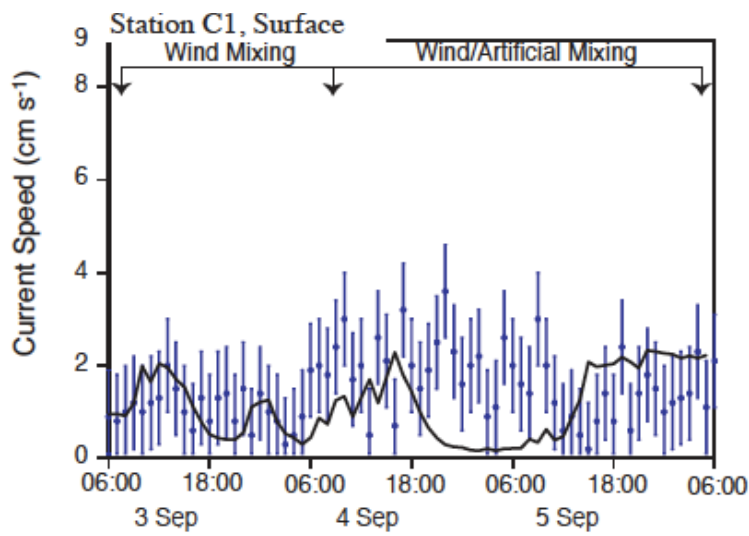
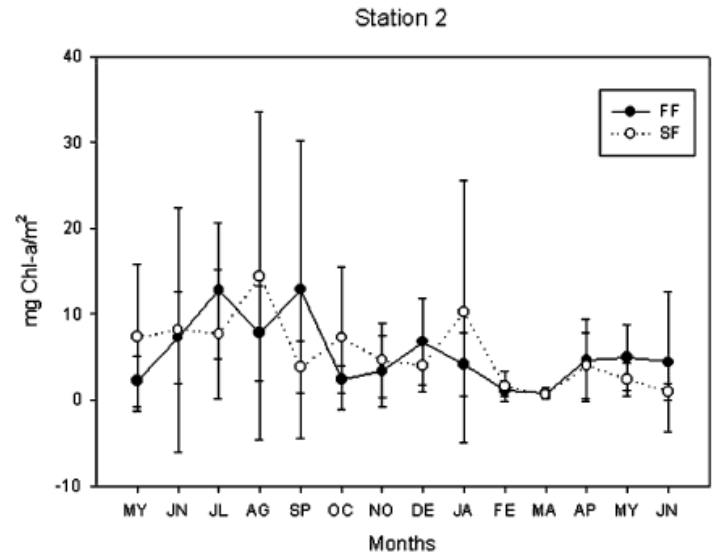
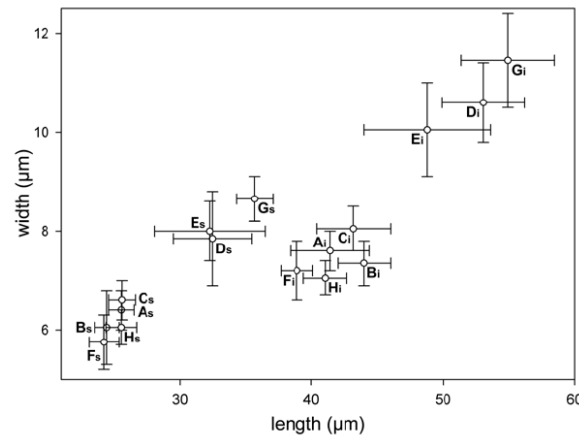
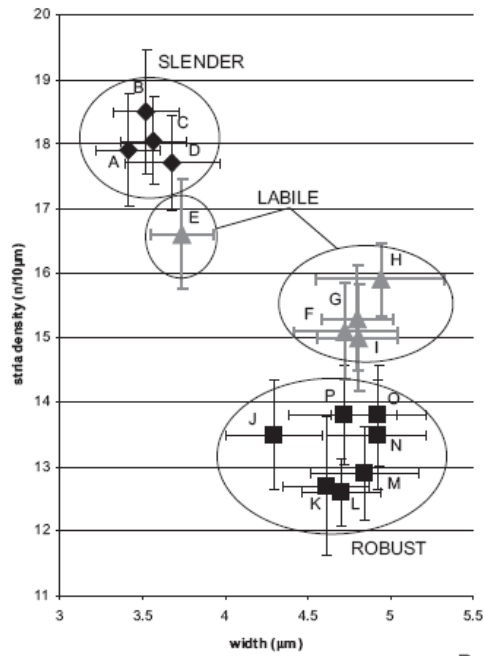
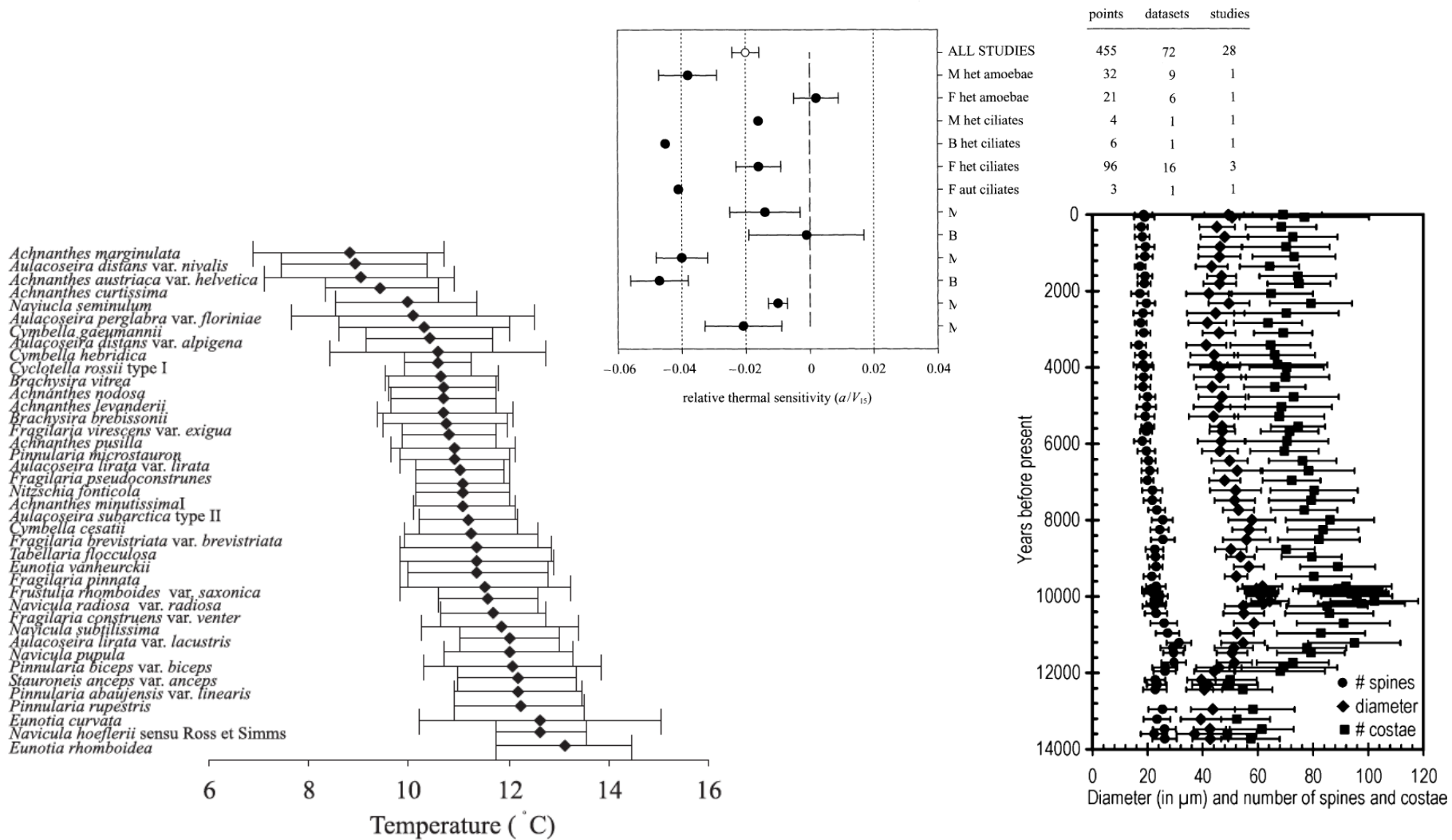


Figure 4. Chemical properties of the sampling sites assigned to the three types: sil\_s = siliceous sites, calc\_s = calcareous sites, org\_s = organic sites. Whiskers show the whole range (0–100%) and boxes represent the main range (25–75%) of the data, the thick black line indicates the median. Circles show extreme values, stars represent outliers.

