Dissertation

Chironomid-based inference models for Tibetan lakes aided by a newly developed chironomid identification key

Andreas Plank

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1. Gutachter: Prof. Dr. Steffen Mischke
2. Gutachter: Prof. Dr. Ulrike Herzschuh

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Abbreviations

shortened	explanation
#	indicates counts
ø	average group value
AIC	Akaike's information criterion
$\mathrm{ANN}_{\mathrm{neu}=2} - 0.1$	transfer model using artificial neural networks and 2 neurons in the hidden or background layer and a learning rate of 0.1
$\mathrm{ANN}_{\mathrm{neu}=\ldots} - 0.1$	transfer model using artificial neural networks and 2, 3 or 4 neurons in the hidden or background layer and a learning rate of 0.1
Bayes	transfer function using the Bayesian approach
$°C_{H_20}$	water temperature
CCA	canonical correspondence analysis
CTP-01	sample code for tour on Central Tibetan Plateau
Δ	delta is used to indicate a difference or generally a subtraction like: $\Delta\mathrm{value} = \mathrm{value}_1 - \mathrm{value}_2$
EC	electrical conductivity
f	frequency of a taxon among different samples
i	is indexing site i in formulae from the first site $i = 1$ to the last sites n
ind.	individuals
j	is indexing species response curves (SRC) in Bayesian model approach for varibles u, N_{ik}, t_k, p_{ik}, P (see p. 16)
k	is indexing taxa in formulae from the first taxon $k = 1$ to the last taxon m
LBC-12	sample code for tour Lhasa-Bamda-Chengdu
LLSESP	is the linear least squares error slope parameter in residual plots (Vasko et al. 2000). Note that residuals are defined as observed − estimated not conversely.
LOOCV	method of checking the goodness of prediction: leave one out cross-validation
m	total number of taxa in formulae
$\mathrm{MAT}_{\mathrm{k}=6}$	modern analogue technique using $k = 6$ closest modern analogues
ML	transfer function using maximum likelihood approach
n	total number of samples in formulae
n	counts of head capsules
$\mathrm{n}_{\mathrm{outliers}}$	boxplot's given outliers
NA	data values not available
NMDS	Kruskal's nonmetric multidimensional scaling
ν (nu)	degrees of freedom in formulae
$\mathrm{P}_{\mathrm{Jan}}$	precipitaion of January in mm
p_k, p_{ik}	probability for taxon k or explicit at site i in formulae
PDF	probability density function in Bayesian model approach
PLS-2	transfer function using partial least squares method and 2 factor components
$\mathrm{Pr}(y\|x)$	mathematical denotation of the probability of abundance y given that environmental variable x is true
r^2	squared spearman correlation between inferred and observed values
r_i	site scores at sample i in formulae
ρ	Riemannian shape distance ρ (rho) between the two configurations (Kendall 1984). Note $0 \leqslant \rho \leqslant \pi/2$
RMSE	root mean squared error for the training set (apparent RMSE)
RMSEP	root mean squared error of prediction, i.e. "$\mathrm{RMSE}_{\mathrm{LOOCV}}$"
$s_{\mathrm{ave\,min}}$; s_i	mean average silhouette width; silhouette width of element i
Sic-07	sample code for tour in province Sichuan
SRC	species response curves in a Bayesian transfer function
$\mathrm{T}_{\mathrm{Jul}}$	air temperature of July in °C
$\mathrm{T}_{\mathrm{H_2O}}$	water temperature °C
t, τ (tau)	tolerances in a Bayesian transfer function

Continued on next page

Abbreviations (continued)

shortened	explanation
t_k	tolerance of taxon k
TDS	total dissolved solids measured in mg·l^{-1} by Zhang et al. (2007)
TS	training set
u_k	optimum for taxon k obtained from measured environmental variable x
$\hat{u}$	estimated optimum for a taxon
VIF	variance inflation factor (used in CCA ordination to detect redundant environmental varibles)
WA	transfer function using weighted averaging
$\mathrm{WA_{tol}}$	transfer function using weighted averaging with tolerance downweighting
$\mathrm{WA_{inv}}$	transfer function using weighted averaging with inverse deshrinking
WAPLS-2	transfer function using weighted averaging partial least squares method and 2 factor components
$\mathrm{WMAT_{k=6}}$	weighted modern analogue technique using $k = 6$ closest modern analogues, i.e. weighted averages by species for the environmental factor
x_i	environmental variable in formulae at site i, e.g. pH or conductivity
$\tilde{x}_i$	environmental site scores used in formulae
$\hat{x}_i$	estimated environmental variable in formulae at site i
$x_{\min}, x_{\max}$	minimum and maximum of environmental variable
y_k, y_{ik}	abundance for taxon k or explicit at site i
y_{i+}, y_{++}	a '+' subscript replaces the appropriate indexing subscript and is ment to be a summation: y_{i+} is $y_{i1} + y_{i2} + \cdots + y_{im} = \sum_{k=1}^{m} y_{ik}$; $y_{++} = \sum_{i=1}^{n} \sum_{k=1}^{m} y_{ik}$
$\hat{y}_k$	estimated abundance for taxon k in formulae
YeR-01	sample code for Yellow River tour
z	centroid of site scores

Abbreviations of taxa

For details see taxa list in Appendix on page 119, Table A.9.

Abla?mon: *Ablabesmyia monilis* type
Ablainde: *Ablabesmyia* sp.
Acri?lon: *Acricotopus longipalpus* type
Acri?luc: *Acricotopus lucens* type
Acriind1: *Acricotopus* indet 1
Acriinde: *Acricotopus* sp.
ChEiinde: *Chironomus/Einfeldia* sp.
ChEim1m1: *Chironomus/Einfeldia* sp. men1 man1
ChEim1m2: *Chironomus/Einfeldia* sp. men1 man2
ChEim1m3: *Chironomus/Einfeldia* sp. men1 man3
ChEim2m1: *Chironomus/Einfeldia* sp. men2 man1
ChEim2m2: *Chironomus/Einfeldia* sp. men2 man2
ChEim2m3: *Chironomus/Einfeldia* sp. men2 man3
ChEim3m1: *Chironomus/Einfeldia* sp. men3 man1
ChEim3m2: *Chironomus/Einfeldia* sp. men3 man2
ChEim3m3: *Chironomus/Einfeldia* sp. men3 man3
ChEimen1: *Chironomus/Einfeldia* sp. men1
ChEimen2: *Chironomus/Einfeldia* sp. men2
ChEimen3: *Chironomus/Einfeldia* sp. men3
Clat?man: *Cladotanytarsus mancus* type
Concinde: *Conchapelopia* sp. type
Corn?arc: *Corynoneura arctica* type
Corn?asc: *Corynoneura arctica/scutellata*
Corn?scu: *Corynoneura scutellata* type
Corninde: *Corynoneura* sp.
CoThinde: *Corynoneura/Thienemanniella* sp.
Cric?bic: *Cricotopus bicinctus* type
Cric?tib: *Cricotopus tibialis* type
Cricgsy1: *Cricotopus sylvestris* gr. indet 1
Cricgsy2: *Cricotopus sylvestris* gr. indet 2
Cricgsyl: *Cricotopus sylvestris* gr.
Cricsano: *Cricotopus salinophilus*
Cricshil: *Cricotopus shilovae*
CrOrinde: *Cricotopus/Orthocladius* sp.
Cryc?fud: *Cryptochironomus fulvus/digitatus*
Crycinde: *Cryptochironomus* sp.
Dicrinde: *Dicrotendipes* sp.
Euki?cla: *Eukiefferiella claripennis* type
Euki?grc: *Eukiefferiella gracei* type
Eukiinde: *Eukiefferiella* sp.
EuTvinde: *Eukiefferiella/Tvetenia* sp.
faChiro1: *Chironomidae* indet 1
faChiro2: *Chironomidae* indet 2
Glyp?pae: *Glyptotendipes pallens* type
Glypinde: *Glyptotendipes* sp.
Hete?mar: *Heterotrissocladius marcidus* type
Limninde: *Limnophyes* sp.
Metr?eur: *Metriocnemus eurynotus* type
Micr?ari: *Micropsectra aristata* type
Micr?ins: *Micropsectra insignilobus* type
Micr?jun: *Micropsectra junci* type
Micr?rad: *Micropsectra radialis* type
Micrinde: *Micropsectra* sp.
Nano?rec: *Nanocladius rectinervis* type
Nanoinde: *Nanocladius* sp.
Orth?fri: *Orthocladius frigidus* type
Orth?obu: *Orthocladius obumbratus* type
Parl?con: *Paracladius conversus* type
Parlinde: *Paracladius* sp.
Part?aus: *Paratanytarsus austriacus* type
Part?dis: *Paratanytarsus dissimilis* type
Part?pen: *Paratanytarsus penicillatus* type
Partinde: *Paratanytarsus* sp.
Patd?nus: *Paratendipes nudisquama* type
Poly?nub: *Polypedilum nubifer* type
Polyinde: *Polypedilum* sp.
Proc?cho: *Procladius choreus* type
Procinde: *Procladius* sp.
Psec?bas: *Psectrocladius barbimanus/sokolovae* type
Psec?obv: *Psectrocladius obvius* type
Psec?sol: *Psectrocladius sordidellus/limbatellus*
Psec?sop: *Psectrocladius sokolovae/pancratovae*
Psecinde: *Psectrocladius* sp.
Psed?per: *Pseudodiamesa pertinax* type
Psesind2: *Pseudosmittia* indet 2
Psesinde: *Pseudosmittia* sp.
Saetinde: *Sætheria* sp.
Serg?lov: *Sergentia longiventris* type
Serginde: *Sergentia* sp.
sfChiron: Chironominae-sp.
sfDiame1: Diamesinae-indet 1
sfDiame2: Diamesinae-indet 2
sfDiame3: Diamesinae-indet 3 (*Pagastia* indet)
sfDiame4: Diamesinae-indet 4
sfOrthoc: Orthocladiinae-sp.
sfTanypo: *Tanypodinae* sp.
Sticind1: *Stictochironomus* sp. 1
Sticinde: *Stictochironomus* sp.
TaCoinde: *Tanytarsus/Corynocera* sp.
Tany?gra: *Tanytarsus gracilentus* type
Tanyinde: *Tanytarsus* sp.
Tany?lap: *Tanytarsus lapponicus* type
Thil?vit: *Thienemanniella vittata* type
trChiron: *Chironomini* sp.
trTanyt1: Tanytarsini indet 1
trTanyta: Tanytarsini sp.
Tvetinde: *Tvetenia* sp.

Summary

Larval chironomids (Diptera: Chironomidae) were investigated to provide climate reconstruction tools using transfer functions and based on 52 lake samples from the Tibetan Plateau. Based on measured environmental variables an obvious electrical conductivity/salinity gradient from 0.015 to 130.0 mS · cm^{-1} was detected as the most influencing factor which can be used to reconstruct chironomid inferred salinities from lake sediment cores. Tested model types were: artificial neural networks (ANN), Bayesian, weighted averaging (WA), partial least squares (PLS), weighted averaging partial least squares (WAPLS), maximum likelihood (ML) and modern analogue technique (MAT). Performances of transfer models, tested by leave one out cross-validation, yield a maximum correlation value of r^2_{LOOCV} 0.762/0.764 with a root mean squared error of prediction (RMSEP) of 0.475/0.473 mS · cm$^{-1}{}_{\log 10}$ for ANN models with three or four hidden neurons and a learning rate of 0.01. For apparent models $r^2_{\mathrm{app.}}$ varies from 0.958 to 0.664 with a root mean squared error (RMSE) of 0.200 up to 0.610 mS · cm$^{-1}{}_{\log 10}$. Summarising all calculated transfer models with their summed error values and whether they yield balanced infer ed values of electrical conductivity a ranking can be stated as follows: Bayesian $\approx$ ANN$_{\mathrm{neu}=3/4}$ – 0.1/0.01 (with three or four hidden neurons and learning rates of 0.1 or 0.01) $\approx$ WAPLS–3 (with 3 components) $>$ PLS–5 (5 components) $\gtrapprox$ WA$_{\mathrm{cla+inv}}$ (classical/inverse) $\gtrapprox$ WA$_{\mathrm{...tol}}$ (with tolerance downweighting) $>$ W/MAT (weighted or unweighted) $>$ ML. Sampling depth as a second important influencing factor detected by Canonical Correspondence Analysis (CCA) yields only week and unreliable transfer models with $r^2_{\mathrm{LOOCV}} = 0.475$ and a RMSEP of 7.2 m. Furthermore the following measured environmental variables showed a statistical significant relationship in CCA for the benthic chironomid community: electrical conductivity, sampling depth, mean air temperature of October, mean precipitation of December, pH value and finally water area respectively in descending order of significance.

To enhance the part of determination the Chironomidae Identification Program CHIP was developed that provides scientists a convenient way to organise all literature, references, images and descriptions of scientific publications related to Chironomidae. It uses interactive, flexible local websites and the free programming language PHP with MySQL as database engine with the possibility of further open-source development. Developed for larvae primarily, the program can be used to work with pupae and adults as well. Including also a tool that provides data for normalised elliptical Fourier outline analysis of black/white scanned images this analysis was tested on related taxa to *Psectrocladius* in separating outlines of menta. Thereby it can give a great advantage for determination as decisions can be made more objectively and it should also be able to detect halves of menta.

Zusammenfassung

Larvale Zuckmücken (Diptera: Chironomidae) von 52 Seen des Tibet Plateaus wurden untersucht, um mittels Transferfunktionen paläoklimatische Rekonstruktionen durch errechnete Transfermodelle zu ermöglichen. Basierend auf Umweltmeßdaten konnte ein eindeutiger Gradient elektrischer Leitfähigkeit/Salinität aufgezeigt werden (0,015 bis 130,0 $\mathrm{mS \cdot cm^{-1}}$), der die wichtigste Einflußgröße in den untersuchten Daten darstellt. Er kann dazu genutzt werden elektrische Leitfähigkeiten/Salinitätswerte von Chironomiden aus Bohrkernproben von Seen des Tibet Plateaus zu rekonstruieren. Näher untersuchte Transferfunktionen waren: Artificial Neural Networks (ANN), Bayesische Transferfunktion, Weighted Averaging (WA), Partial Least Squares (PLS), Weighted Averaging Partial Least Squares (WAPLS), Maximum Likelihood (ML) und Modern Analogue Technique (MAT). Die Güte der berechneten Transfermodelle wurde durch Leave-One-Out-Kreuzvalidierung (LOOCV) getestet und ergab maximale Korrelationswerte für LOOCV Modelle von $r^2_{\mathrm{LOOCV}} = 0,762/0,764$ mit einem Standardfehler (RMSEP) von 0,475/0,473 $\mathrm{mS \cdot cm^{-1}_{\log 10}}$ für ANN Modelle mit drei oder vier Neuronen und einer Lernrate von 0,01. Die berechneten Transfermodelle hingegen variierten für $r^2_{\mathrm{app.}}$ von 0,958 bis 0,664 mit Standardfehlern (RMSE) von jeweils 0,200 bis 0,610 $\mathrm{mS \cdot cm^{-1}_{\log 10}}$. Eine Zusammenfassung aller berechneten Transfermodelle, basierend auf summierten Fehlerwerten und basierend auf der Ausgeglichenheit berechneter Streuungswerte, ergibt die folgende Rangfolge: Bayesische Transferfunktion $\approx \mathrm{ANN_{neu=3/4}} - 0,1/0,01$ (mit drei oder vier Neuronen und einer Lernrate von 0,1 bzw. 0,01) $\approx$ WAPLS–3 (mit 3 Komponenten) $>$ PLS–5 (5 Komponenten) $\gtrapprox \mathrm{WA_{cla+inv}}$ (klassisch/invers) $\gtrapprox \mathrm{WA_{...tol}}$ (mit tolerance downweighting) $>$ W/MAT (mit Wichtung oder ohne) $>$ ML. Die Probentiefe konnte als zweitwichtigste Einflußgröße mittels Kanonischer Korrespondenzanalyse (CCA) ausgemacht werden, ergab aber ungenaue Transfermodelle für Kreuzvalidierungstests mit $r^2_{\mathrm{LOOCV}} = 0,475$ und einem Standardfehler von 7,2 m. Insgesamt konnten sechs Einflußgrößen als signifikant in der CCA ermittelt werden, die die bentischen Chironomidenzönosen beschreiben: elektrische Leitfähigkeit, Probentiefe, mittlere Lufttemperatur im Oktober, mittlerer Niederschlag im Dezember, pH Wert und schließlich Wasserfläche jeweils in abnehmender Signifikanz.