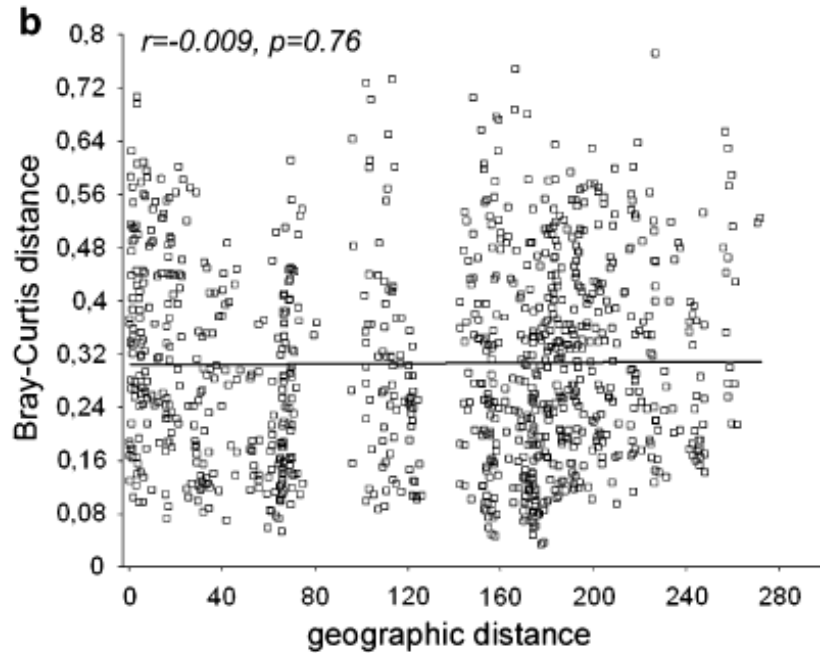
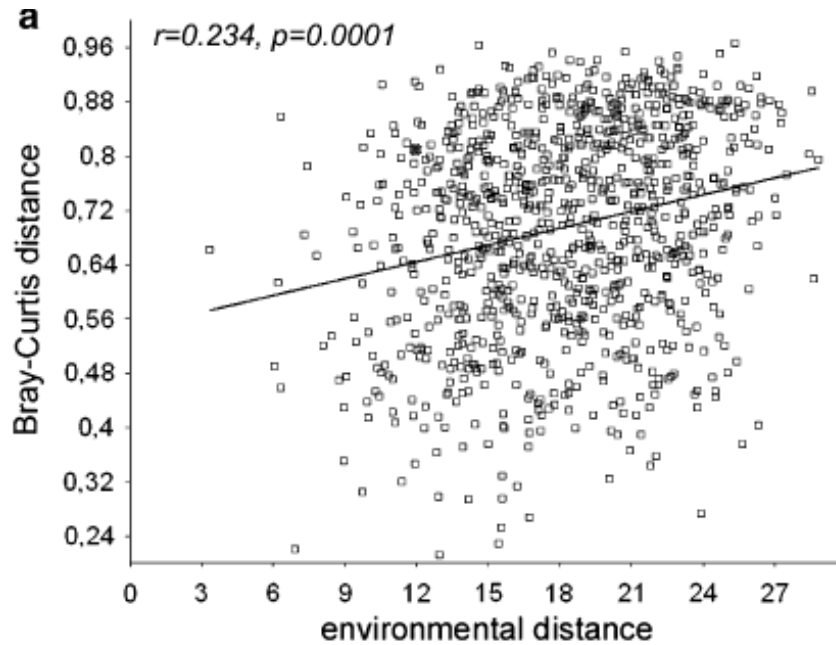
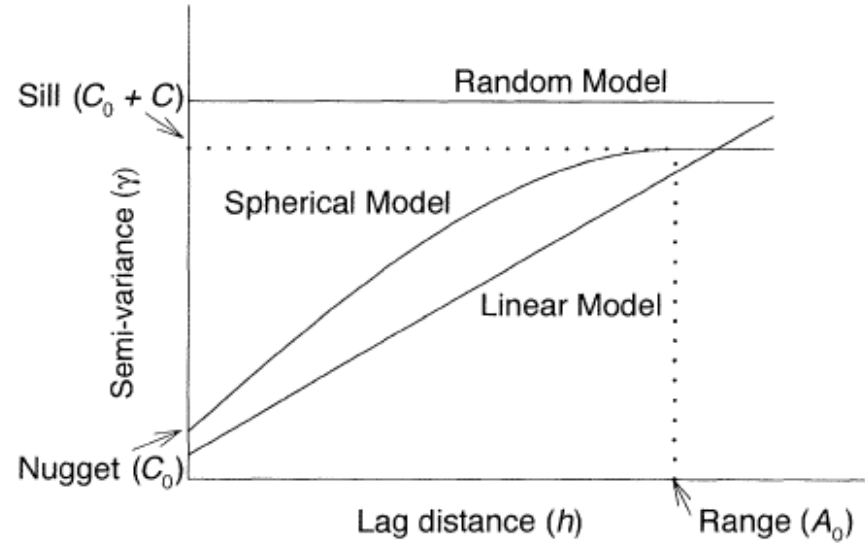
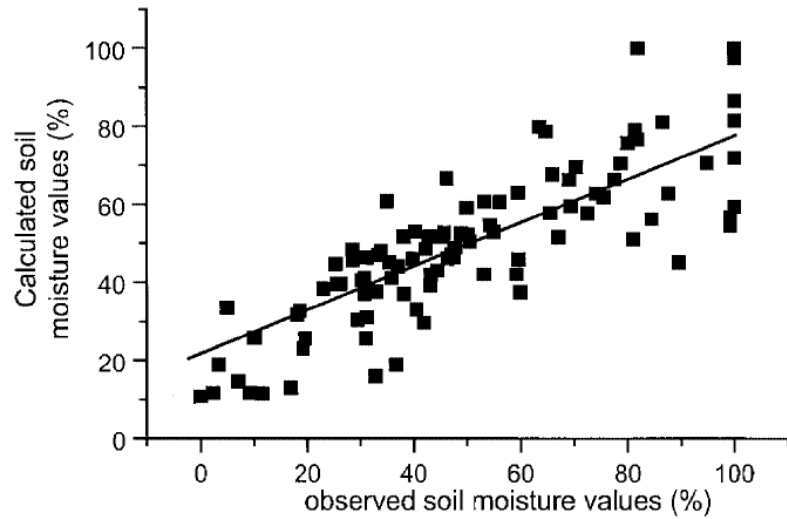
# CENTROIDY/PRŮMĚRNÉ HODNOTY s odchytkami



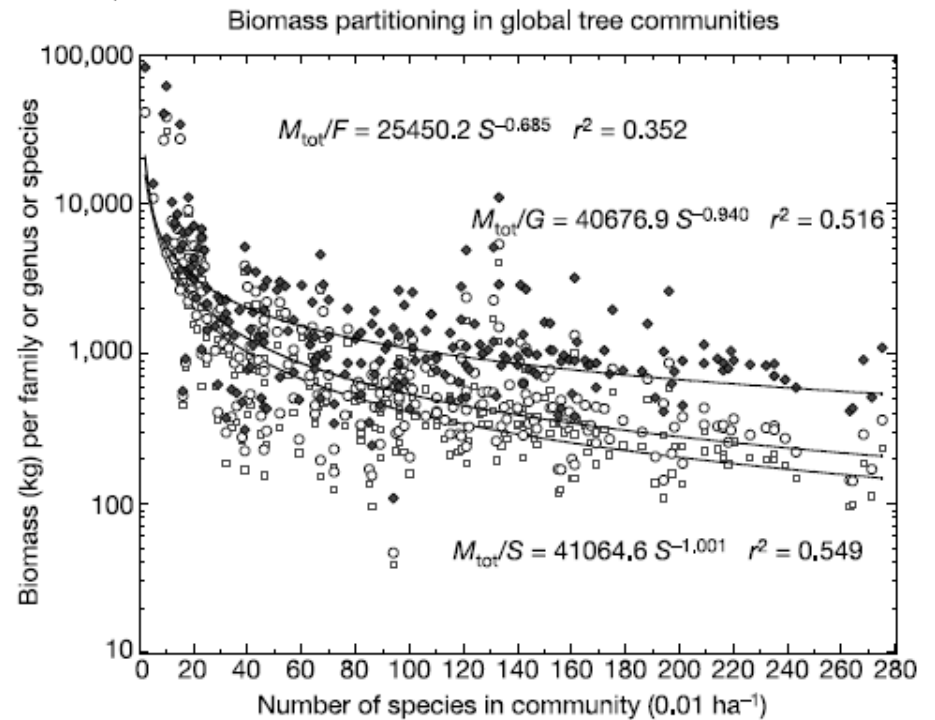
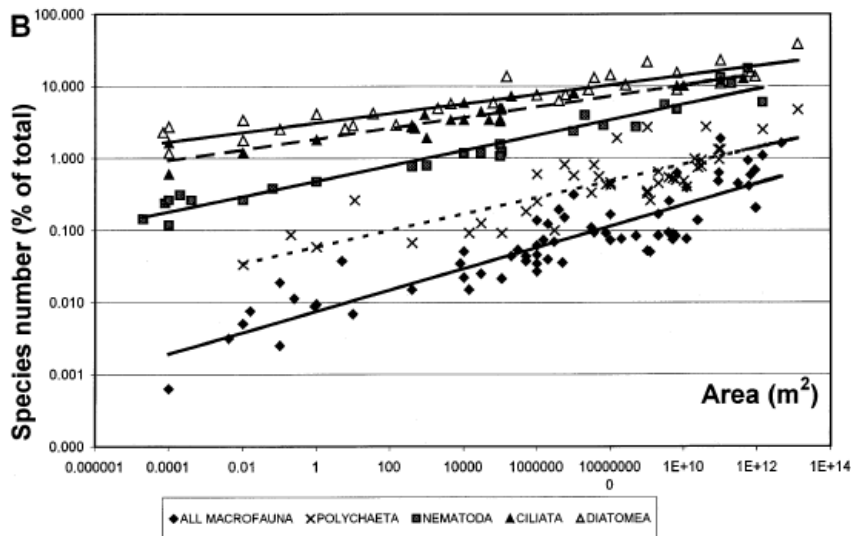
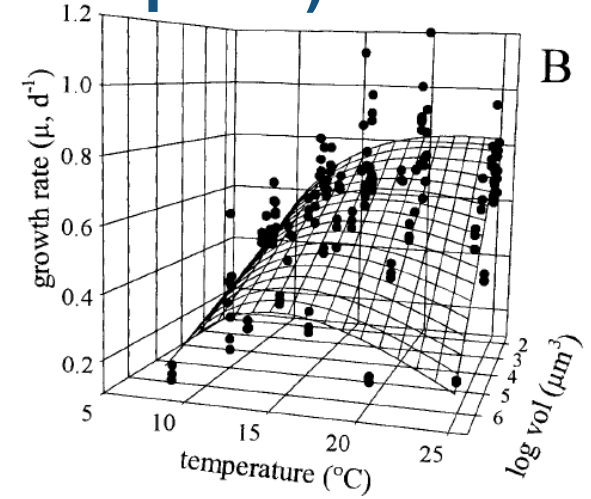
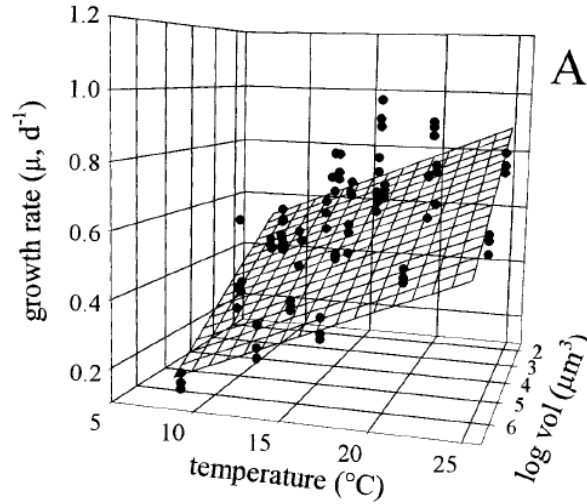
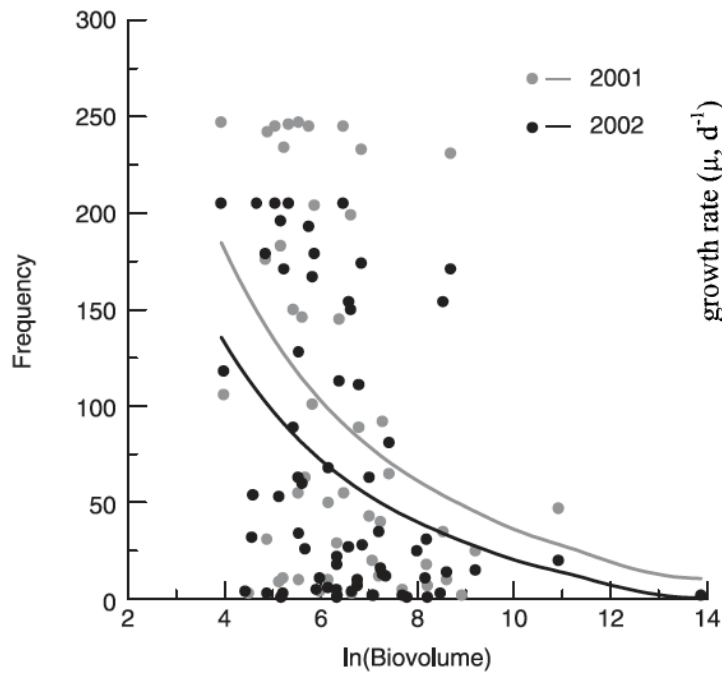
# CENTROIDY/PRŮMĚRNÉ HODNOTY s odchytkami