Um den Teil der Bestimmungsarbeit zu verbessern, wurde das Chironomiden Identifikations Programm CHIP entwickelt, welches Wissenschaftlern in zweckmäßiger Art und Weise hilft Referenzen, Bilder und Beschreibungen von wissenschaftlichen Veröffentlichungen auf dem Gebiet der Chironomiden zu verwalten. Es nutzt dabei interaktive, dynamisch generierte, lokale Webseiten und die Programmiersprache PHP in Verbindung mit MySQL Datenbanken, was die Möglichkeit einer weiteren Open-Source Entwicklung eröffnet. Ursprünglich nur für Larven entwickelt, kann CHIP auch für Puppenstadien und adulte Chironomiden genutzt werden. Mit Hilfe eines implementierten Werkzeugs zur Bild-Umrißanalyse kann eine normalisierte elliptische Fourier Analyse von gescannten schwarz/weiß Bildern durchgeführt werden. Diese Analyse wurde für Taxa der Gattung *Psectrocladius* getestet, um verschiedene Umrisse von Mentumstrukturen aufzutrennen. Dadurch wird die Bestimmungsarbeit begünstigt, da einerseits Entscheidungen in der Bestimmung objektiver werden und ebenso die Möglichkeit besteht gebrochene Strukturen, wie Mentumhälften auftrennen zu können.

1. Introduction

In the last years many limnological research activities were focused on the field of climate change in developing transfer models based on taxa on the one hand and assigned measured abiotic variables on the other, because developing future climate models can be done only on the basis of understood past and present conditions. For Europe and North America a quite large number of palaeoclimate models is published for different organisms such as diatoms (Holden et al. 2008; Yang et al. 2004; Birks et al. 1990), plants (Li et al. 2007; Langdon et al. 2004; Song and Sun 1997), ostracods (Mischke et al. 2007; Mezquita et al. 2005; Mourguiart et al. 1998) and chironomids (Luoto 2009; Heinrichs and Walker 2006; Langdon et al. 2004; Walker et al. 1995). Hereby lakes or ponds are referred to as climate archives in which organisms are preserved in the benthos and that is colonised by limnic organisms such as chironomids according to their ecological preferences (e.g. Clair and Paterson 1976). Investigating then lake sediment cores and developing transfer models based on numerous surface samples reveals regional environmental conditions reconstructable for several abiotic factors that are related to the climate and hence this approach gives an idea of how climate has changed over long time periods.

Although chironomid larvae live in almost all wet habitats with high abundances up to 33,000 ind.$\cdot$m^{-2} (Armitage et al. 1995) their diffcult determination of larval head capsules preserved in lake sediments often prevents them from being investigated more precisely. However, shown in numerous publications chironomids provide a good indication to reconstruct palaeoenvironmental conditions (e.g. Hofmann 1988; Brooks 2006) and they are recorded to respond for instance to lake level changes (Korhola et al. 2000; W. Hofmann 1998), palaeotemperature/palaeoclimate (Brooks 2006; Velle 2003; Bigler et al. 2003; Olander et al. 1997; Walker 1987) and palaeosalinity (Heinrichs and Walker 2006; Walker et al. 1995; Zhang et al. 2007).

Regarding literature data and applications of Chironomidae there exist many references but the most difficult task in investigating numerous samples regarding Chironomidae still remains the determination. There exist well illustrated determination guides like Brooks et al. (2007), Schmid (1993) and Cranston (1982) or the interactive key from Klink and Moller-Pillot (2003) but likewise also many other taxa have to be managed that are described in publications. However, there is no convenient way to integrate them together. Especially in sparsely investigated geographic regions with only few available literature an interactive and dynamic program as a framework can deal with tasks like collecting ecological/morphometric data, doing morphometric measurements, identify species and manage also described specimens. For this purpose the Chironomidae Identification Program CHIP was developed to identify larval chironomids as good as possible and which is the basis and part of this work.

During the last decade scientific research acitivities related to climate change became gradually more concerned also with Asia due to its huge land mass and its relevant link to climatic processes (Domrös and Peng 1988). However, transfer models in Asia related to chironomids (Zhang et al. 2007) are rare and need further comparable investigations. Therefore samples for this study were collected from a part of China, where the Tibetan Plateau and monsoon activities intertwine.

1.1. Climatic and geological aspects of the Tibetan Plateau

China as the third largest country on earth including the Tibetan Plateau with its huge land mass influences substantially the climatic patterns of Asia as it has been shown that the global variation of climate is comparable to the climate variation in China alone (Domrös and Peng 1988). It has a typical monsoon climate with seasonal changes where the monsoon limit is reaching the eastern edge of the Tibetan Plateau (Mei'e et al. 1985). Therefore changes in the climate's past are suggested to influence also the monsoon limit on the Tibetan Plateau to which organisms respond. Beside monsoon climate, the Tibetan Plateau can be characterised by strong daily and monthly temperature variation due to high elevation and a continental climate (Moores and Fairbridge 1997). Its vegetation types range from grassland dominated, tree- and brushless central areas to wooded steppe environments influenced by the monsoon in the east (Moores and Fairbridge 1997). Regarding climate's classification it ranges from the arid alpine zone HO in the west to the humid, semiarid, arid temperate zone in the east HII covering the subhumid and semi-arid subalpine zone HI (Fig. 1.1). Due to these arid climatic conditions over longer time periods also a number of saline lakes can be found on the Tibetan Plateau with most salty lakes in northwestern China (Williams 1991).

The sedimentary strata of Tibetan Plateau range from lower Palaeozoic to Quaternary and tectonically it can be divided into four terranes (Moores and Fairbridge 1997) ranging from the southern edge to the northern one as follows (Fig. 1.2): Himalayan Orogenic Belt, Lhasa Micro Plate, Qiangtang Micro Plate and the Kunlun-Qinling Orogenic Belt. Geographically and stratigraphically the Tibetan Plateau ranges from the Ceno- and Mesozoic vertical uplift region of Himalayan Mountains in the south where the East Indian and Asian Plate converging together and the Altun, Qilian Mountains in the north characterised by Palaeozoic and Proterozoic strata. Pamir and Kunlun Mountains margin the Tibetan Plateau in the west and finally Henduan Mountains in the east with an over-all average elevation of about 4,000–5,000 m above sea level (Mei'e et al. 1985). The Tibetan Plateau shows a complex stratigraphical structure of mainly Cenozoic and Mesozoic strata with

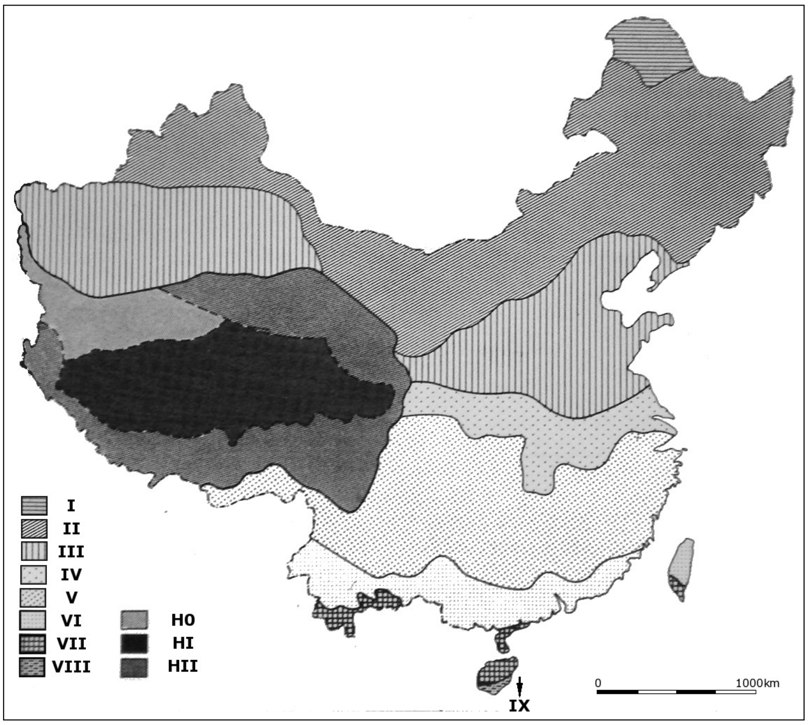


Fig. 1.1.: Climate zones of China redrawn after Huang (1986) in Domrös and Peng (1988):
I: Cold Temperate, II: Middle Temperate, III: Warm Temperate, IV: Northern Subtropical, V: Middle Subtropical, VI: Southern Subtropical, VII: Peripheral Tropical, VIII: Middle Tropical, IX: Equatorial Tropical, HO: Plateau Alpine, HI: Plateau Sub-alpine, HII: Plateau Temperate. Note that in Domrös and Peng's map of climate zones HI is HII which is probably an erratum.

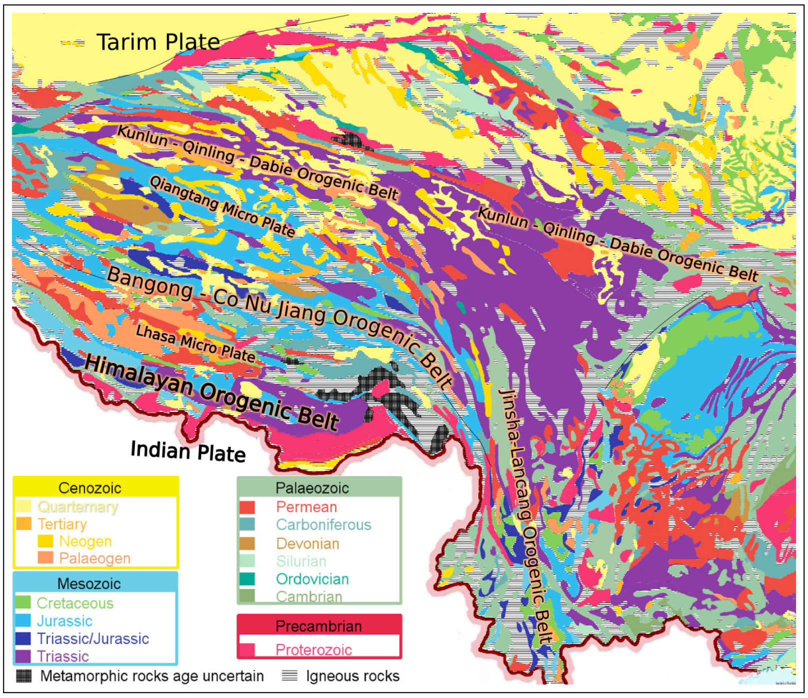


Fig. 1.2.: Stratigraphical map of the Tibetan Plateau with major geological belts and plates redrawn after Ma (1999) and Li (1999). Strata were combined to geological periods or eon with indication colours following Walker and Geissman (2009).

the Triassic dominating in the east and the Jurassic dominating in the central part.

1.2. Transfer models

Applied transfer models are one frequently used mean to link organisms to abiotic variables on the one hand and reconstruct abiotic variables of lake sediment cores with a specific transfer function on the other (Frey and Deevey 1998). Frequently used transfer functions are models using Maximum Likelyhood (Birks 2001; ter Braak and van Dam 1989), Weighted Averaging (ter Braak and Barendregt 1986), Weighted-Average-/Partial-Least-Squares (ter Braak and Juggins 1993; ter Braak 1995b) and Modern Analogue Technique (e.g. Overpeck et al. 1985; Gavin et al. 2003). With evolved computer power also other complex and robust transfer functions were developed that need more computational resources, like the Bayesian model approach (Vasko et al. 2000; Holden et al. 2008) or models using Artificial Neuronal Networks (e.g. Racca et al. 2001) but these transfer functions are underutilised and less applied to data sets as the transfer functions mentioned above. The number of developed transfer functions also illustrates that no model can handle data perfectly and therefore scientific research has been tried to develop and improve those tools by reducing errors and misestimations of models. One frequently observed negative effect is the 'edge effect' which is known from WA-based methods (Frey and Deevey 1998) and causes more or less over- or underestimation at margins of the gradient of interest. In some approach, e.g. WAPLS, it is tried to reduce this error but it still seems an issue (Frey and Deevey 1998). An application and comparison of all these different model types is an aim of this study and it will show which models yield lowest error values.

Hence the focus of this study is to develop transfer models that provide further climatic reconstructions based on lake surface sediments from the Tibetan Plateau by means of larval chironomids.

2. Methods

2.1. Sampling methods and environmental parameters

All samples included in this study were collected in July and August during 2003–2005 on the Tibetan Plateau spanning from 29.5 to 38.9° N and 87.6 to 102.3° E (Fig. 2.1) with the same sampling methods used for Mischke et al. (2007). Thereby sediment surface samples were taken from the water bottom and stored in plastic bags at cool temperatures later in a refrigerator. Geographical position and elevation data at each sampling site was determined with a handheld GPS device. For water characteristics pH value, electrical conductivity, dissolved oxygen and water temperature were measured with a portable field device (WTW Multi 340i) at 0.3 m water depth. At sample's location Secchi depth was measured and sampling depth with a portable echo sounder.

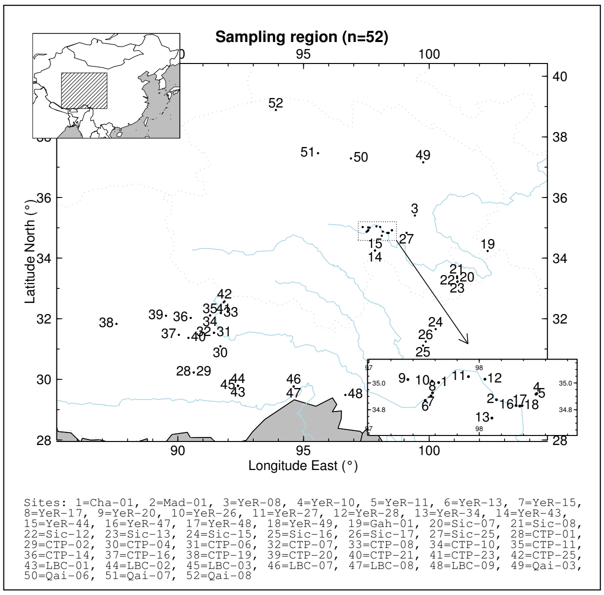


Fig. 2.1.: Map of samples on the Tibetan Plateau for all 52 samples with borders of Provinces.

For dissolved oxygen and water temperature it has to be mentioned that they may differ compared to values obtained with data loggers for a whole day. Those whole day measurements could not be carried out practically. Therefore the measured values represent only current conditions at a single sampling time at sites in a lake or pond.

2.2. Chironomid analysis

To obtain head capsules of chironomids,discuss collected sediment samples were prepared with 10 % KOH using common methods following recommendations of Walker and Paterson (1985) and afterwards they were gently sieved using 100 µm-sieves. In each sieved sample at least 50 head capsules (Quinlan and Smol 2001; Larocque 2001) were collected under a binocular microscope (10–50×) and embedded on microscope slides in Euparal medium for further investigations and determination with a microscope (100–400×). Broken head capsules were summed up and the total number was rounded up to integer.

2.2.1. Identification key CHIP

Analysis and determination of larval head capsules of chironomids is most complicate especially in regions where comprehensive but rare reviewed literature exists. And in facing the challenge of ordering numerous literature to get Chinese descriptions of larval Chironomidae (e.g. checklist in Wang 2000), a way to organise and determine chironomid taxa was required. Hence for working with a determination and manage tool the following deliberations and requirements were considered: storage of contents in a flexible and dynamic way and providing usability for other interested scientists. Therefore it was decided to take an approach using free software and to develop the Chironomidae Identification Program CHIP with MySQL as database engine and PHP/HTML language scripts for generating webpages dynamically on a (local) web server software like Apache Friends. Written in PHP code (v. 5 ⩾) with the software Quanta Plus CHIP is communicating via a local web server with the MySQL database engine for data storage. Its advantage is that it can be installed on every platform with at least an internet browser as interface. For the usability it was decided to license CHIP under "Creative Commons Attribution-Noncommercial-Share Alike" for the usage of everybody's interest and also with the possibility of further open-source development.

References that were used are listed in CHIP and on my own website at http://www.chironomidaeproject.com/. Also a detailed documentation is given within the program explaining all features and usage in detail.

Included images were scanned or downloaded from other references or captured by a digital photo camera and referenced to their original source by adding authors' short reference name into the image itself. These pictures are organised in MySQL table `images` and linked to table `names_authors` containing all references used in CHIP (Fig. 2.2). References

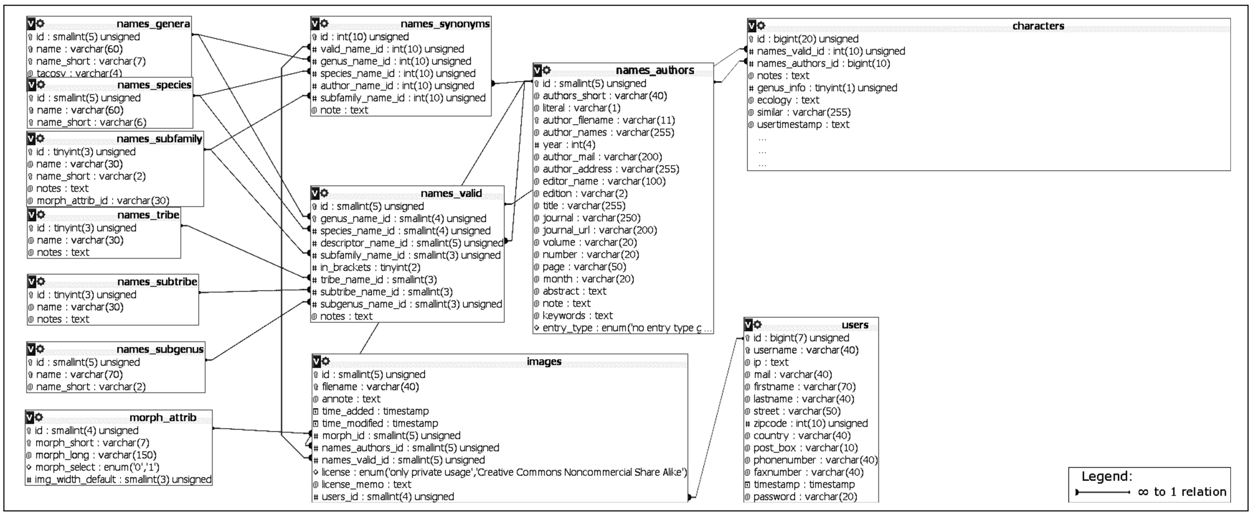


Fig. 2.2.: Scheme of tables' relations indicated by lines with ∞ to 1 relations used in the Chironomidae Identification Program CHIP. Field names of tables are given with their data types used for MySQL databases.

are cited as usual with author year citation by text strings and are stored in table `characters` as well as structured, formatted text or other determination keys and annotations. From table `characters` a webpage is generated for each genus or specimen and can be modified to access easier determination, e.g. with tables sortable by numeric characters or structured text as lists, paragraphs and sections. To minimise database's memory, all input text is stored in Wikipedia-like text syntax and will be formatted automatically to tables, lists, paragraphs, sections etc.

This software can be obtained from http://www.chironomidaeproject.com and also all cited references within the identification key. But currently a version with all images is only for private usage due to restricted copyrights from journals and authors.

2.2.1.1. Determination

Due to the frequent lack of characters for determination of larval head capsules it was tried to reach the best taxonomic level for specimens. For some cases it was decided to group taxa together due to difficult separation. In the case of genera *Chironomus* and *Einfeldia* only a few whole head capsules were available that allow the separation between *Einfeldia* and *Chironomus*. Obtaining yet information about these taxa they were divided into morphological types such as mentum and mandible types following Vallenduuk et al. (1997).

Within the genus *Psectrocladius* separation between *P. barbimanus*, *P. pancratovae* and *P. sokolovae* was not possible. The type *P. barbimanus/-sokolovae* is meant as tending to *P. barbimanus* with middle teeth slightly lower to slightly higher than the first lateral teeth of the mentum. Regarding *P. sokolovae* or *P. pancratovae* there was only one whole larvae *P. sokolovae* found with a yellow head capsule and 5 long + 2 short setae on procerus. Similar taxa to this whole larvae were named *P. sokolovae/-pancratovae* with distinctly higher middle teeth and yellow head capsules. In the same way *P. sordidellus/limbatellus* were grouped following Moller-Pillot (1984b).

For the difficult separation between *Tanytarsus gracilentus* and *Corynocera oliveri* it was decided to group them together as *Tanytarsus/Corynocera* sp. in the case when there was a mandible but no dark plate behind the mentum as described by Brooks et al. (2007) for *Tanytarsus gracilentus* type and following Langdon et al. (2008).

2.2.1.2. Outline analysis

CHIP provides the basis of outline analysis of morphological shapes from prepared black/white images by using normalised elliptic Fourier analysis (Kuhl and Giardina 1982). Hereby all reconstructed outlines are independent of shape's size and orientation and starting point of contour's trace. A detailed description is given in Kuhl and Giardina (1982) and the used method is described here briefly.

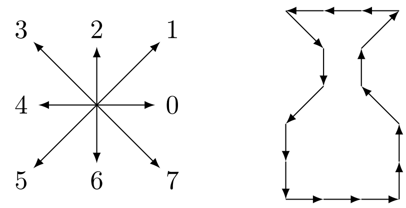


Fig. 2.3.: Chain code after Freeman (1974) and its directions for outlined images (left) and a given chain code 7656600022321444 with 16 points (right).

An outline is transcoded into a chain code (Fig. 2.3) by outlining in counter clockwise direction. Traverse a particular chain code with i elements the distance Δt between each element is:

$$\Delta t_i = 1 + \left(\frac{\sqrt{2}-1}{2}\right)\left(1-(-1)^i\right) \tag{2.1}$$

The length of an outline with p points is therefore given by:

$$t_p = \sum_{i=1}^{p} \Delta t_i \tag{2.2}$$

and has—related to time analysis as Fourier analysis was first applied to—a basic period of $T = t_k$ from all k points. A shape with a closed two-dimensional contour can be approximated as the sum of elliptical harmonics by elliptic Fourier analysis. Let's consider a closed contour which has k points and is approximated by N harmonics with four Fourier coefficients a_n, b_n, c_n, d_n for each harmonic:

$$A_n = \frac{T}{2n^2\pi^2}\sum_{i=1}^{k}\frac{\Delta x_i}{\Delta t_i}\left(\cos\frac{2n\pi t_i}{T} - \cos\frac{2n\pi t_{i-1}}{T}\right) \tag{2.3}$$

and

$$B_n = \frac{T}{2n^2\pi^2}\sum_{i=1}^{k}\frac{\Delta x_i}{\Delta t_i}\left(\sin\frac{2n\pi t_i}{T} - \sin\frac{2n\pi t_{i-1}}{T}\right) \tag{2.4}$$

where n is the harmonic order and Δx_i are the distances of points in x-direction. Note that $t_0 = 0$ and Δx_k is the distance of the last point k to the first one. A_i and B_i represent the projection on the x-axis for the i^{th} harmonic. C_i and D_i on the y-axis are found in the same way.

To make elliptic Fourier coefficients invariant to size, rotation and start point of contour traces, the following matrix transformation is used:

$$\begin{bmatrix} a_n & b_n \\ c_n & d_n \end{bmatrix} = \frac{1}{E^*}\begin{bmatrix} \cos\phi & \sin\phi \\ -\sin\phi & \cos\phi \end{bmatrix} \cdot \begin{bmatrix} A_n & B_n \\ C_n & D_n \end{bmatrix} \cdot \begin{bmatrix} \cos n\theta & -\sin n\theta \\ \sin n\theta & \cos n\theta \end{bmatrix} \tag{2.5}$$

where E^* is the magnitude of the semi-major axis of the best fitting ellipse:

$$E^* = \sqrt{(a^*)^2 + (b^*)^2} \tag{2.6}$$

ϕ (phi) is the orientation of this ellipse in radians:

$$\phi = \arctan\frac{c^*}{a^*} \tag{2.7}$$

θ (theta) is the rotation of the starting point from the end of the ellipse with:

$$\theta = \frac{1}{2}\arctan\left[\frac{2(A_1B_1 + C_1D_1)}{A_1^2 + C_1^2 - B_1^2 - D_1^2}\right] \tag{2.8}$$

The values of a^* and c^* are given by:

$$a^* = A_1\cos\theta + B_1\sin\theta \tag{2.9}$$

and

$$c^* = C_1\cos\theta + D_1\sin\theta \tag{2.10}$$

These calculations starting from a chain coded outline image yield an approximation of outline shapes with N harmonics. The more harmonics are calculated the more exact is this normalised elliptic Fourier approximation to the outline. Functions for usage in R (2008) are documented in Plank (2009).

2.3. Statistical analysis

2.3.1. Used software

Statistical analysis was done using R (2008), C^2 (Juggins 2003), for Bayesian transfer functions a FORTRAN program from Philip B. Holden in Holden et al. (2008) was used and for Artificial Neural Networks (ANN) the program PaleoNet (Racca et al. 2007) was used. As R consists of multiple packages all methods are given in curly brackets as follows: `method{package}`.

2.3.2. Data acquisition and preparation

2.3.2.1. Climate and abiotic data

Mean air temperature and mean precipitation data were obtained from Webgis-China (2008). A linear gridded bivariate interpolation was then undertaken upon own samples localities with `interp{akima}` to get better estimates of samples' conditions. Afterwards it was tried to improve approximation to own localities by checking linear relationships for temperature or precipitation that can possibly inferred from the parameters latitude, longitude or elevation. A linear approximation calculated from these geographical parameters was used instead of linear interpolation with `interp{akima}` as follows when the goodness of regression was high enough:

1. calculate absolute values of Pearson–correlation ($\text{cor}_{\text{Pears.}}$) and Fisher's adjusted r^2_{adj} for a linear model with `lm{stats}` (note that r^2_{adj} is less biased than the ordinary r^2).

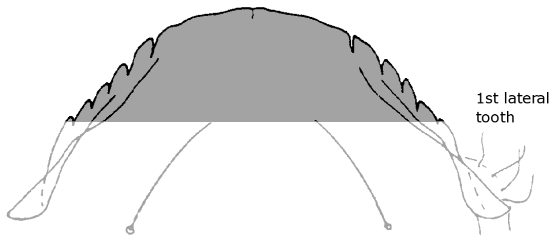


Fig. 2.4.: Outlining an image of mentum's structure of *Psectrocladius (M.)* sp. Cranston et al. (1983). Image was optionally rotated to equalise both 1^{st} lateral mentum teeth. Then a straight line was drawn from the point of deepest incision of both 1^{st} lateral teeth.

2. check for linearity: if $\sum |\text{cor}_{\text{Pears.}}| + r^2_{\text{adj}} \geqslant 1.5$, then this linear model was used to obtain temperature or precipitation values, otherwise interpolation with `interp{akima}` was done.

The following data were adjusted by a linear estimation from samples' latitude or elevation instead using the gridded, bivariate, linear interpolation:

$$\begin{aligned}
\mathrm{T_{Jan}} &= a \cdot \text{Latitude}_{\text{sample}} + b \\
\mathrm{T_{Feb}} &= a \cdot \text{Latitude}_{\text{sample}} + b \\
\mathrm{T_{Mar}} &= a \cdot \text{Latitude}_{\text{sample}} + b \\
\mathrm{T_{Jul}} &= a \cdot \text{Elevation}_{\text{sample}} + b \\
\mathrm{T_{Aug}} &= a \cdot \text{Elevation}_{\text{sample}} + b \\
\mathrm{T_{Nov}} &= a \cdot \text{Latitude}_{\text{sample}} + b \\
\mathrm{T_{Dec}} &= a \cdot \text{Latitude}_{\text{sample}} + b \\
\mathrm{T_{Annual}} &= a \cdot \text{Latitude}_{\text{sample}} + b
\end{aligned}$$

where a is equation's slope and b the intercept.

Water surface area, measured in m^2 and transformed with $\log_{10}$ for statistical analysis, was obtained by satelite images with software Google Earth in addition with image software GIMP. Scaling by $\log_{10}$ was also done for electrical conductivity as the measured data range covers 5 logarithmic scales.

2.3.2.2. Species data and image analysis

Species data were transformed as in Zhang et al. (2007). That is, taxa which occurred only in one lake or with a maximum abundance $\leqslant 1\,\%$ were eliminated from subsequent statistical analyses.

Sorting the taxonomic community according to their diversity the suitable Rényi_∞ diversity was chosen (Tóthmérész 1995). That means order's weighting is focused rather on abundances than on different number of taxa.

Capturing image outlines as described above was done only for genus *Psectrocladius*, to ensure difficult separation among related taxa similar to *P. barbimanus*. Reconstructed image outlines by normalised and not normalised elliptic Fourier analysis was done calculating 200 harmonics with a subsequent shape analysis using R-package `shapes` (Dryden 2007). Normalised outlines have their first landmark according to the best fit of the first ellipse of normalised elliptic Fourier analysis and can therefore also be rotated slightly. The first landmark instead using not normalised outlines is in all outline shapes the same: at the outermost left edge of each mentum. Shapes were compared using Riemannian shape distance ρ (rho, Kendall 1984) and a mentum's outline was obtained as illustrated in Figure 2.4.

2.3.3. Gradient analysis

An analysis of gradients and significant taxa distributions was done by calculating Huisman-Olff-Fresco models following Huisman et al. (1993). They were calculated with the program HOF (Oksanen and Minchin 2002) for all significant environmental factors obtained from canonical correspondence analysis (CCA). All HOF-model types from 1 to 5 show an increasing complexity concerning biological information and try to describe taxon's distribution. These model types are briefly described as follows having an upper bound M (dotted line):

$$\text{I} : \quad y = M\frac{1}{1+e^{a}} \tag{2.12}$$

$$\text{II} : \quad y = M\frac{1}{1+e^{a+bx}} \tag{2.13}$$

$$\text{III} : \quad y = M\frac{1}{1+e^{a+bx}} \cdot \frac{1}{1+e^{c}} \tag{2.14}$$

$$\text{IV} : \quad y = M\frac{1}{1+e^{a+bx}} \cdot \frac{1}{1+e^{c-bx}} \tag{2.15}$$

$$\text{V} : \quad y = M\frac{1}{1+e^{a+bx}} \cdot \frac{1}{1+e^{c+dx}} \tag{2.16}$$

where b and d have opposite signs in 2.15 and 2.16.

This analysis of gradients is dependent on the kind of data's transformation and leads then of course to different model types. The same transformation was applied to environmental variables as for CCA.