# KORELACE (bodové grafy, xy plots)



# KORELACE (bodové grafy, xy plots, scatter plots)



# DALŠÍ TYPY GRAFŮ

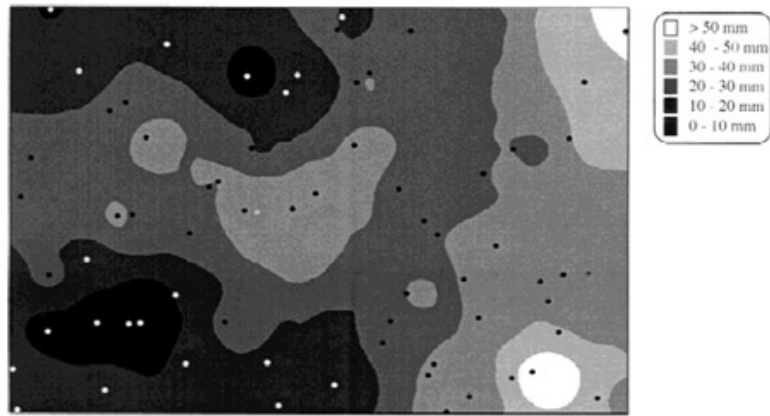


Fig. 6. Interpolated map of the microtopography (altitude in millimeters above an arbitrary level). Gridding parameters as for Fig. 2.

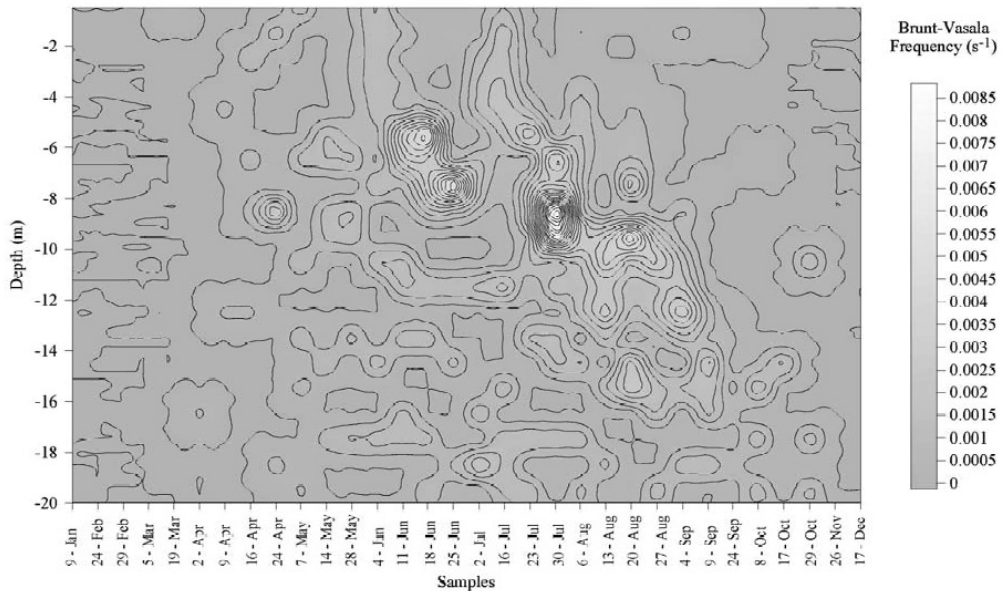
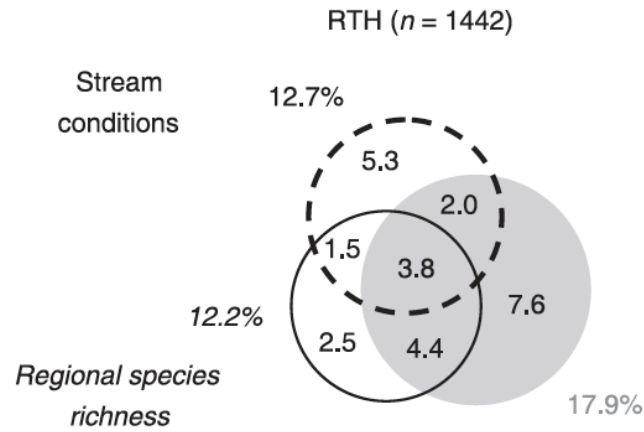
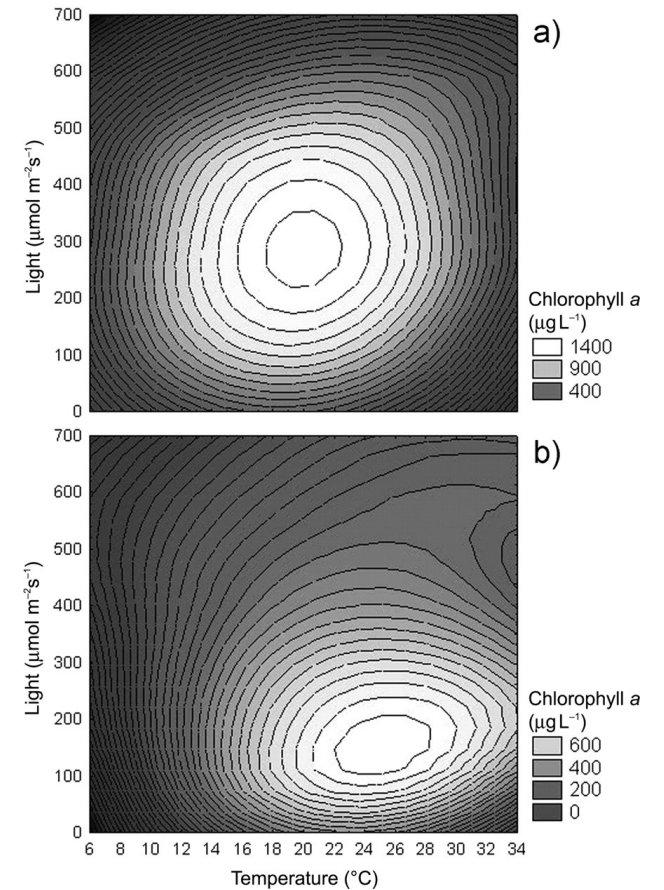
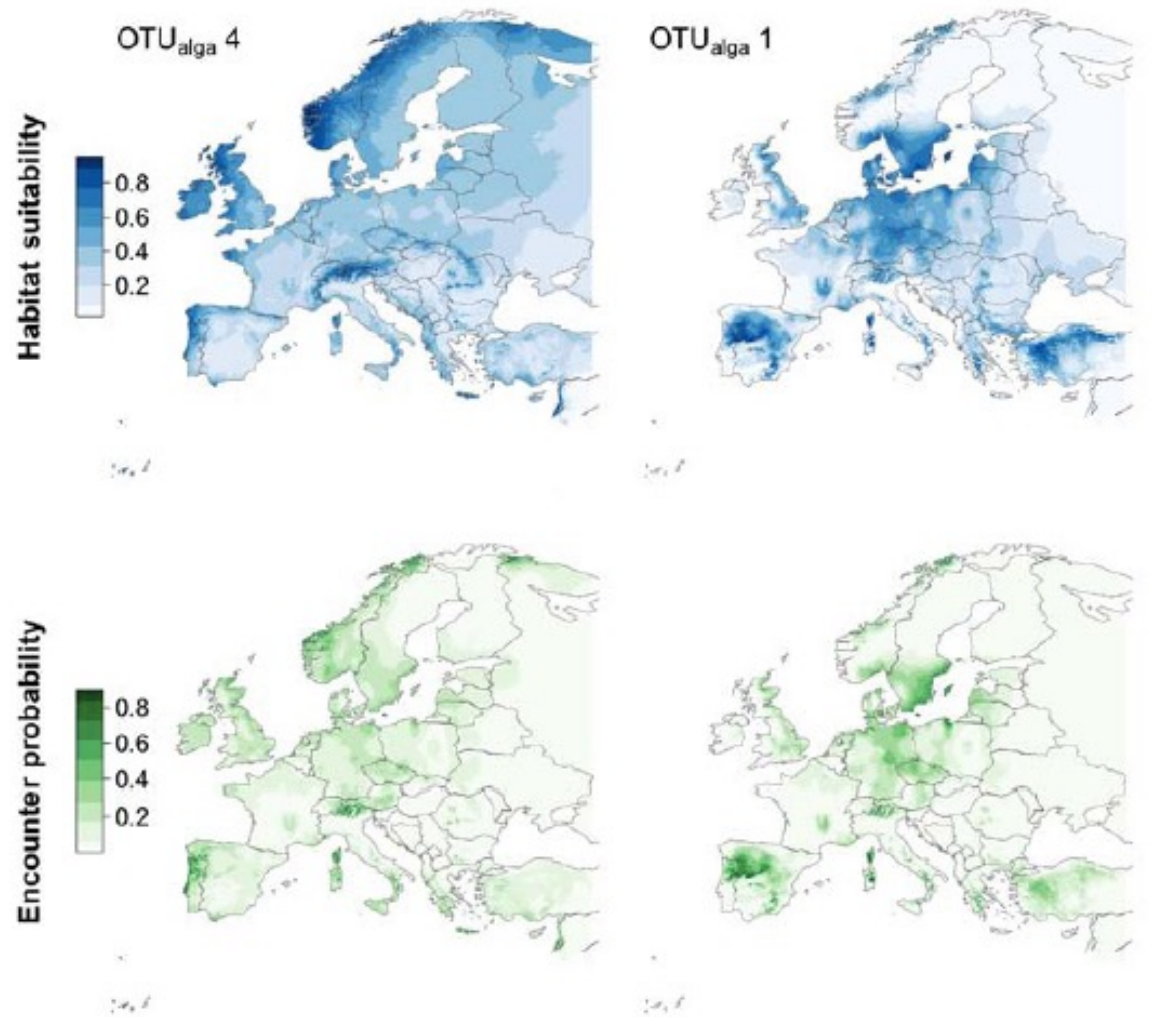


Figure 3. Seasonal changes of the Brunt-Väisälä frequency in the 0–20 m water layer.





# DALŠÍ TYPY GRAFŮ



# MNOHOROZMĚRNÉ ANALÝZY

# SHLUKOVÉ ANALÝZY (cluster analyses)

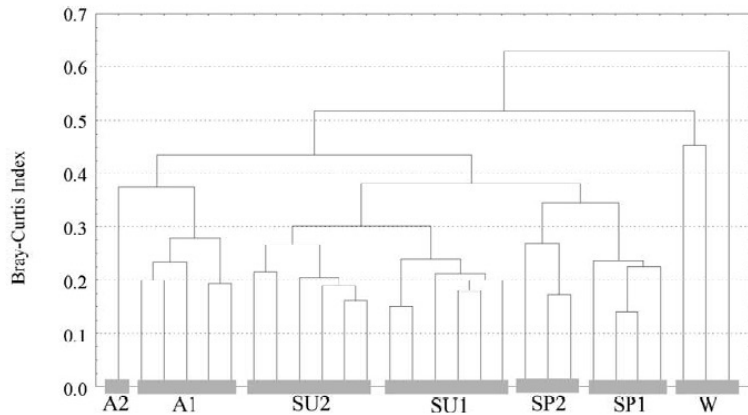
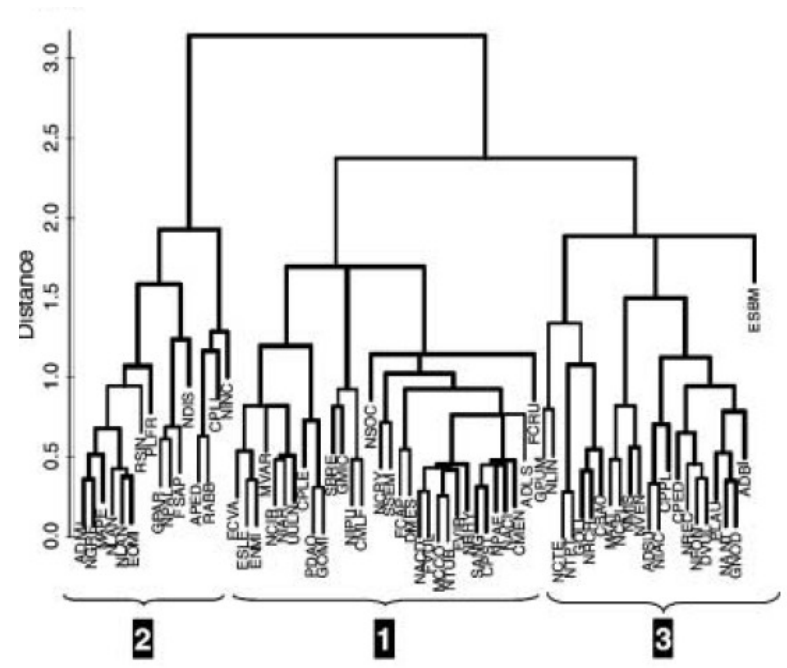
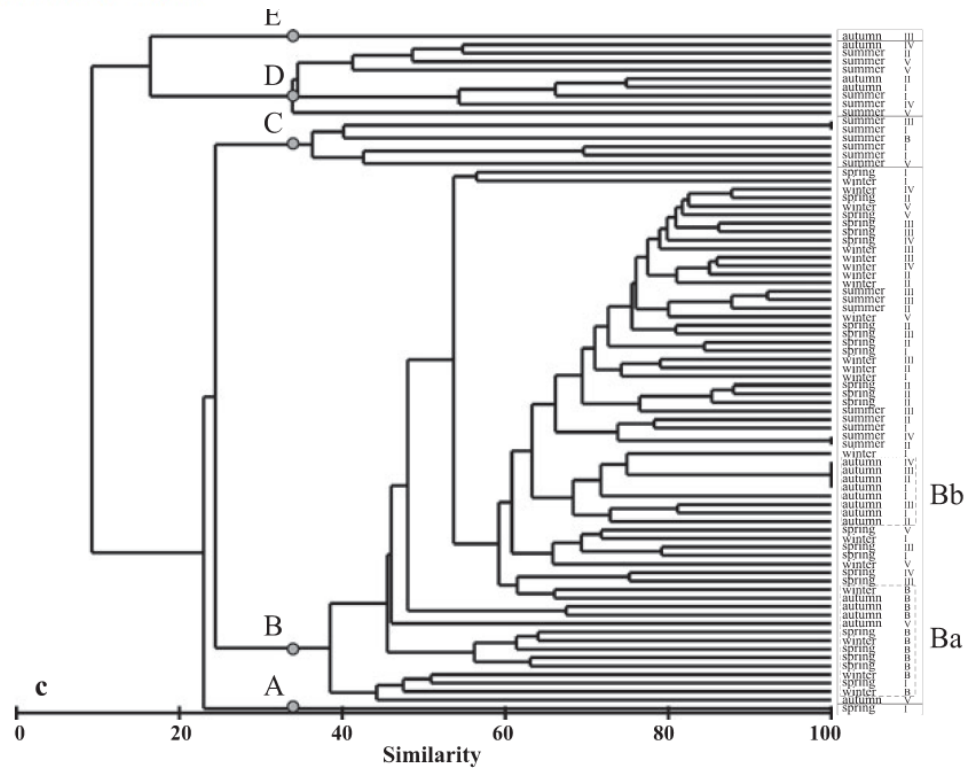
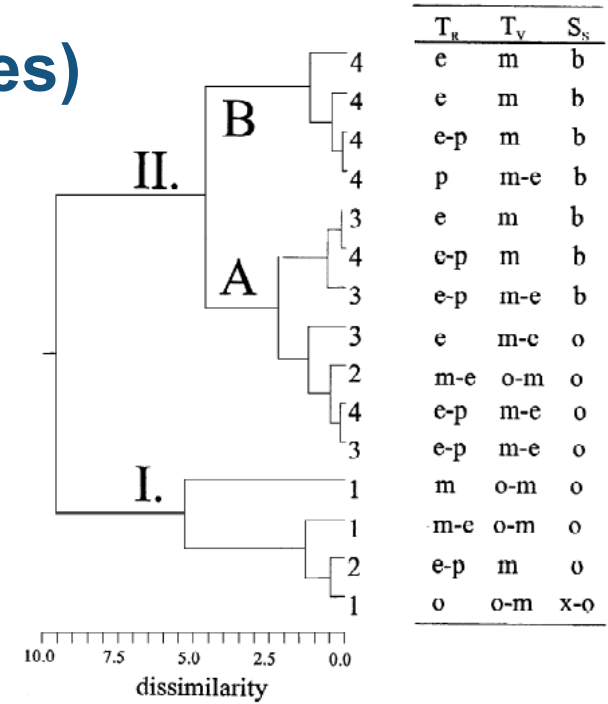
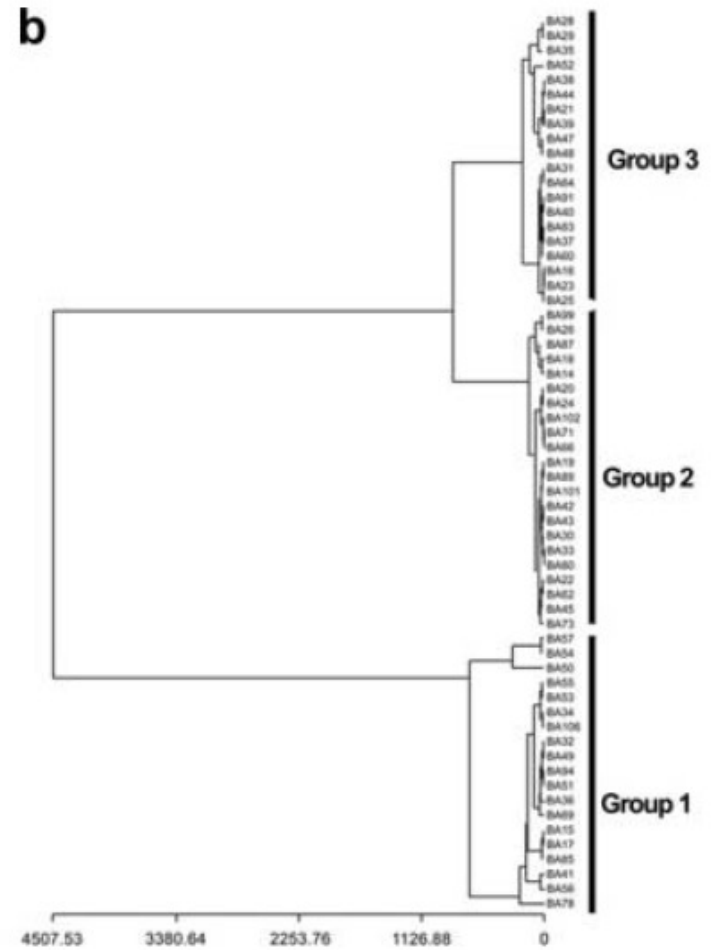
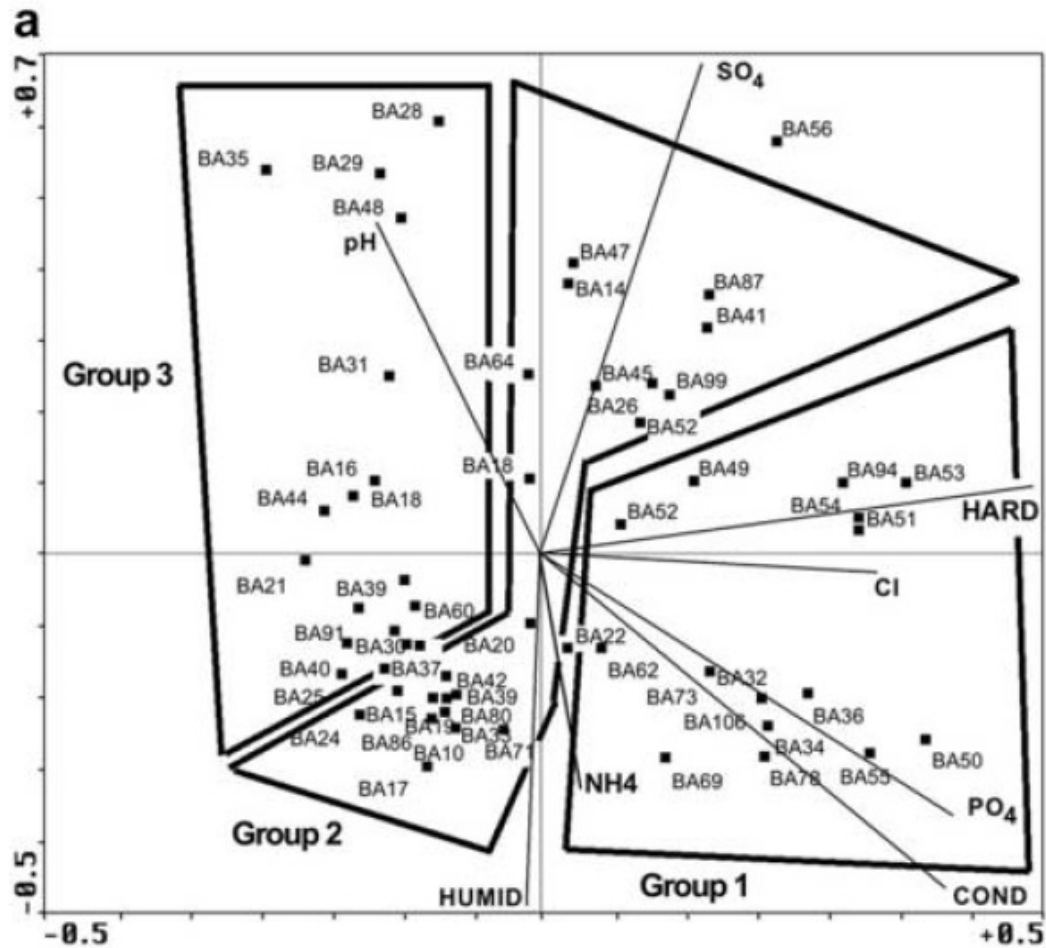