2.3.4. Ordination

2.3.4.1. Canonical correspondence analysis (CCA)

For factor analysis it was decided to use an unimodal approach as measured data reached from very low values up to very high ones and therefore a linear approach is rather inappropriate and should be used for really linear model cases (Oksanen 2004).

To find out which abiotic environmental factors can describe taxa's communities a CCA was calculated several times. As in R (2008) other forward and backward selection methods exists than in the often used program CANOCO, a similar approach to CANOCO was done as follows:

1. using `step{stats}` to select automatically a base model with minimised AIC (Oksanen 2008), i.e. starting with a Null–modell and adding more variables step by step and minimise thereby AIC value.

2. adding variables which maximise the sum of eigenvalues explained by selected variables using function `step.cca` (Roberts n.d.) and checking their significance by `anova.cca{vegan}` with at least n = 1000 permutations. Additional variables were included only with variance inflation factors (VIF) lower than about 10.

Rare species were down-weighted in all ordination analyses with `downweight` and potential explaining variables with marginal influence were excluded.

Comparison of different configurations of ordinations was performed by Procrustes analysis with `procrustes{vegan}` to test statistical differences with `protest{vegan}`. 1000 permutations were used.

2.3.4.2. Non-metric Multidimensional Scaling (NMDS)

In order to follow recommendations of Minchin (1987) and to obtain an optimal configuration with a low stress-value in NMDS, multiple ordinations were computed with function `metaMDS{vegan}`. After obtaining lowest stress-value, this configuration was used in further statistical calculations. The steps in `metaMDS{vegan}` after manual of package `vegan` are:

1. Transformation: if the data values are larger than common class scales, the function performs a Wisconsin double standardisation. Species are first standardised by maxima and then sites by site totals. If the values look very large, the function also performs square root transformation. Both of these standardisation are generally found to improve the results.

2. Choice of dissimilarity: the default dissimilarity of Bray and Curtis (1957) was tested manually with function `rankindex{vegan}` and reconsidered by calculating the stress-value in NMDS ordination.

3. Step-across dissimilarities: if a large proportion of sites have no shared species, ordination may be very difficult. Results can be improved then by changing the dissimilarity matrix and modifying the shortest path from all distances to a so called flexible shortest path (Bradfield and Kenkel 1987). This depends on the no shared species composition in sites. So the distances are recalculated between pairs of sites with little or no overlap. It is recommended to use this only with high proportion values of no shared species. Default proportion of 10 % was used and means: if sites have more than 10 % of no shared species, a modified dissimilarity is calculated after Bradfield and Kenkel (1987). No annotation in results indicates no modifying of the distance matrix.

4. NMDS with random starts: comparing multiple configurations with Procrustes analysis to minimise the stress-value and select an optimal configuration.

5. Scaling of the results: centring moves the point of origin to the average of the axes. Principal components rotate the configuration so that the variance of points is maximised on first dimension. Half-change scaling scales the configuration so that one unit means halving of community similarity from replicate similarity.

6. Adding species scores as weighted averages to sites scores and expand species scores that sites and species have equal variances.

Steps 1–6 were rerun 100 times with maximum 100 random starts at step 4 in each replication. Fitting environmental data to the final best NMDS configuration was done using function `ordisurf{vegan}` that fits a smooth Gaussian surface model for a given variable.

2.3.5. Cluster Analysis

Choice of cluster method and the appropriate dissimilarity measurement was aided by function `cophenetic{stats}` to calculate a cophenetic correlation between original dissimilarities and dissimilarities estimated from a cluster tree. The higher the correlation, the better the distance measure and cluster method describes all data. All dissimilarities in `vegdist{vegan}` were checked.

Good fitted clusters were detected by analysing silhouette plots retained from the cluster tree with `silhouette{cluster}` (Rousseeuw 1987). Thereby all possible groups were tested calculating the silhouette width. For each observation i, the silhouette width s_i is defined as follows (Maechler et al. 2005):

1. put a_i = average dissimilarity between i and all other points of the cluster to which i belongs.

2. for all other clusters C, put $d_i(\mathrm{C})$ = average dissimilarity of i to all observations of C. The smallest of these $d_i(\mathrm{C})$ is $b_i = \min_{\mathrm{C}} d_i(\mathrm{C})$, and can be seen as the dissimilarity between i and

its "neighbour" cluster, i.e. the nearest one to which it does *not* belong, finally:

$$s(i) = \frac{(b_i - a_i)}{\max(a_i, b_i)} \tag{2.17}$$

If the number of optimal cluster groups was too high for graphical analysis it was decided to pool groups by optimising their decreased average silhouette width and divide into a more suitable number of groups having less than 8–9 groups. Cluster configurations with only 2 optimal groups were checked for a suitable subdivision but optimised in the same manner to reveal more details for graphical analysis.

Revealing possible stable cluster branches was done using bootstrap tests with `pvclust{pvclust}` and n = 1000 calculations.

2.3.6. Transfer functions

All calculated methods were checked for outliers and their stability using leave one out cross-validation (LOOCV). Hereby the same approach as in Zhang et al. (2007) was undertaken. That is, when absolute residuals exceeded the standard deviation of the model variable in all trial models and if their removal reduced the RMSEP by at least 5%, only then they were deleted.

In all models the following model parameters were calculated and are additionally indicated by an LOOCV-subscript when LOOCV was performed:

r^2 is the squared Pearson correlation interpretable as strength between observed and modelled variable and is dependent on the data's range (Frey and Deevey 1998) whereas the following parameters are not dependent on the data's range.

RMSE is the root mean square error and shows apparent model's error, whereas the mean square error of prediction (RMSEP) shows the same kind of error but after LOOCV was done. RMSE and RMSEP are related to standard deviation.

Bias_{avg} is the average bias and shows the mean of model's aberration, that is the mean of residuals.

Bias_{max} is the maximum bias (ter Braak and Juggins 1993), but it is the maximum of residuals subdivided into 10 equal intervals and hence the maximum of one of these intervals.

LLSESP is the linear least squares error slope parameter (Vasko et al. 2000) and is the slope of linear regressed residuals on the observed variable. It illustrates model's tendency for over or underestimation of inferred values and therefore whether the model is balanced or not.

To compare more easily all transfer models, a rank index was calculated. The idea behind this index is that error values represent negative effects whereas r^2 shows a positive one. Hence pooling all absolute error values together with the inverse correlation value $(1 - r^2)$ yielded values showing only negative effects. Values were not rescaled to an interval $[0, 1]$, as if values of a particular error parameter yield a very low range, e.g. the interval $[0.01, 0.02]$, rescaling to $[0, 1]$ would lead to improper weights even on small variations within $[0.01, 0.02]$. Therefore absolute error values were used.

2.3.6.1. Modern analogue technique (MAT)

Modern analogue technique is a k-nearest neighbour method and popular in vegetation science for comparing fossil pollen spectra with modern pollen spectra from a range of vegetation types and environments (Overpeck et al. 1985). If a composition of a fossil pollen spectrum can be "matched" with one or more modern pollen spectra, the modern sampling site is regarded as an analog for the past ecosystem centered on the fossil pollen sampling site. Establishing a transfer model can also be done by replacing the "fossil pollen spectra" with an environmental variable and matching then the best modern analogues to the variable by calculating a dissimilarity measure d_{ij}. This is calculated between samples i and j comparing the proportion p_{ik} in sample i for taxon k with the proportion p_{jk} in sample j respectively. A popular choice for instance is the squared chord distance (ter Braak 1995b) and it can be written for all taxa $k = 1$ to m as (Gavin et al. 2003):

$$d_{ij} = \sum_{k=1}^{m} \left(\sqrt{p_{ik}} - \sqrt{p_{jk}}\right)^2 \tag{2.18}$$

With this dissimilarity approach a close matching can be calculated.

In this study all available dissimilarity coefficients in `mat{analogue}` were used to test for close matching of chironomid data with the environmental variable: Euclidean, squared Euclidean, Chord, squared Chord, Bray-Curtis, Chi squared, squared Chi squared, Information, Chi distance, Manhattan, Kendall, Gower, $\text{Gower}_{\text{alt}}$, Mixed (see Simpson (2007) for details). A suitable decision for k was focused in obtaining a high correlation value r^2 on the one hand and a lowest RMSE value on the other.

2.3.6.2. Partial least squares (PLS)

Partial least square regression is related to principal component analysis (PCA), but uses environmental site scores $\tilde{x}_i$ in its algorithm whereas PCA uses arbitrary initial site scores (ter Braak and Juggins 1993). The algorithm of PLS is described below following ter Braak and Juggins (1993):

Step 0: optionally pre-process the environment and species data (e.g. subtract means). Thereafter denote the environmental data for site $i = 1$ to n by $\tilde{x}_i$ and the related taxonomic data $\tilde{y}_{ik}$ for taxa $k = 1$ to m.

Step 1: take the environmental variable $\tilde{x}_i$ as initial site scores r_i.
Do steps 2 to 7 for each component:

Step 2: calculate new taxa scores b_k by weighted summation of the site scores, i.e.:

$$b_k = \sum_{i=1}^{n} \tilde{y}_{ik} r_i$$

Step 3: calculate new site scores r_i by weighted summation of the taxa scores, i.e.:

$$r_i = \sum_{k=1}^{m} \tilde{y}_{ik} b_k$$

Step 4: for the first component go to step 5. For remaining components, make the new site scores r_i uncorrelated with the previous components by orthogonalisation (ter Braak 1995a, Tab. 5.6 b):

Step 4.1: denote the site scores of the previous component by f_i, and the trial scores of the present component by $x_{i,\text{comp}}$

Step 4.2: calculate degrees of freedom $\nu = \sum_{i=1}^{n} x_{i,\text{comp}} \cdot f_i$ for all sites i

Step 4.3: calculate $r_{i,\text{new}} = r_{i,\text{old}} - \nu f_i$

Step 4.4: repeat substeps 4 for all previous components

Step 5: standardise the new site scores r_i (ter Braak 1995a, Tab. 5.6 c):

Step 5.1: calculate the sum of squares of the site scores $s^2 = \sum_{i=1}^{n} r_i$

Step 5.2: calculate $r_{i,\text{new}} = r_{i,\text{old}}/s$

Step 6: take the standardised scores $r_{i,\text{new}}$ as the new component.

Step 7: regress the environmental variable $\tilde{x}_i$ on the components obtained so far and take the fitted values as current estimates of $\tilde{x}_i$. Go to Step 2 with the residuals of the regression as the new site scores r_i. Note, that the residuals r_i now contain the remaining variance in the taxon-site assemblage.

By using this approach it is therefore tried to extract taxon-site variances to uncorrelated components (i.e. axes) and to match the optimal number of components that can regress the environmental variable. The appropriate number of components is then determined by cross-validation on the basis of predictive power (ter Braak and Juggins 1993). In this study only the first 5 components were calculated.

2.3.6.3. Weighted averaging (WA)

Weighted averaging consists of three parts: WA regression, WA calibration and a deshrinking regression. It uses the idea that the most abundant taxon at a site is suggested to be near its own optimum (ter Braak and Barendregt 1986). Thus its optimum can be calculated by weighting taxon's abundances using the measured environmental variable. The WA regression is to estimate abiotic optimum $\hat{u}_k$ (WA estimate) of taxon k for each site ($i = 1$ to n) with its abundance y_{ik} (Birks et al. 1990):

$$\hat{u}_k = \frac{\sum_{i=1}^{n} y_{ik} \cdot x_i}{\sum_{i=1}^{n} y_{ik}} \tag{2.19}$$

where x is the measured environmental variable at site i.

After performing WA regression, the estimated optima $\hat{u}_k$ for taxa ($k = 1$ to m) can be used to infer the environmental variable $\hat{x}_i$ at site i from the taxonomic assemblage (WA calibration) by:

$$\hat{x}_i = \frac{\sum_{k=1}^{m} y_{ik} \cdot \hat{u}_k}{\sum_{k=1}^{m} y_{ik}} \tag{2.20}$$

Inferring values for $\hat{x}_i$ averages are taken twice. Once for estimate taxon k's optimum $\hat{u}_k$ (Eq. 2.19) and when calculating WA calibration for the inferred environmental value $\hat{x}_i$ at site i (Eq. 2.20). Thus the range of inferred environmental variable is shrunken and a deshrinking is commonly done to correct this. Either by a so-called 'classical' linear regression (Marchetto 1994):

$$\hat{x}_i = a_{\text{cla}} + b_{\text{cla}} x_i \tag{2.21}$$

where a is the intercept and b is the slope or by 'inverse' linear regression:

$$x_i = a_{\text{cla}} + b_{\text{cla}} \hat{x}_i \tag{2.22}$$

by regressing x_i on $\hat{x}_i$ instead.

The regression equation is then used to deshrink the inferred values:

$$(\hat{x}_i)_{\text{cla}} = \frac{\hat{x}_i - a_{\text{cla}}}{b_{\text{cla}}} \quad \text{or} \tag{2.23}$$

$$(\hat{x}_i)_{\text{inv}} = a_{\text{inv}} + b_{\text{inv}} \hat{x}_i \tag{2.24}$$

If the species optima $\hat{u}$ (WA estimate) is shrunk and the bias can be reduced, rescaled optima have to be used for further calculations, such as, tolerance estimates. A simple estimated tolerance $\hat{t}_k^*$ or weighted standard deviation for taxon k's is:

$$\hat{t}_k^* = \sqrt{\frac{\sum_{i=1}^{n} y_{ik} \cdot (x_i - \hat{u}_k)^2}{\sum_{i=1}^{n} y_{ik}}} \tag{2.25}$$

This weighted averaging tolerance is then adjusted by dividing Hill's (1973) diversity measure N2 for Hill number 2:

$$\hat{t}_k = \frac{\hat{t}_k^*}{\sqrt{1 - 1/N2}} \tag{2.26}$$

and thus a tolerance-weighted estimate would then be:

$$\hat{x}_t = \frac{\sum_{k=1}^m y_{ik} \cdot \hat{u}_k / \hat{t}_k^2}{\sum_{k=1}^m y_{ik} / \hat{t}_k^2} \tag{2.27}$$

The effect of these tolerance estimates is to decrease the importance of rare species with very small tolerances in predictions obtained by tolerance downweighted WA (Marchetto 1994).

Applying tolerance downweighting to inverse or classical deshrinking results then in:

$$(\hat{x}_i)_{\text{cla tol}} = \frac{\hat{x}_t - a_{\text{cla}}}{b_{\text{cla}}} \quad \text{or} \tag{2.28}$$

$$(\hat{x}_i)_{\text{inv tol}} = a_{\text{inv}} + b_{\text{inv}} \hat{x}_t \tag{2.29}$$

For calculating weighted averaging transfer models, all 4 combinations where calculated: $(\hat{x}_i)_{\text{cla}}$, $(\hat{x}_i)_{\text{cla tol}}$, $(\hat{x}_i)_{\text{inv}}$ and $(\hat{x}_i)_{\text{inv tol}}$.

2.3.6.4. Weighted averaging partial least squares (WAPLS)

WAPLS combines the two ideas of taking weighted environmental data averaged by taxa (WA) and extracting variances from the assemblage onto ordination components (ter Braak and Juggins 1993). Thereby the environmental variable x is regressed with each uncorrelated component obtained by a PLS procedure and residuals of this regression, i.e. the remaining variance, is further regressed with the next component. Following ter Braak and Juggins (1993), the method of WAPLS is:

Step 0: center the environmental variable x_i by subtracting the weighted mean, i.e.:

$$x_i = x_i - \sum_i^n y_{i+} \frac{x_i}{y_{++}}$$

Step 1: take this centered environmental variable x_i as the initial site score r_i.

Do steps 2 to 7 for each component:

Step 2: calculate new species scores u_k^* by weighted averaging of the site scores. i.e.:

$$u_k^* = \sum_{i=1}^n y_{ik} \frac{r_i}{y_{+k}}$$

Step 3: calculate new site scores r_i by weighted averaging of the species scores, i.e. new:

$$r_i = \sum_{k=1}^m y_{ik} \frac{u_k^*}{y_{i+}}$$

Step 4: for first component go to step 5. For the remaining components, make the new site scores r_i uncorrelated with the previous components by orthogonalisation (ter Braak 1995a, Tab. 5.2 b):

Step 4.1: denote the site scores of the previous component by f_i, and the trial scores of the present component by r_i

Step 4.2: calculate degrees of freedom: $\nu = \sum_{i=1}^n y_{i+} r_i \cdot f_i / y_{++}$

Step 4.3: calculate $r_{i,\text{new}} = r_{i,\text{old}} - \nu f_i$

Step 4.4: repeat substeps 4 for all previous components

Step 5: standardise the new site scores r_i (ter Braak 1995a, Tab. 5.2 c):

Step 5.1: calculate the centroid z of site scores r_i:

$$z = \sum_{i=1}^n y_{i+} \frac{r_i}{y_{++}}$$

Step 5.2: calculate the dispersion of the site scores $s^2 = \sum_{i=1}^n y_{i+} (r_i - z)^2 / y_{++}$

Step 5.3: calculate $r_{i,\text{new}} = (r_{i,\text{old}} - z)/s$

Step 6: take the standardised scores as the new component

Step 7: regress the environmental variable x_i on the components obtained so far using weights (y_{i+}/y_{++}) in the regression and take the fitted values as current estimates $(\hat{x}_i)$. Go to step 2 with the residuals of the regression as the new site scores r_i.

Comparing extracted components, one can state the first component to be a two-way weighted-average for the original environmental variable x_i. Two-way in the sense of the centered weighting (WA-step 0) and of the centered weighting by species scores (step 2). In contrast, further components are tow-way weighted averages for the residuals of the environmental variable x_i and hence the variance of remaining independent components.

Cross-validation procedure is then used to get an appropriate number of components based on model's parameters for the predictive power (ter Braak and Juggins 1993). In this study only the first 5 components were calculated.

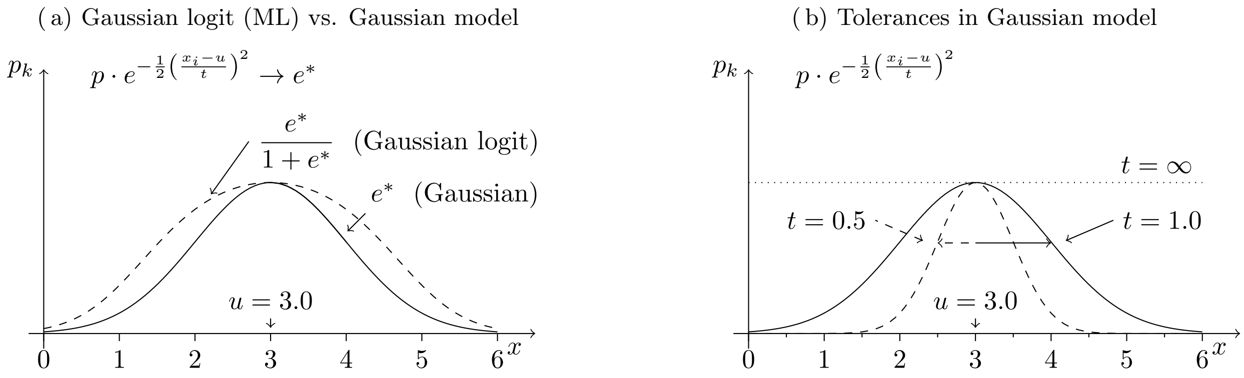


Fig. 2.5.: Illustrated response curves. a) taxon k's probability p_k at site i compared for a Gaussian model (used for Bayesian approach) and Gaussian logit model (used in ML); b) taxon's tolerances shown for 3 different values of t. If tolerance $t \to \infty$ a taxon can be described as indifferent. Taxon's optimum is denoted as u along an environmental gradient x.

2.3.6.5. Maximum likelihood (ML)

The approach to infere data using ML is different from previous transfer functions and operates with probabilities (Jongman et al. 1995). Furthermore a particular response curve consisting of systematic and random components is modelled for all taxa along the environmental gradient (Birks et al. 1990), e.g. measured conductivity. Following ter Braak and Looman (1986) a Gaussian logit response curve as illustrated in Figure 2.5 a was used as model response (Jongman et al. 1995):

$$p_k(x) = \frac{p \cdot e^{-\frac{1}{2}\left(\frac{x-u_k}{t_k}\right)^2}}{1 + p \cdot e^{-\frac{1}{2}\left(\frac{x-u_k}{t_k}\right)^2}} \tag{2.30}$$

Hereby the parameters of taxon's optimum u_k (systematic component) and its tolerance t_k (random component) are regarded as unknown. At a given taxonomic assemblage, the Gaussian logit response model is then used to calculate the propability that a particular conductivity value would occur, i.e. for a particular site i. Thereby an iterative procedure tries to find out the maximum probability p_k for taxon k. The optimum value u with its tolerance t that result in this maximum probability p_k is then taken as the estimated optimum value.

2.3.6.6. Bayesian approach

The essential characteristic of Bayesian methods is their explicit use of probability for quantifying uncertainty in inferences based on statistical analysis (Gelman et al. 2004). In general there are two philosophically distinct approaches to statistical analysis (Holden et al. 2008):

Conventional, or frequentist, statistics assumes that the parameters being estimated (the "model") are fixed and that measured data are random observations distributed about these values. Conversely, Bayesian statistics assumes that the model is the unknown and it is the measured data which are fixed and it considers all possible solutions and ascribes a probability to each of them, thus calculating not only the most likely reconstruction but also the uncertainty associated with that reconstruction (Holden et al. 2008).

Using Bayesian data analysis there are in general 3 steps (Gelman et al. 2004):

Step 1: setting up a full probability model—a joint probability distribution for all observable and unobservable quantities in a problem.

Step 2: conditioning on observed ("fixed") data: calculating and interpreting the appropriate posterior distribution ("unknown model")—the conditional probability distribution of the unobserved quantities of ultimate interest, given the observed data

Step 3: evaluating the fit of the model and the implications of the resulting posterior distribution

Due to this different philosophical approach, Bayesian models deal with hypothesis (H) and data (D) in a probabilistic calculation and introduce a so called probability density function (PDF) which ascribes probabilities to model terms (Gelman et al. 2004). This is used to describe mathematically what is known about measured values, but is different from measured values' frequencies. After Bayes (1763) the relation of probabilities in an observed system between measured data D and a hypothesis H (e.g. a species response curve) is simplified denoted as a proportionality:

$$\Pr(H|D)_{\text{posterior}} \propto \Pr(D|H)_{\text{likelihood}} \cdot \Pr(H)_{\text{prior}} \tag{2.31}$$

where the term on the far right, $\Pr(H)$, is called the *prior* PDF, and represents our state of knowledge before the measurement of data. This is modified by the *likelihood* function, $\Pr(D|H)$, of seeing the data D given that the hypothesis H is true which yields the *posterior* PDF. Altogether the *posterior* PDF represents then our refined understanding of the system in the light of the observed data (Holden 2006) and all decisions and inferences are made from that posterior PDF (Gelman et al. 2004).

Holden et al. (2008) discuss the Bayesian model used here in detail and following paragraphs therefore try to explain the model more briefly, but nevertheless the meaning of model settings has to be explained and follows Holden et al. (2008).

The probability p_{ik} that taxon k is present in site i is assumed to follow a Gaussian distribution (Fig. 2.5 b):

$$p_{ik} = p_k \cdot \exp\left\{-\frac{1}{2}\left(\frac{x_i - u_k}{\tau_k}\right)^2\right\} \tag{2.32}$$

where p_k is the probability that taxon k is present at its optimum u_k with the environmental variable x_i at site i. The tolerance τ_k (tau) is a measure how far away a species can survive from its optimum u_k (*c.f.* Kühl et al. (2002); Fig. 2.5 b).

If a taxon is present, the expected abundance N_{ik} is calculated in the same way but with the tolerance t instead of τ:

$$N_{ik} = N_k \cdot \exp\left\{-\frac{1}{2}\left(\frac{x_i - u_k}{t_k}\right)^2\right\} \tag{2.33}$$

where N_k is the expected abundance (given presence) at the taxon's optimum u.

Regarding the tolerance values in Eq. 2.32 and 2.33 as being independent it does not complicate the probability theory to express the equations in terms of t_k and τ_k respectively (Holden 2006). Presuming this one can introduce the proportion of tolerances $P_k = t_k^2/\tau_k^2$ which enables the probability p_{ik} to be calculated from expected abundances when Eq. 2.33 is rewritten by raising P_k to the power on both sides of Eq. 2.33:

$$\begin{aligned}\left(\frac{N_{ik}}{N_k}\right)^{\frac{t_k^2}{\tau_k^2}} &= \exp\left\{-\frac{1}{2}\frac{(x_i - u_k)^2}{t_k^2}\cdot\frac{t_k^2}{\tau_k^2}\right\}\\ &= \exp\left\{-\frac{1}{2}\frac{(x_i - u_k)^2}{\tau_k^2}\right\}\end{aligned} \tag{2.34}$$

Now Eq. 2.34 is exactly as in Eq. 2.32 and one can calculate p_{ik} by using:

$$\begin{aligned}p_{ik} &= p_k \cdot \left(\frac{N_{ik}}{N_k}\right)^{\frac{t_k^2}{\tau_k^2}}\\ &= p_k \cdot \left(\frac{N_{ik}}{N_k}\right)^{P_k}\end{aligned} \tag{2.35}$$

The probability of a non-zero count y_{ik} of taxon k from site i at a given measured environmental value x_i is assumed to follow an exponential decay, with decay constant $1/N_{ik}$, normalised so that the total probability of all non-zero counts is equal to the probability of presence p_{ik}:

$$\Pr(y_{ik}|x_i) = \frac{p_{ik}}{N_{ik}} \cdot \frac{1}{\exp\left(\frac{y_{ik}}{N_{ik}}\right)} \tag{2.36}$$

with the probability of zero counts conversely given by:

$$\Pr(y_{ik}|x_i) = (1 - p_{ik}) \tag{2.37}$$

In summary, the probability distribution is described by five Species Response Curve (SRC) variables: optimum u_k, expected abundance N_k, tolerance t_k, probability p_k, and tolerances' ratio P. Each variable is discretised and forms a collection of s SRCs for each taxon k, where all combinations of the species-specific variables are represented by the index j with $j = 1, \ldots, s$ as SRC_{jk}. The model here considers $s = 8,000$ SRCs for each taxon k, derived from a matrix of dimensions 20, 4, 5, 5, 4 for u_k, N_k, t_k, p_k and P_k respectively. The a-priori probabilities of each model $\Pr(\mathrm{SRC}_{jk})$ are assumed to be equal. If a species is measured at an abundance y_{ik} within a training set lake with environmental variable x_i, Bayes' equation (2.31) can be used to refine the relative probabilities of the models:

$$\begin{aligned}\Pr(\mathrm{SRC}_{jk}|y_{ik}, x_i) \propto{}& \Pr(y_{ik}|\mathrm{SRC}_{jk}, x_i)\\ &\cdot \Pr(\mathrm{SRC}_{jk}|x_i)\end{aligned} \tag{2.38}$$

where the likelihood term $\Pr(y_{ik}|\mathrm{SRC}_{jk}, x_i)$ is:

$$\begin{aligned}\Pr(y_{ik}|\mathrm{SRC}_{jk}, x_i) &= \frac{p_{ik}}{N_{ik}} \cdot \frac{1}{\exp\left(\frac{y_{ik}}{N_{ik}}\right)} \quad && y_{ik} > 0\\ &= 1 - p_{ik} && y_{ik} = 0\end{aligned} \tag{2.39}$$

following Eqs. 2.36 and 2.37. This is applied across the training set (TS) of n lakes, or $(n-1)$ lakes in a LOOCV calculation:

$$\Pr(\mathrm{SRC}_{jk}|\mathrm{TS}) = \frac{\prod_{i=1}^{n} \Pr(y_{ik}|\mathrm{SRC}_{jk}, x_i)}{\sum_{j=1}^{s}\prod_{i=1}^{n} \Pr(y_{ik}|\mathrm{SRC}_{jk}, x_i)} \tag{2.40}$$

Thus, each taxon is ascribed a series of SRCs of different probabilities $\Pr(\mathrm{SRC}_{jk})$, dropping the implicit conditionality on TS for notational simplicity. The model is also constraint and normalised by setting over all k-taxa $\sum_{j=1}^{s} \Pr(\mathrm{SRC}_{jk}) = 1$.

Tab. 2.1.: Ranges of Species Response Curve (SRC) variable settings used for Bayesian data analysis. These values define $8,000 = 20 \times 4 \times 5 \times 5 \times 4$ SRCs for each taxon k along the environmental gradient of electrical conductivity$_{\log 10}$ (EC) and are assigned an equal a-priori probability which is refined by Bayes' equation for each training set count (including zero counts). $\%\mathrm{occ}_k$ is the percentage of training set sites in which a given species is present; * indicates different setting compared to Holden et al. (2008).

SRC variable	Minimum	Maximum	Resolution
*optimum u_k	$\mathrm{EC_{min}} - 2.7\ (= -4.52)$	$\mathrm{EC_{max}} + 2.7\ (= 4.81)$	20
expected abundance N_k	$0.2 \cdot N_{k\,\max}$	$1.0 \cdot N_{k\,\max}$	4
*abundance' tolerance t_k	0.4	2.0	5
tolerance relation P_k	0.4	1.0	5
*taxon's probability p_k	$1.0 \cdot \%\mathrm{occ}_k$	$7.0 \cdot \%\mathrm{occ}_k$	4
$\mathrm{abundance_{min}} \geqslant 2$			

As common species are well constrained by the training set and result in only few SRCs of high probability, rare species instead, often without clear unimodal response, show many significant SRCs (Holden et al. 2008). And therefore it is defined as "significant" for these purposes, somewhat arbitrarily, by a probability > 10% of the most likely SRC. But note that all SRCs are included in the reconstruction so this definition does not affect the calculation.

Used settings for calculate SRC were modified from Holden et al. (2008) with a wider setup range for optimum u_k (Tab. 2.1) to calculate suitable probability density functions for all SRCs. This is necessary even if extreme values are ecologically unrealistic (Holden et al. 2008).

2.3.6.7. Artificial neural networks (ANN)

The last model approach is using so called artificial neural networks as transfer function and is a branch of artificial intelligence. In analogy of how mammal neuron-structures learn patterns, a learning computer-system can be formed to approximate to a given target value or vector (=environmental variable) from a set of input signals (=taxa) through incremental adjustments of a set of parameters (Malmgren and Nordlund 1997; Bishop 1995). ANN consists of at least 3 succeeding layers that were also used in this study: input, hidden and output layer. Each of them is connected with all subsequent elements from the next layer (Fig. 2.6). Thereby the number of input elements is fixed by the number of taxa and the number of output elements by the number of desired environmental variables, i.e. one in this study. The learning process is a cyclic one and proceeds by giving weights to each connection in the hidden layer and by a summarisation of an activation function from the output layer if the fit was improved or not. Now this backpropagation procedure (BP) sets all weights anew for the next cycle (Racca et al. 2007; Racca and Racca 2005). It should also be noted that, theoretically, a BP network is able to learn any pattern perfectly (Malmgren and Nordlund 1997), but LOOCV was used to determine the training procedure's end by getting a minimal prediction error.