Figure 6. Ordination of the samples in seasonal clusters, according to the Bray & Curtis similarity index. W = Winter; SP 1 & 2 = Early Spring & Late Spring; SU 1 & 2 = Early Summer and Late Summer; A1 & 2 = Early Autumn & Late Autumn. The samples are clustered according to the dates reported in Figure 8.



# KOMBINOVANÉ ANALÝZY



# ORDINAČNÍ ANALÝZY

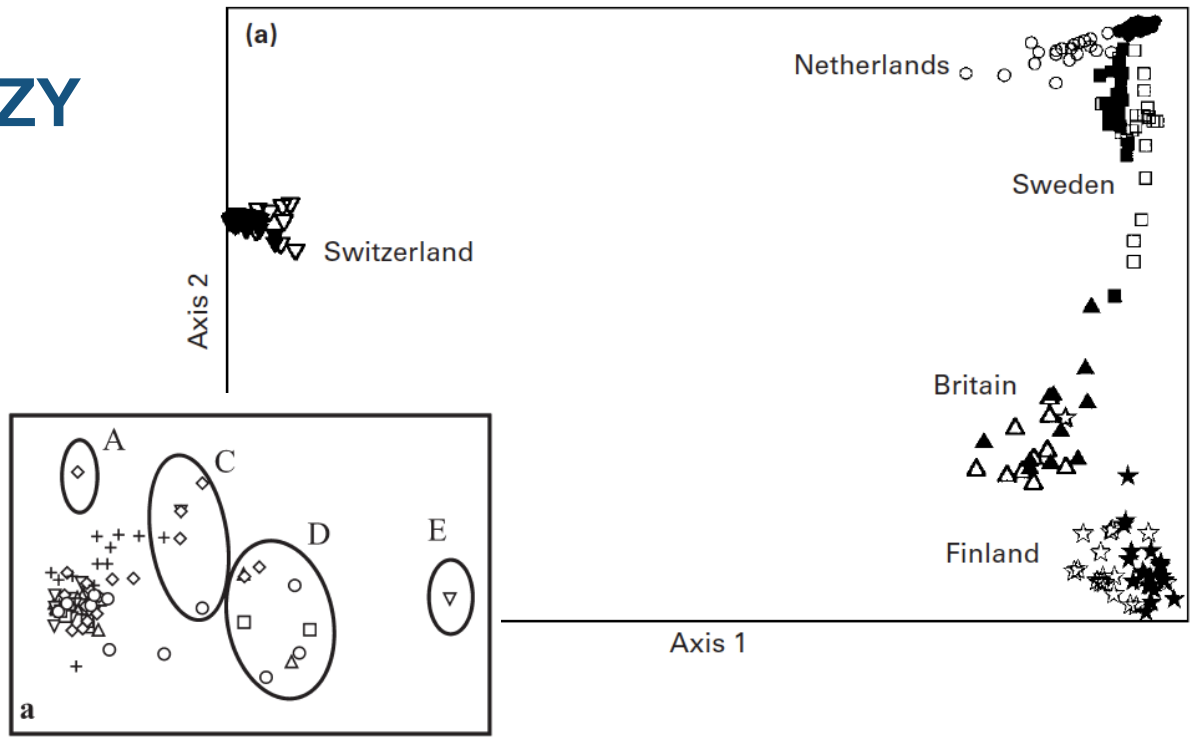
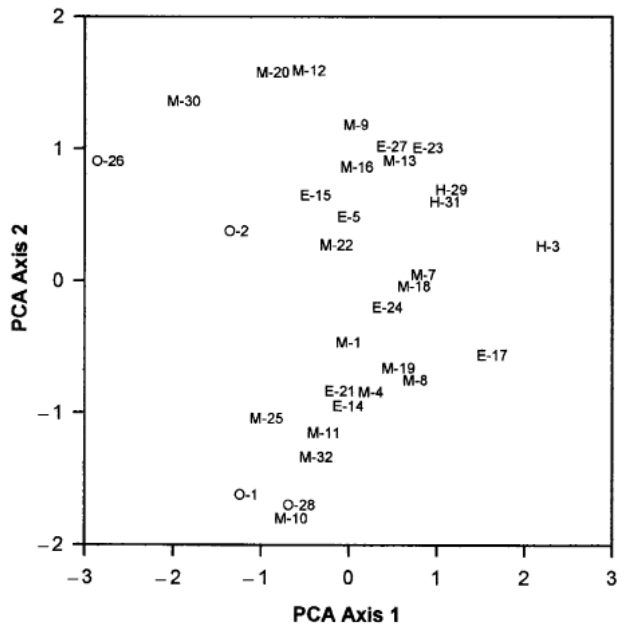
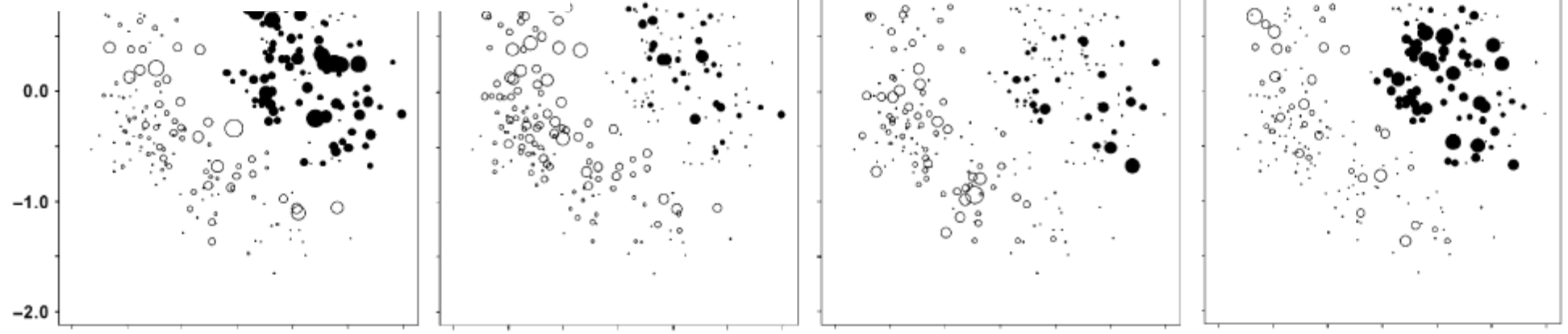


Fig. 2. Principle components ordination of lakes based on the correlation matrix of environmental variables. Codes numbers for lakes are given in Table 1. O, oligotrophic; M, mesotrophic; E, eutrophic; H, hypereutrophic lakes based on OECD classification.



# ORDINAČNÍ ANALÝZY

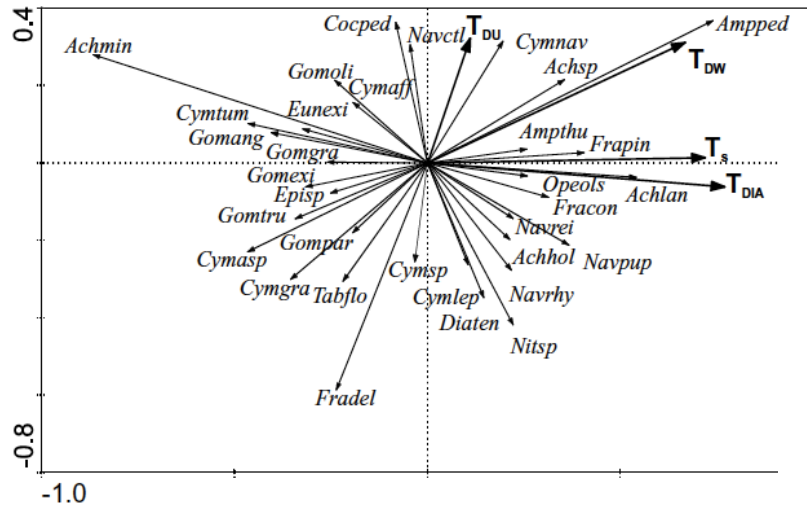


Fig. 4. Canonical Correspondence Analysis ordination diagram showing the principal taxa and their relationship with the environmental variables (ACON *Achnanthes confusa*, ALAN *A. lanceolata*, AMIN *A. minutissima*, AUER *A. auri*, DARC *Diademesis arcuata*, DCOM *D. comperi*, DCRO *D. crozetikerguelensis*, DVID *D. ingee*, DHUS *Diatomella hustedtii*, EFAL *Eunotia fallax*, EPAL *E. paludosa*, FCA2 *Fragilaria capucina*, FEX1 *F. exigua*, FGER *F. germanii*, FMAI *F. maillardii*, FPIN

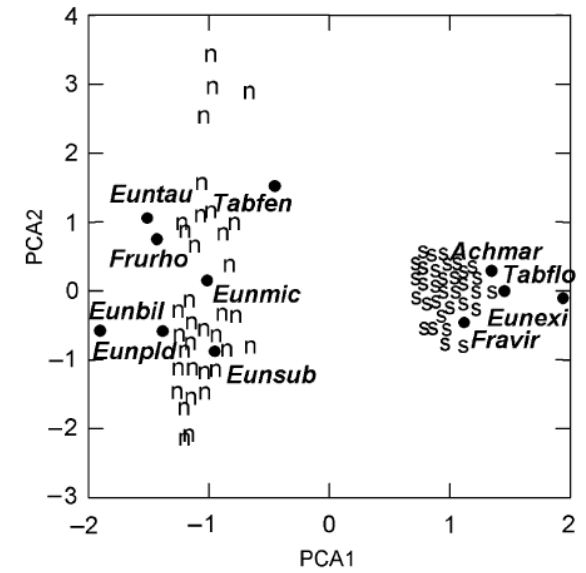
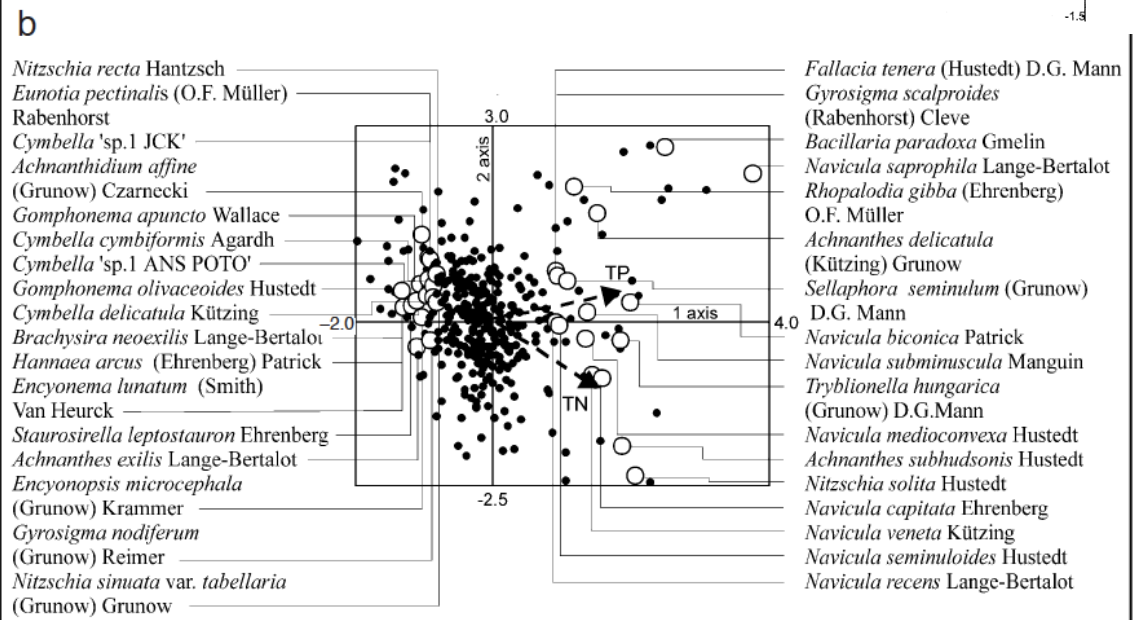
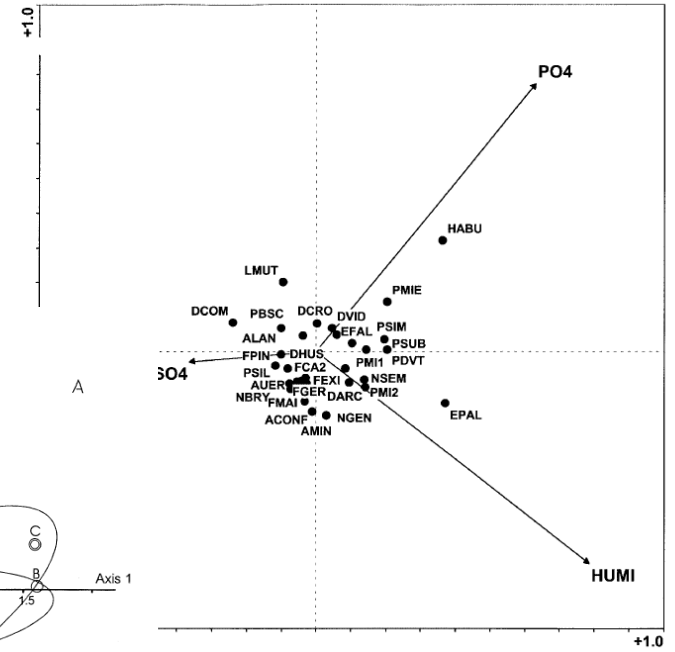
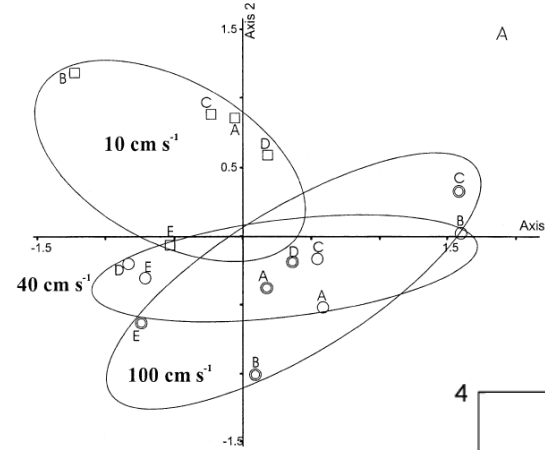
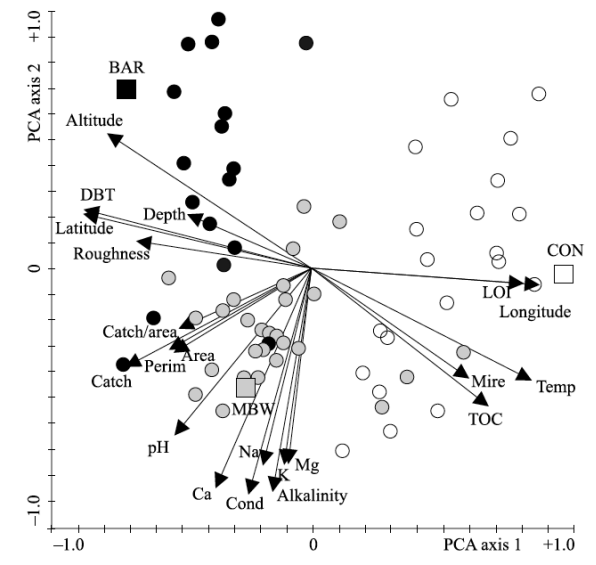
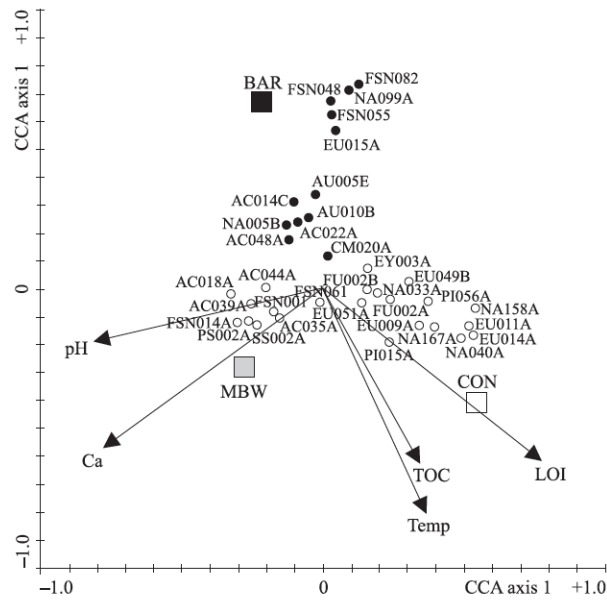
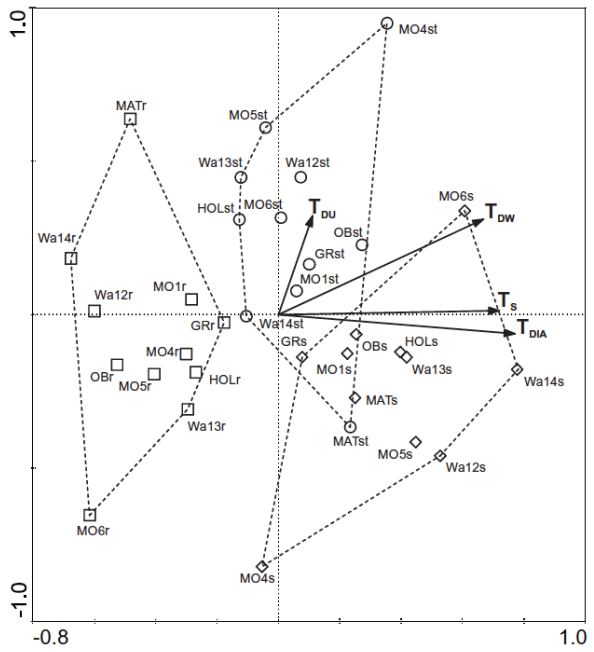
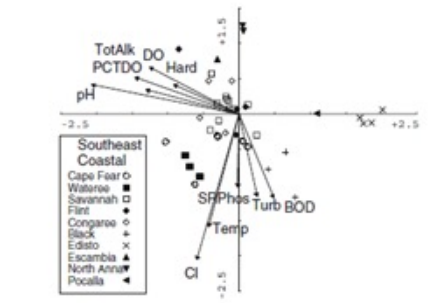
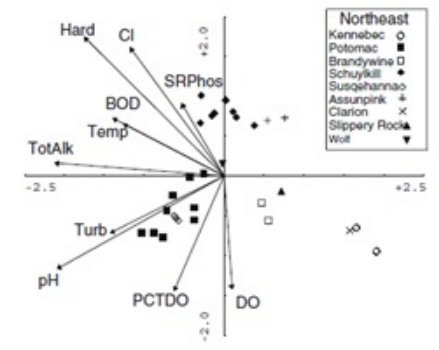
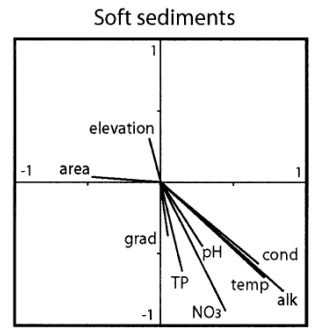
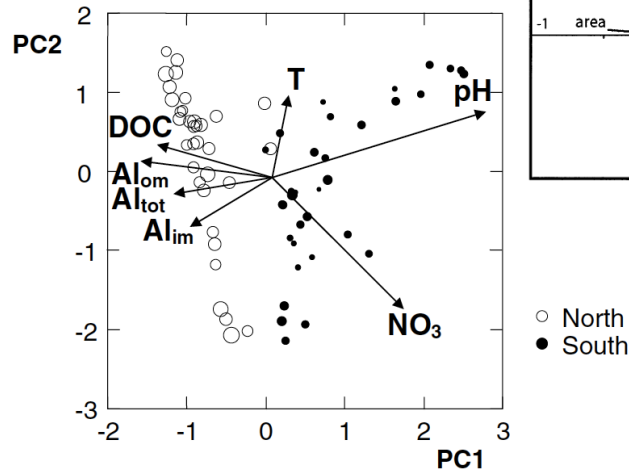
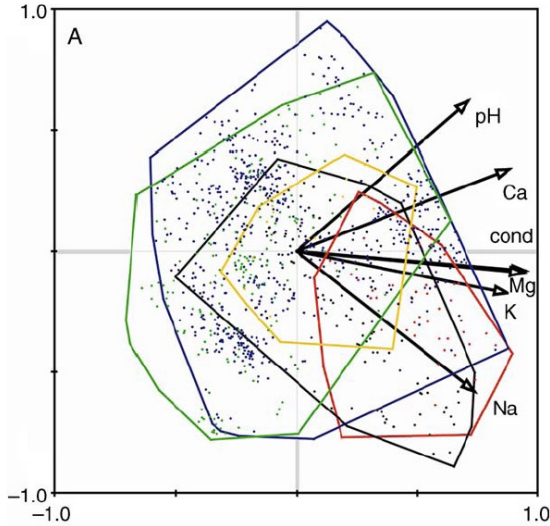