Training the model is also influenced by some model settings (Racca and Racca 2005):

learning rate $[0, 1]$***:*** defines the decreasing "speed" of adjusting weights of interconnected elements (default: 0.001; values 1, 0.1, 0.01 and 0.001 were calculated)

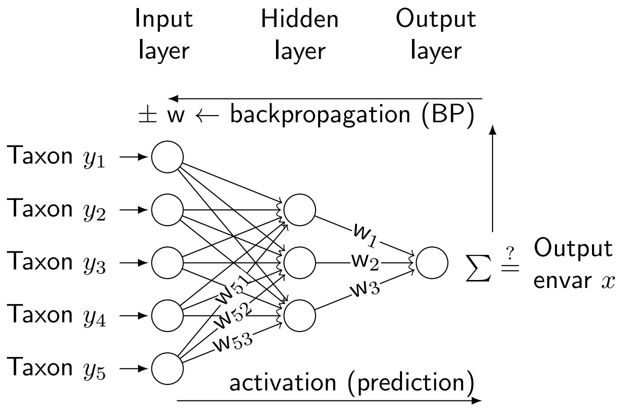


Fig. 2.6.: Structure of an artificial neural network (ANN): taxa abundances y, as inputs vectors ("signals"), are approximated to fit to the desired output (=environmental variable x) by adjustment of weights (w) before and after the hidden layer. An activation function $\sum$ summarise incoming values and backpropagation verifies weights (w) back through the system by minimising approximation errors. This is done multiple times until a stop criterion is reached (e.g. lowest RMSEP from LOOCV).

momentum $[0, 1]$***:*** it allows the smoothing out of the gradient decrease (default value used: 0.9)

number of cycles: it represents the maximum length of a learning process. At each cycle, all the learning vectors (input-output couples) are presented to the network (default used: 500)

number of hidden neurons: they connect taxonomic data with the desired predictive environmental variable. 2, 3 and 4 hidden neurons were calculated (default: 3)

3. Results

3.1. Identification key CHIP

To organise related references to larval Chironomidae and their morphological images and to determine chironomid head capsules the Chironomidae Identification Program CHIP was developed. Resulting in numerous features it provides an easy handling of related contents regarding literature of Chironomidae and therefore it helps to determine taxa as good as possible. The features described below are summarised in a scheme given in Figure 3.1:

Image comparison, determination can be done at two entry levels. By using the default morphological structure (mentum) one has access to subfamily level or genus level (Fig. 3.1 (1) or (2)). Down from the genus level all other taxa within the genus can be compared and also genera regarded as similar, defined by the user. All remaining images from other morphological structures are now shown that are hidden by default (Fig. 3.1 (3)). At subfamily or genus levels non-default morphological structures like mandibles, antenna, premandibles can be selected as well instead of default one.

Obtaining image information as mouseover text integrated with JavaScript. As HTML language by itself can be linked dynamically to other script languages these mouseover texts or images give appropriate information like reference, notes, authority and external links when the mouse is moved over an image. In this manner it is also easy to refer to images within texts of determination keys, because the referred image can be viewed just where the described text is by mouseover the text and look at the mouseover content. This is indicated by underlined text, like: "surface of head with a large grainy sculpture"

Image inclusion/upload can be done only when a reference for an image exists. To avoid confusions about an image's reference the reference itself will be appended to the image at the bottom's edge.

Measuring images/ratios is possible for all uploaded images and also with temporary saved images to capture lengths by mouse clicks and thus also length ratios can be computed (Fig. 3.1 (4)).

Citing literature in text produces a reference list sorted alphabetically. From there a reference management is accessable to modify, insert or delete bibliographical items. It is also possible to export a reference in BibTeX format.

Writing structured text can be used to write article-like texts as each genus and taxon page is divided into default sections: 'Ecology', 'Notes', 'Images' and 'References'. Additional sections can also structure each local website and a generated 'Table of contents' helps to navigate within the document itself. The user is able to write normal and formatted text, unordered lists, sortable and filterable tables for numeric properties/size data or determination keys for instance as numbered lists.

Creating distribution maps: world maps with different maptypes from the OpenLayers-project can be created. Having access to the internet this feature holds available the storage of biogeographical information. In sparsely investigated regions this provides information for instance whether taxa from other well investigated regions are likely to be found as well.

Searching in online databases: for instance name search with Fauna Europaea project (http://www.faunaeur.org), project of Integrated Taxonomic Information System (http://www.itis.usda.gov) or image search with ordinary web search engines.

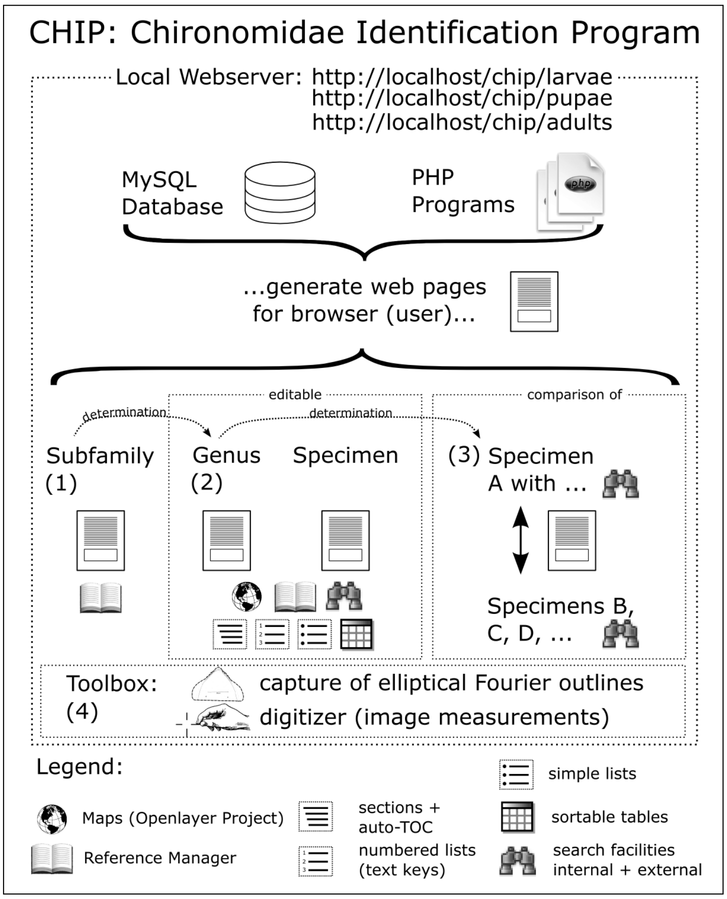
Basic specimens management: as scientific names will be revised sometimes by current research a non-valid name can be moved to table `names_synonyms` (Fig. 2.2). By giving it a new name it will be updated with a note in table `images` and this note appears subsequently within the given mouseover information of the image.

This software can be used of course during offline sessions, but then all features that need online access (e.g. maps, search) won't work. In addition to improve determination of the frequently found genus *Psectrocladius* in investigated samples, the Russian key of *Psectrocladius* in Makarchenko and Makarchenko (1999) was translated into English and integrated as citation for usage within CHIP.

3.2. Chironomid taxa

As in general almost no whole larva could be examined, most taxa are named as morpho types. Table A.9 on page 119 lists all 97 found taxa from all 52 samples in detail with notes. It has to be

Fig. 3.1.: Working scheme for Chironomidae Identification Program (CHIP) running on a local webserver with features indicated by pictograms. Outlines of black/white images are captured as chain codes (Freeman 1974) and in addition elliptic Fourier coefficients (Kuhl and Giardina 1982) are calculated for further statistical analysis e.g. with R and using appropriate morphometric tutorials such as for instance *Morphometrics with R* by Claude (2008).



noticed that often undetermined groups like Orthocladiinae, Tanytarsini or *Chironomus/Einfeldia* may reveal more taxa if a more accurate determination would be possible. By ordering all taxa in Figure 3.2 according to their weighted average abundance on the one hand and Rényi$_\infty$ diversity on the other there are some less diverse samples like YeR–27, CTP–19, YeR–15 and Sic–13 with about 2–5 taxa containing 8 % of all data. These samples are dominated by *Cricotopus shilovae*, *Acricotopus* indet 1, *Acricotopus longipalpus* type and *Sergentia longiventris* type respectively. With a similar percentage of about 6 % most diverse samples contain about 20–23 taxa. The average number of different taxa lies between 10–20 taxa covering about 70 % of all species data.

Among all taxa the most frequently found are *Acricotopus longipalpus* type, *Paratanytarsus* sp., *Tanytarsus gracilentus* type, *Cricotopus salinophilus*, *Psectrocladius sordidellus/limbatellus*, *Psectrocladius barbimanus/sokolovae* and *Chironomus/Einfeldia* sp. men1 followed by other taxa also within *Chironomus/Einfeldia* sp. Unidentified higher taxonomic groups with high counts of head capsules are tribe Tanytarsini and subfamily Orthocladiinae followed by subfamily Tanypodinae and tribe of Chironomini.

3.2.1. Outline analysis

Due to difficult morphological separation of *Psectrocladius barbimanus* and related taxa 29 outlines from menta of the genus *Psectrocladius* described by other authors were compared with two test outlines which I determined previously as *P. pancratovae/sokolovae* morpho types (Fig. 3.3). Analysis by Riemannian shape distance ρ shows for tested specimens *P. (P.)* spec Qai-08-1 and *P. (P.)* spec Qai-08-1-2-s from the same sample a close similarity to *P. (P.) barbimanus* type described by Brooks et al. (2007) in both cases for either normalised or not normalised outline data. All other described *P. barbimanus* menta plot more distantly: *P. barbimanus* from Tang (2006) plots at the 5^{th} position close with *P. ishimicus* (4^{th}) and *P. sokolovae* (6^{th} or 7^{th}) from Makarchenko and Makarchenko (1999). *P. barbimanus* from Makarchenko and Makarchenko (1999) plots for normalised data at 9^{th} and for not normalised data at 12^{th} position.

A strong influence for separation was detected by different image resolutions. But using more than 800 points as chain code and increasing the number of harmonics from 200 to 300 does not change the rank order of results. After processing of outline analysis both tested specimens were assigned to

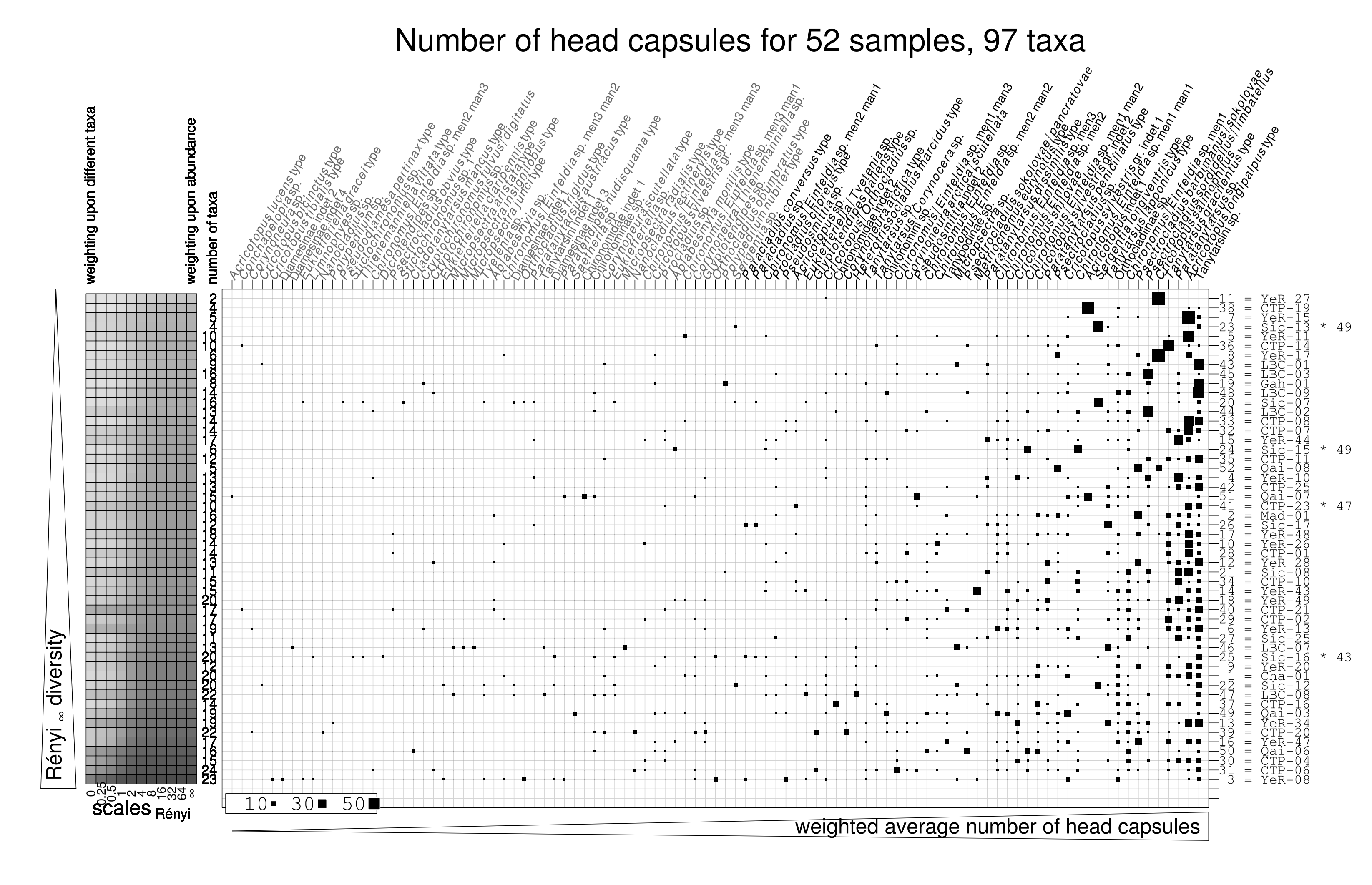


Fig. 3.2.: Number of counted head capsules versus sites. Taxa sorted by their weighted average number of head capsules and samples sorted by Rényi$_\infty$ diversity (Tóthmérész 1995). That is, samples are rather sorted according to their head capsule counts than to their different number of taxa and rare taxa with only one occurrence have therefore less influence on ordering. Samples with abundances lower than 50 head capsules are indicated by the actual number of counts; grey colours of taxa names indicate n < 10 and box size indicates counted numbers. Numeric data see Table A.17 on page 158.