FIG. 3. Principal component analysis biplot of species scores (multiplied by 2 for clarity) and sample scores from chronically acidified (north = n) and episodically acidified (south = s) tributary.

# ORDINAČNÍ ANALÝZY



# **INTERAKTIVNÍ ON-LINE SHRNU TÍ MOŽNOSTÍ VIZUALIZACE DAT**

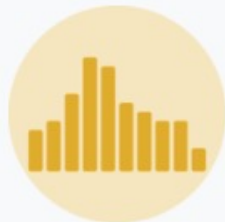




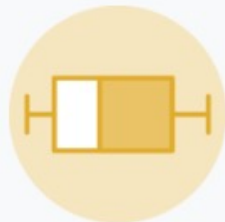
Violin



Density



Histogram



Boxplot



Ridgeline



Scatter



Heatmap



Correlogram



Bubble



Connected scatter



Density 2d



Barplot



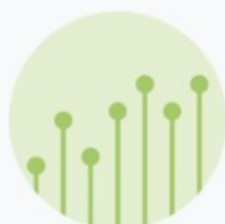
Spider / Radar



Wordcloud



Parallel



Lollipop

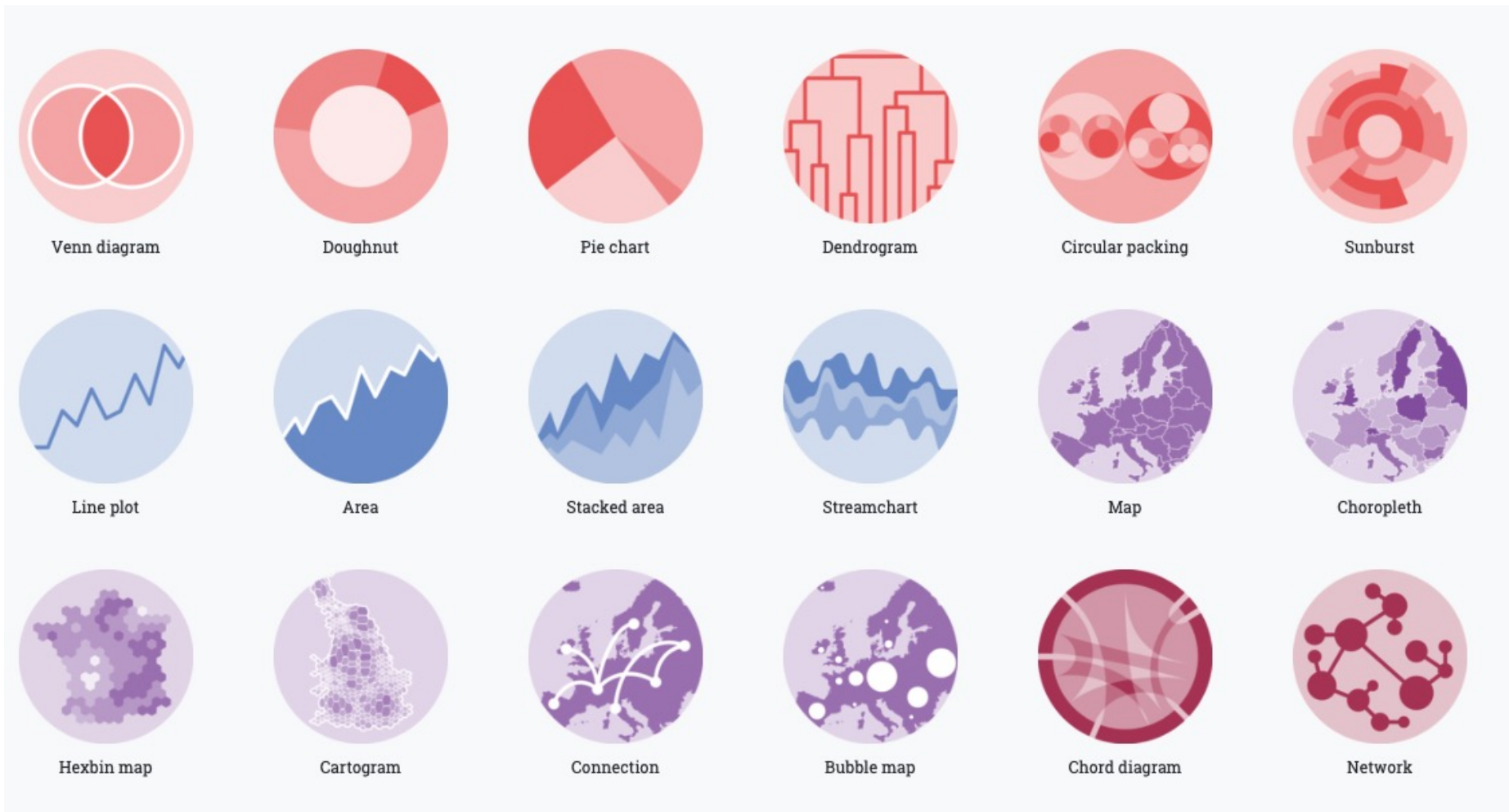


Circular Barplot

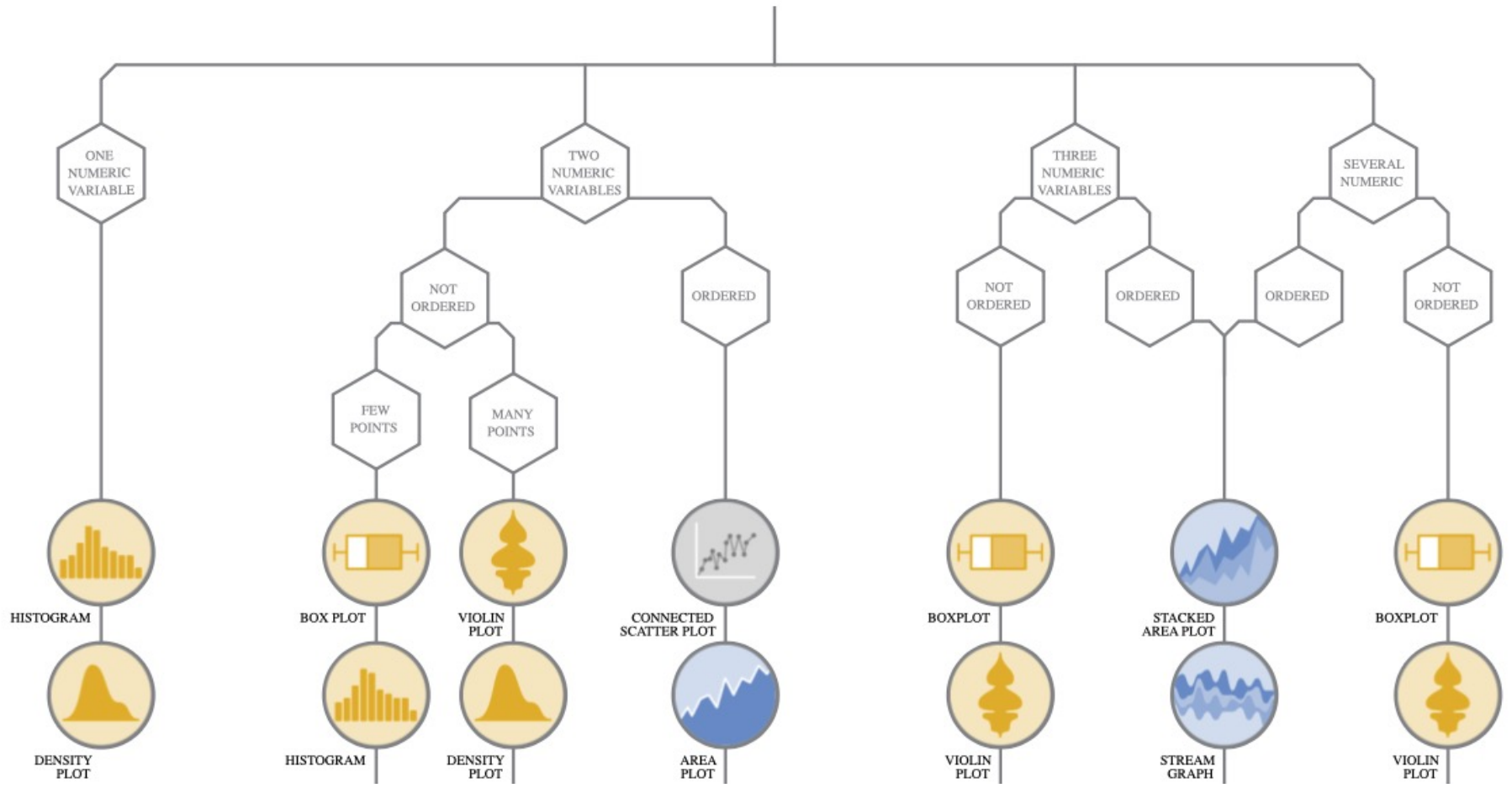


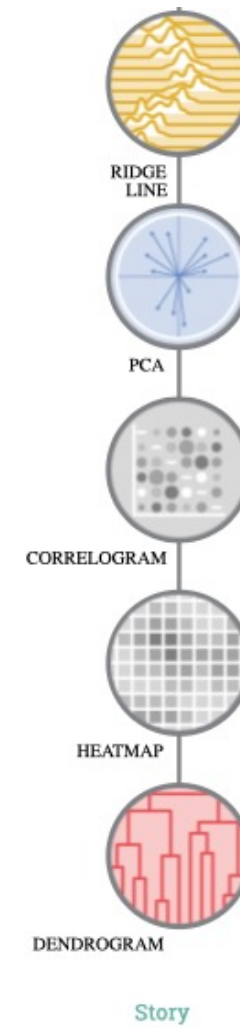
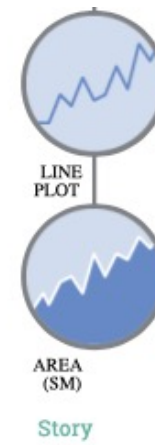
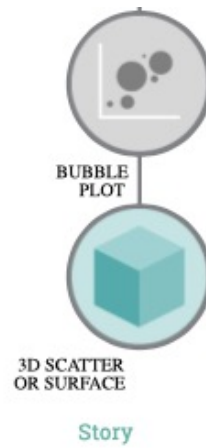
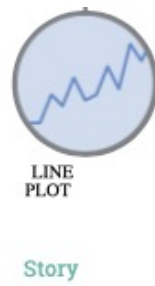
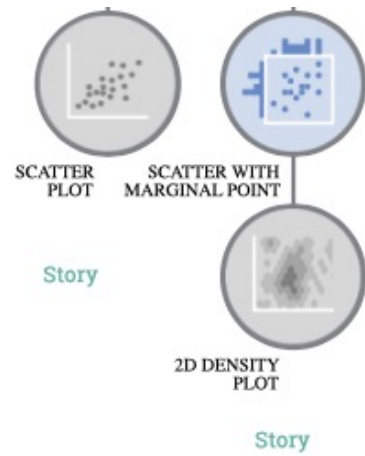
Treemap

[www.data-to-viz.com/#explore](http://www.data-to-viz.com/#explore)



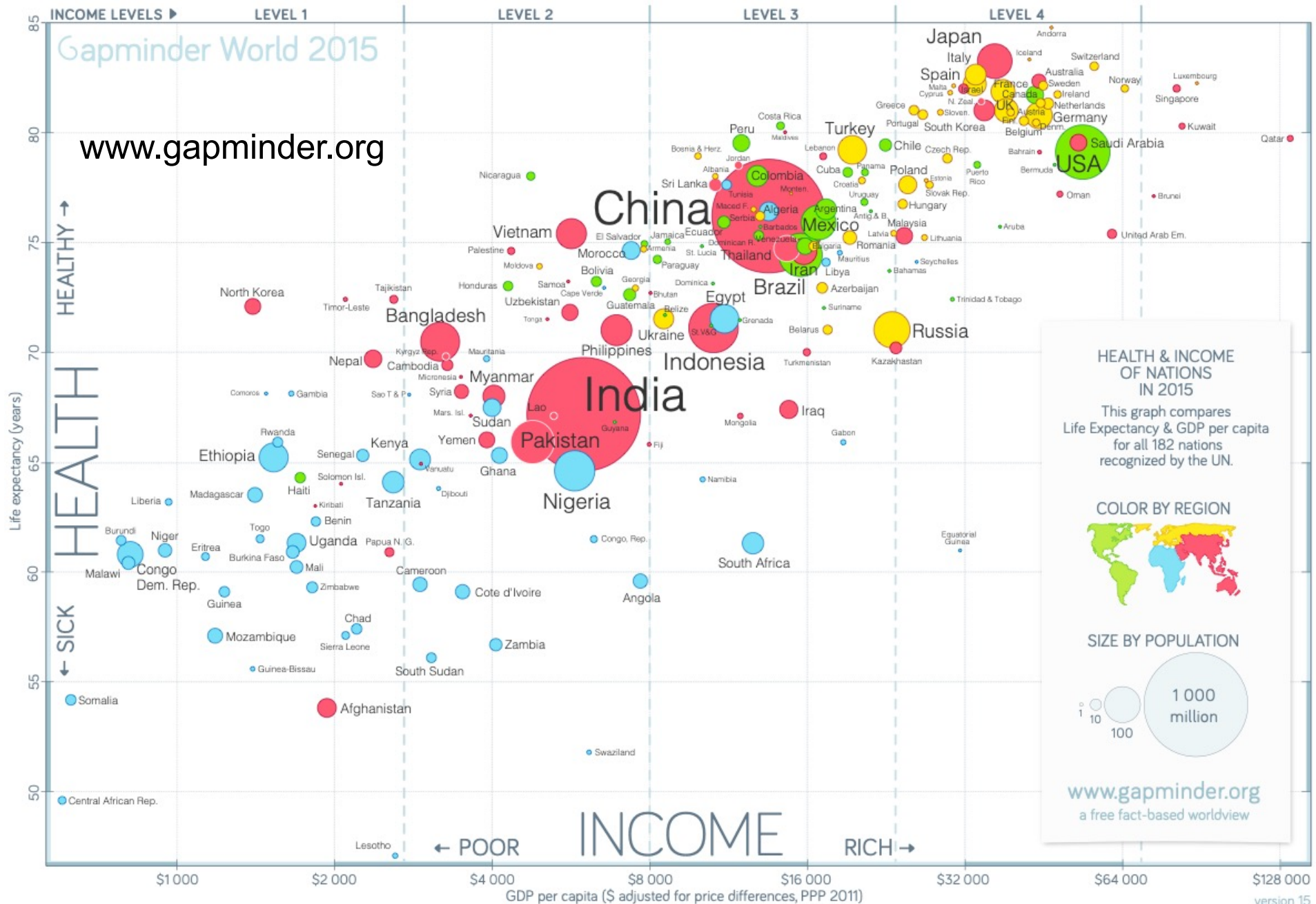
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[www.data-to-viz.com/#explore](http://www.data-to-viz.com/#explore)

# ZATRAKTIVNĚNÍ „NUDNÉ“ STATISTIKY PRO ŠIROKOU VEŘEJNOST



# Seaweed: food, fertilizer, feed, fuel

Can it be all these things - and tackle our emissions problem?

## Sea Trees

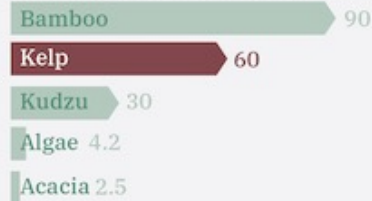


Seaweed absorbs at least as much CO<sub>2</sub> as trees, but without taking up valuable land. A dry tonne of kelp absorbs about **a tonne of CO<sub>2</sub>** in its lifetime.

source: Nature Geoscience, Science, FAO, ScienceNordic, Project Drawdown

## Ultra Fast Growing

MAX GROWTH PER DAY (cm)



Kelp seaweed grows incredibly quickly - it's one of the fastest growing plants in nature. So fast, it could be harvested for its various uses **every 90 days**.

source: Drawdown, FAO, NPS, Earth Observatory, The Monterey Bay Aquarium, PLOS One, BBC, EarthWorld

## Biofertilizer

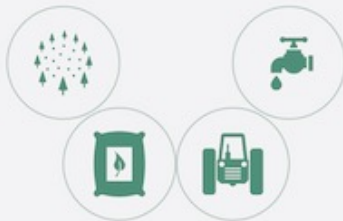


Seaweeds contain powerful, growth-stimulating hormones\*. They stimulate seed germination and nutrient uptake while protecting plants from infections.

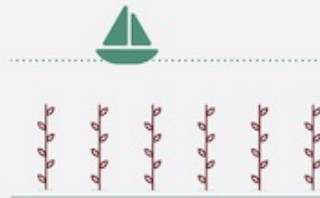
\*auxins, cytokinins, gibberellins

source: Journal Of Scientific & Industrial Research

## 100% Sustainable, Low-Carbon Crop



Ocean seaweed farms have none of the major downsides of land farming: **deforestation, over-use of fertilisers, fresh water and fuel-burning machinery.**



Because they grow vertically, seaweed farms **use less space**, and attract aquatic life, boosting the ecosystem. They also sit 25m underwater so boats can pass above.



Harvesting is simple and often done by hand, using very little CO<sub>2</sub> burning fuel.

The first seaweed farms are in trials off the coast of Hawaii.

source: Project Drawdown, Matters Journal, The Atlantic, World Bank, National Geographic, BBC

## Seafood Diet



Widespread seaweed farms could supply very high quality, high nutrient food. Great sources of **calcium, iron, magnesium, potassium & iodine.** Plus it's very tasty!

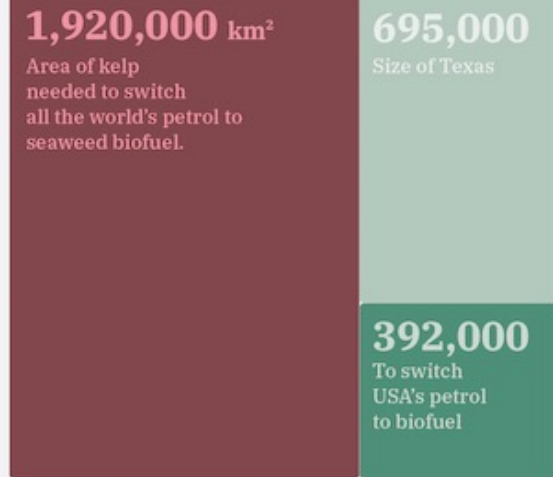
source: Nutrition Reviews, Nutrition Value

## Fuel for Thought

About 50% of seaweed is oil, perfect for making biofuel.

It yields **30x more energy per acre** than other biofuel crops like soy or corn.

And there's no need to clear forests to grow it!



source: Project Drawdown, World Bank, Biotechnology Reports, Renewable & Sustainable Energy Reviews, Oceanography, ADFC, Applied Energy

## Livestock Feed

There's preliminary evidence that cattle feed made from seaweed reduces the methane expelled from both ends of the animal.



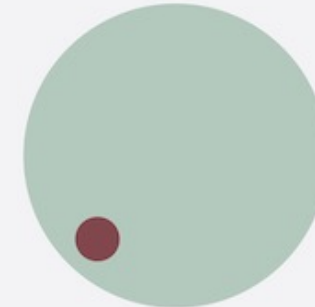
12% of the world's methane emissions come from the billions of cows, sheep and goats around the world.

In ongoing studies, cows fed *limu kohu* seaweed saw their methane emissions drop between **12-58%**. In sheep, it was **80%**



source: Project Drawdown, NASA, Carbon Brief, Animal Microbiome, Matters Journal

## Ocean Forest



Today's wild **kelp forests** cover just **76,000km<sup>2</sup>** - approximately the size of Austria. But that's only **2%** of the fertile ocean. **Imagine if that was larger...**

source: Project Drawdown

<https://informationisbeautiful.net>