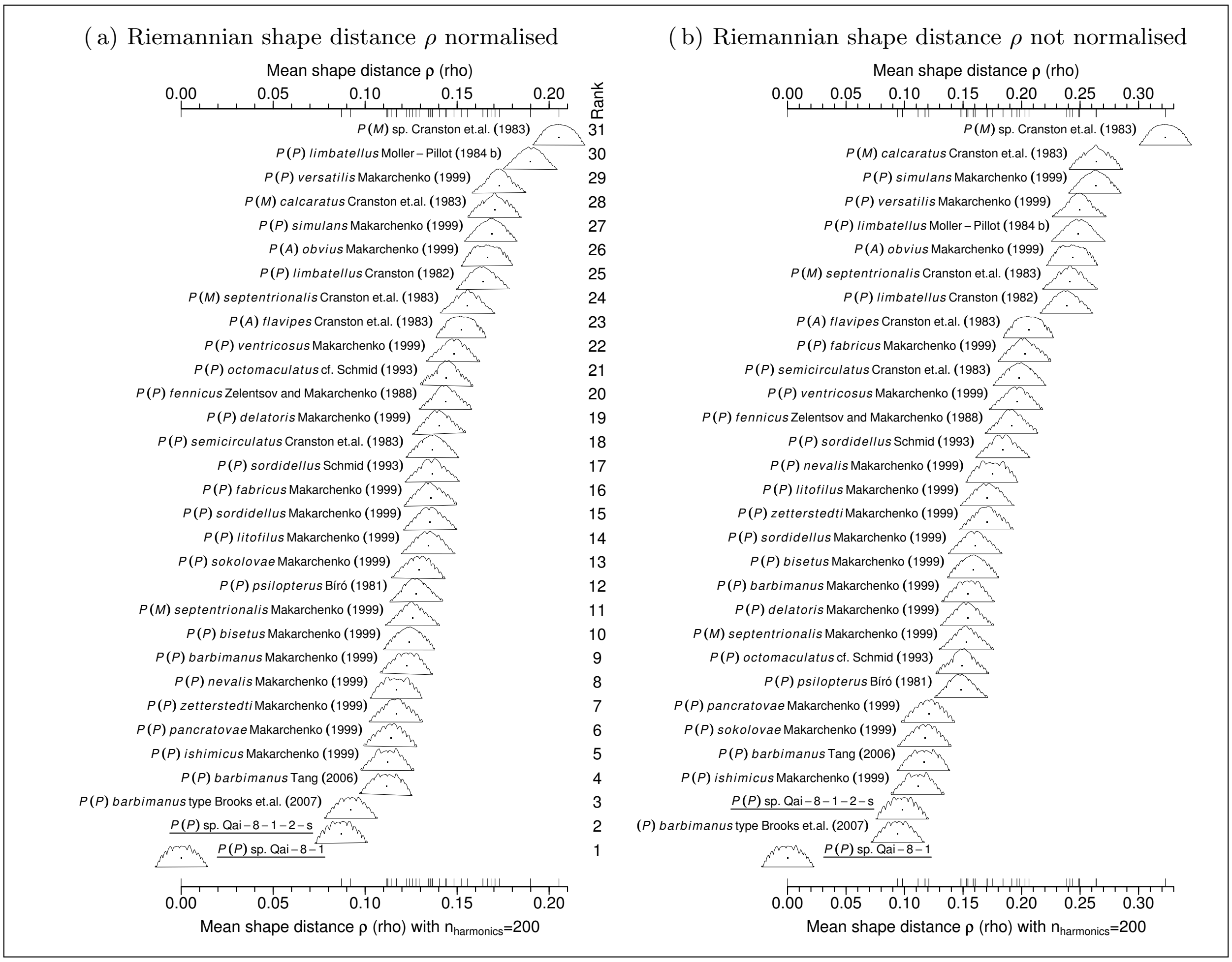


Fig. 3.3.: Outlines of menta of *Psectrocladius* ordered by Riemannian shape distance ρ (rho, Kendall 1984) of normalised shapes (a) and not normalised ones (b) compared to *P. (P.)* spec Qai-08-1. 200 landmarks were used obtained from 200 harmonics by elliptic Fourier analysis. Underlined taxa indicate tested specimens previously determined as *P. pancratovae/sokolovae* morpho type. Note $0 \leqslant \rho \leqslant \pi/2$

P. barbimanus/sokolovae type.

3.3. Environmental parameters

Figure 3.4 shows data ranges of environmental variables used for calculations with all 52 samples. In addition some more variables were measured like acidity, total hardness, Secchi depth and maximum water depth and salinity but for statistical analysis such as Canonical Correspondence Analysis (CCA) they decreased the number of samples as they contained missing values.

In general all collected samples have high altitudes spanning from 2,800 to 5,100 m and ranged from small ponds of 400 m^2 ($2.6_{\log 10}$) up to large lakes with about 4,100,000,000 m^2 ($9.6_{\log 10}$). Regarding sampling depth most samples were collected at moderate depths around 0.5 to 3 m with some deeper locations indicated as boxplot outliers in Figure 3.4. Measured electrical conductivity covers a wide data range from 0.015 up to 130 mS · cm^{-1} with most values at about 0.1–1.7 mS · cm^{-1} which is equivalent to the $\log_{10}$ scale with values –1 up to 0.2. Dissolved oxygen-saturation shows values around 100 %. Water temperature resembles closely mean air temperature of July and August with values of about 11–14 °C. All other data of mean air temperatures vary during seasons with lowest values in December and January with about –14 to –7 °C and highest ones in July and August. Similar to this variation pattern mean monthly precipitation show lowest values during December with about 0.2–2.0 mm and with slight higher values in January with about 0.7–3.4 mm. Maximum values appear during summer months June to August with mean values of about 70–90 mm and a range of 7–135 mm.

3.4. Ordination—CCA

To develop a transfer model for reconstructions it is necessary to know major key factors. A factor analysis like CCA is then the usual way to discover

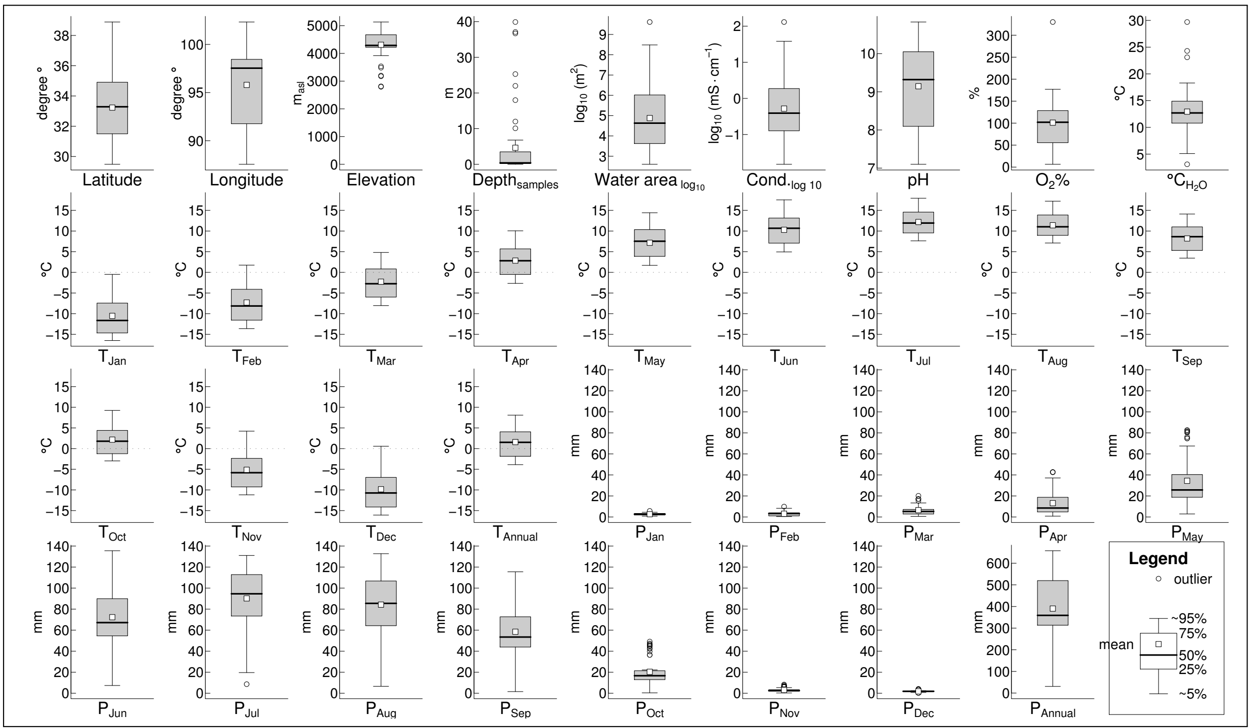


Fig. 3.4.: Boxplots of measured environmental variables from all 52 sample sites. Abbreviations see on pages VI–VIII.

underlying and influencing environmental key factors in biotic comunities (Tab. 3.1, 3.2; Fig. 3.5, 3.6). Two models were calculated: one optimal model and a second one enforced to have mean July air temperature included to provide comparison of transfer models focused in general on July mean air temperature reported from other regions (e.g. Asia: Ilyashuk et al. 2005; Europe: Heiri and Millet 2005, Bigler et al. 2003; North America: Walker et al. 1997).

In the optimal model all six variables account for 21.4 % of total inertia whereas the model enforced with mean July air temperature with seven variables accounts for 23.5 % (Tab. 3.1 a). Statistical significance for CCA axes with $p < 0.01$ concurs for all first three axes in both models and they account for 15.3 % and 15.9 % of total inertia for the optimal and July model respectively. Also in both models five environmental variables contribute significantly to CCA: electrical conductivity$_{\log 10}$ (EC$_{\log 10}$), sampling depth, pH, water area$_{\log 10}$ and mean precipitation of December, respectively in the order of their contribution on these axes, i.e. score loadings (Tab. 3.1 b). Enforcing the model to have mean July air temperature included causes inclusion of mean precipitation of January but rules out mean October air temperature. All remaining environmental variables show no statistical significances and less influence or overlapping correlations with other variables. Salinity showed high correlations to EC$_{\log 10}$ but reduced the number of includeable samples due to missing values and was therefore taken out as redundant variable. Water temperature influences CCA and has on the first two factor axes a score loading of 0.420 and 0.400, respectively for the optimal and July model with p-values of about 0.2. On these factor axes it is also directly correlated with EC$_{\log 10}$. Geographical variables such as elevation and latitude show also an influence with similar score and p-values as water temperature and are also highly correlated to values of monthly mean air temperatures. This relationship was used to estimate samples' mean air temperatures from latitude or elevation. Nevertheless they showed no statistical significance in concert with the significant variables described above. Latitude has lower score values of about 0.2. Finally dissolved oxygen-saturation as a potential constraint variable showed only marginal influence with score values of 0.1.

Both models can be compared mathematically by using a Procrustes analysis. Subsequent significance tests upon all three CCA axes show no statistical difference between the optimal and suboptimal model. A comparison among axes 1:2, 1:3, 2:3 is revealing high correlation values with 0.9751, 0.9531, 0.948 respectively.

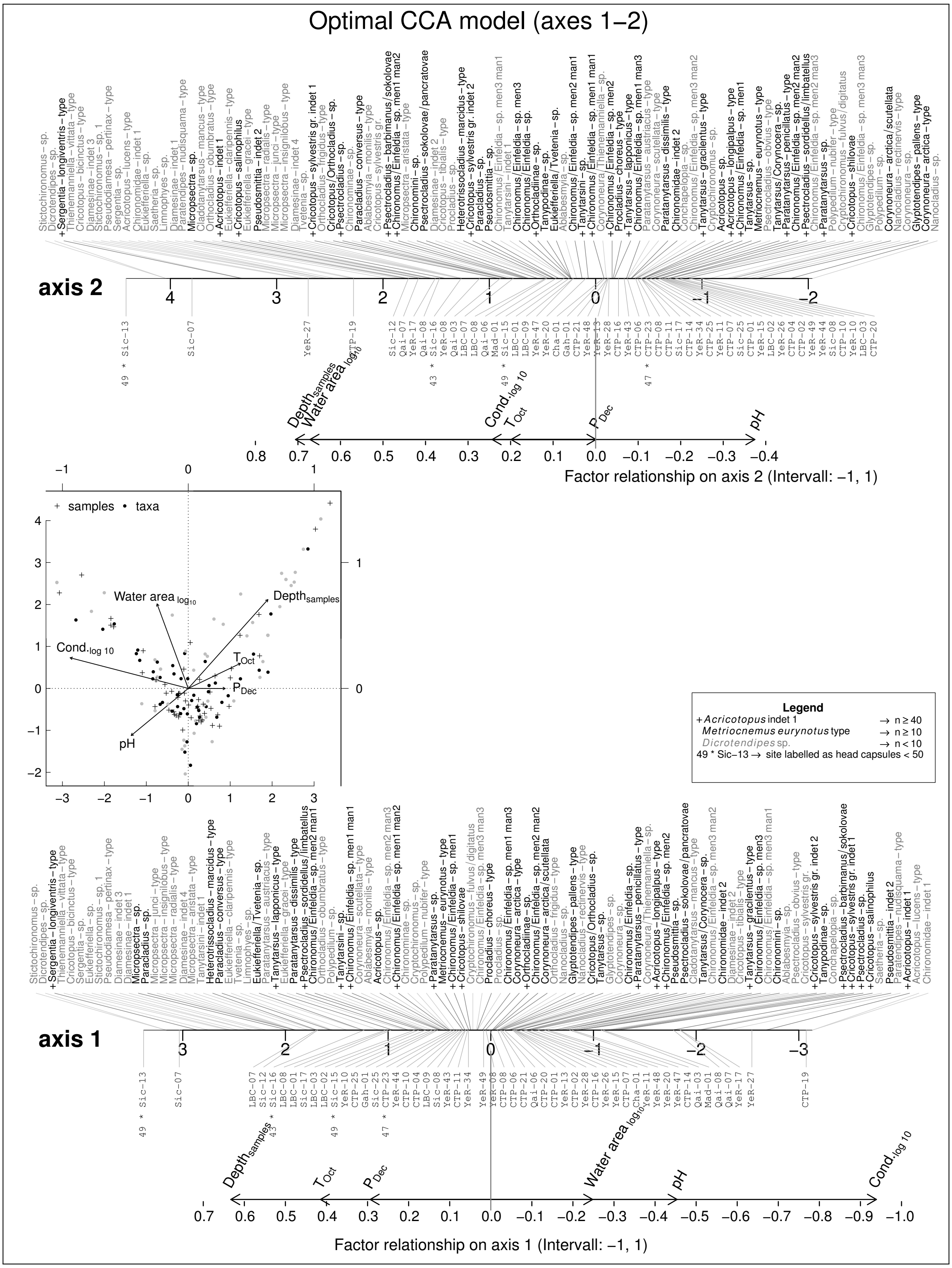


Fig. 3.5.: Canonical Correspondence Analysis (CCA) optimal model: taxa versus sites with significant environmental variables tested by ANOVA permutations (n= 8, 999, $p < 0.05$): electrical conductivity$_{\log 10}$, sampling depth, mean October air temperature, mean December precipitation, pH value and water area$_{\log 10}$ in descending order of their eigenvalue $\Delta\lambda$. Remaining axes see appendix Figures A.9–A.10.

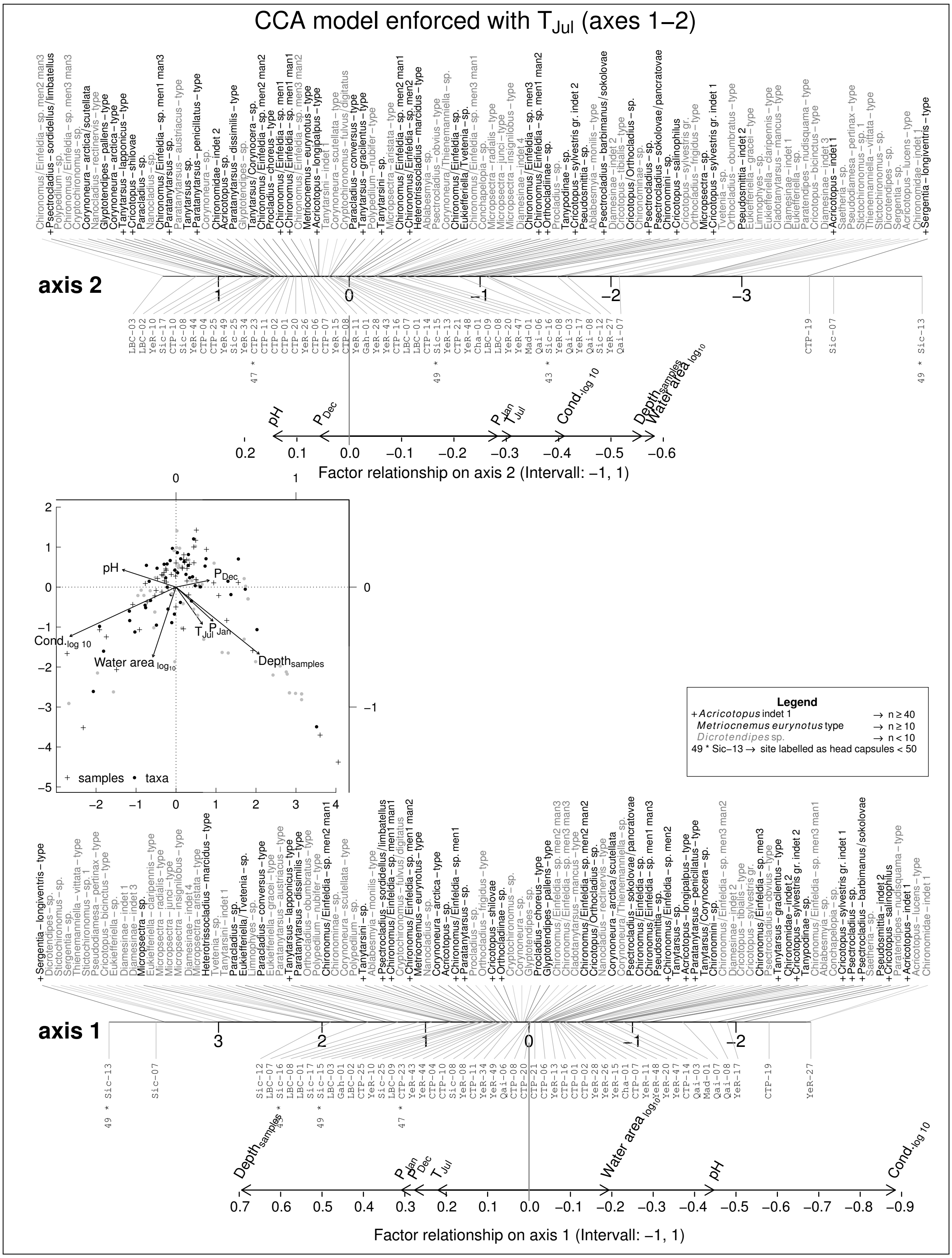


Fig. 3.6.: Canonical Correspondence Analysis (CCA) T_{Jul}–model (axes 1 + 2): taxa versus sites with significant environmental variables (constraints) tested by ANOVA permutations (n= 8,999, $p < 0.05$): mean July air temperature (enforced), electrical conductivity$_{\log 10}$, sampling depth, mean December precipitation, pH value, water area$_{\log 10}$ and mean January precipitation in descending order of their eigenvalue $\Delta\lambda$. Remaining axes see appendix Figures A.11–A.12.

Tab. 3.1.: Results of CCA: significances of axes and correlations of constraints to factor axes. Significances of axes (a): done by ANOVA permutations (n=1,000) for optimal chosen model with 6 variables and forced model with T_{Jul} with 7 variables. Correlations of CCA constraints to factor axes (b): summary of axis-variable-correlation related to the first 3 significant axes of optimal and T_{Jul} model. Values are printed smaller when their value $\leqslant 0.4$ to emphasise variables which contribute to the variance accumulated on each independent CCA axis.

(a) Test of CCA-axes by ANOVA permutations

axis	λ	% - accounted	p-value
optimal: 6 variables account for 21.4 % of 6.717 (total inertia) using all axes			
CCA1	0.449	6.68	0.001 ***
CCA2	0.313	4.66	0.001 ***
CCA3	0.263	3.91	0.003 **
CCA4	0.162	2.42	0.206
T_{Jul} model: 7 variables account for 23.5 % of 6.717 (total inertia) using all axes			
CCA1	0.459	6.83	0.001 ***
CCA2	0.342	5.09	0.001 ***
CCA3	0.265	3.95	0.007 **
CCA4	0.167	2.49	0.309

Boxes indicate relative amount of %-accounted.
Signif. codes: 0 *** 0.001 ** 0.01 *

(b) Axis-variable-correlations and composition of axes

	CCA1	CCA2	CCA3
optimal model:			
$\text{conductivity}_{\log 10}$	−0.939	0.243	−0.230
$\text{depth}_{\text{samples}}$	0.633	0.706	0.017
pH	−0.454	−0.374	−0.531
T_{Oct}	0.415	0.199	0.639
P_{Dec}	0.294	−0.001	−0.462
$\text{water area}_{\log 10}$	−0.248	0.672	0.372
T_{Jul} model:			
$\text{conductivity}_{\log 10}$	−0.885	−0.411	0.209
$\text{depth}_{\text{samples}}$	0.694	−0.559	−0.164
pH	−0.447	0.145	0.659
P_{Jan}	0.308	−0.283	0.261
P_{Dec}	0.277	0.056	0.374
T_{Jul}	0.220	−0.310	−0.535
$\text{water area}_{\log 10}$	−0.193	−0.583	−0.503

Tab. 3.2.: Summary of optimal model and model enforced with T_{Jul} obtained from all environmental variables with variance inflation factors (VIF) $\leqslant 10$ and given calculated significance from ANOVA permutation test (n=1,000). Environmental variables sorted by their eigenvalue influence $\Delta\ \lambda$ to the model when added.

optimal model:				model enforced with T_{Jul}:			
environmental variable	$\Delta\ \lambda$ (% - accounted)	p-value	VIF	environmental variable	$\Delta\ \lambda$ (% - accounted)	p-value	VIF
$\text{Conductivity}_{\log 10}$	0.429 (6.4)	0.0001 ***	2.61	T_{Jul}	0.214 (3.2)	0.0001 ***	2.73
$\text{Depth}_{\text{samples}}$	0.301 (4.5)	0.0003 ***	1.59	$\text{Conductivity}_{\log 10}$	0.422 (6.3)	0.0001 ***	2.35
T_{Oct}	0.204 (3.0)	0.0007 ***	3.16	$\text{Depth}_{\text{samples}}$	0.273 (4.1)	0.0013 **	1.59
P_{Dec}	0.175 (2.6)	0.0174 *	2.20	P_{Dec}	0.175 (2.6)	0.0176 *	2.24
pH value	0.173 (2.6)	0.0070 **	1.84	pH value	0.161 (2.4)	0.0083 **	2.70
$\text{Water area}_{\log 10}$	0.155 (2.3)	0.0180 *	2.28	$\text{Water area}_{\log 10}$	0.168 (2.5)	0.0157 *	1.79
P_{Jan}	0.139 (2.1)	0.0806	2.81	P_{Jan}	0.162 (2.4)	0.0094 **	3.96
				Elevation	0.143 (2.1)	0.0703	3.17

Signif. codes: 0 *** 0.001 ** 0.01 *

3.5. Transfer models

Transfer models were established for 8 different model types with a summary given for all model performances calculated for the environmental variable electrical $\text{conductivity}_{\log 10}$ in Figures 3.7–3.8 and numerical results in Table A.10. It was also tried to develop transfer models for the second important CCA constraint sampling depth but this results in too low correlation values of r^2 and therefore also in high error values, i.e. aberrations from measured sampling depth values. Hereby for instance a WAPLS–1 model with one (=best) component results after leave one out cross-validation in a weak $r^2_{\text{LOOCV}} = 0.475$ and a high root mean square error of prediction (RMSEP) of ± 7.2 m.

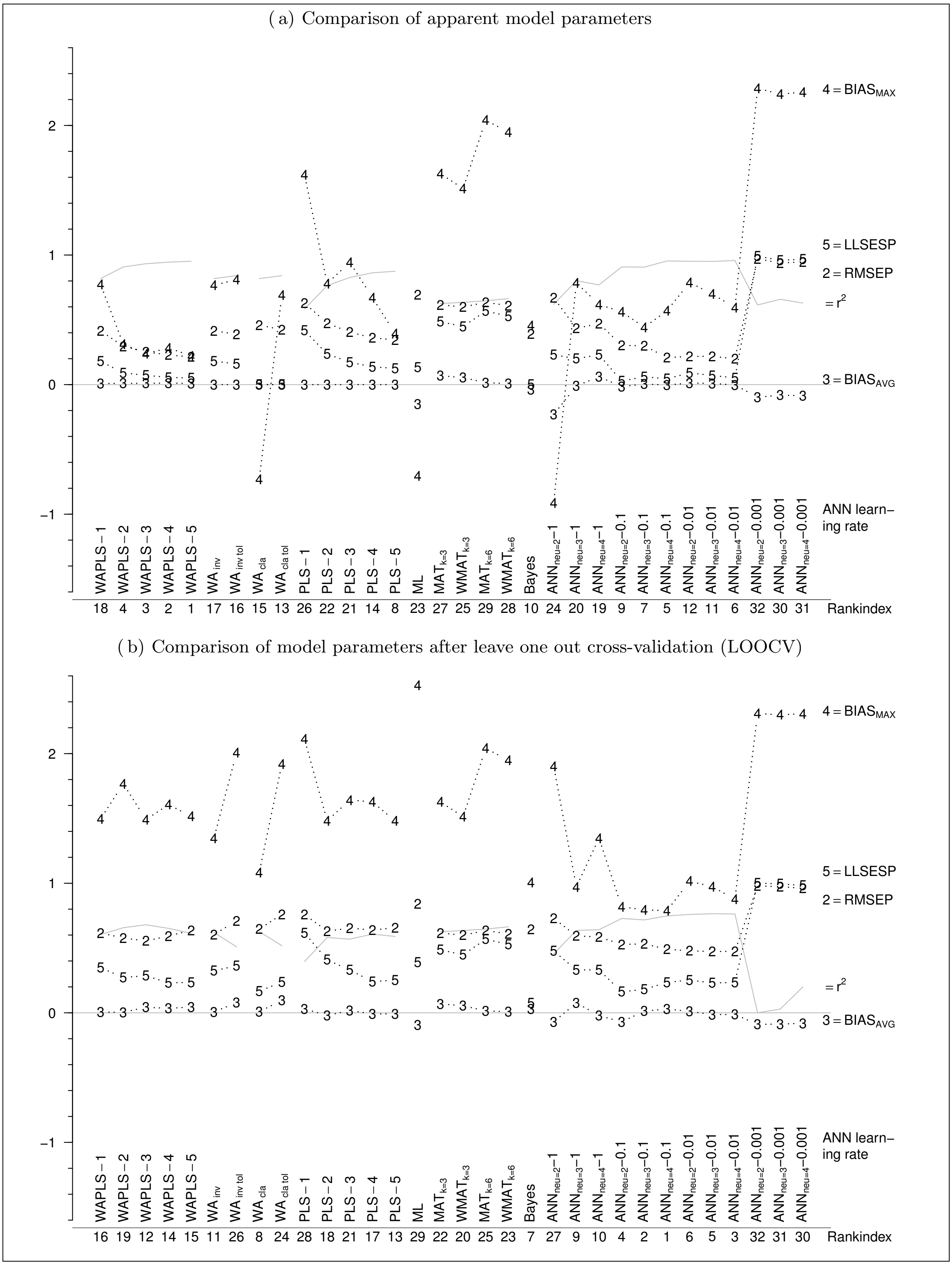


Fig. 3.7.: Model parameters of all computed transfer models of conductivity$_{\log 10}$ for apparent estimation (a) and after LOOCV procedure was done (b). Numeric results see Table A.10 on page 145, abbreviations of models on page VI, explained model parameters on page 12.

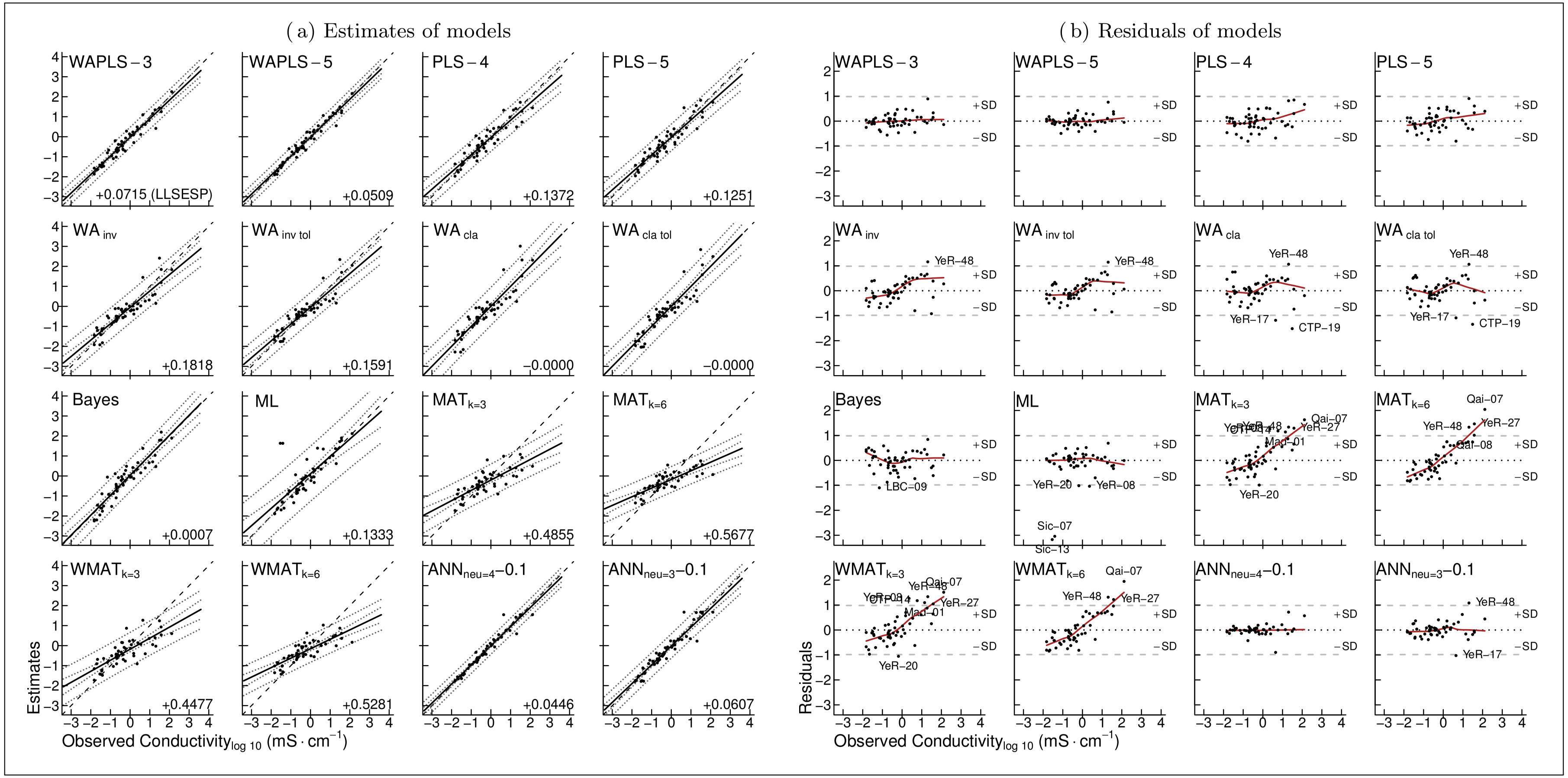


Fig. 3.8.: Transfer models of most suitable apparent models calculated for electrical conductivity$_{\log_{10}}$ (EC). Figure (a): observed EC$_{\log 10}$ versus estimated model values with LLSESP (slope parameter of a linear residual model line) and confidence intervals of a linear relationship between observed vs. estimated EC (95% confidence interval of slope [inner lines] and prediction [outer lines]); Figure (b): observed EC$_{\log 10}$ versus model aberrations, called residuals, which are defined as observed − estimated not conversely. Horizontal dotted lines indicate standard deviations (SD) of observed EC$_{\log 10}$ for revealing possible outliers (labelled by sample's code). Trends in the residuals are highlighted with a LOESS smoother (span 2/3). Abbreviations of models see on page VI.

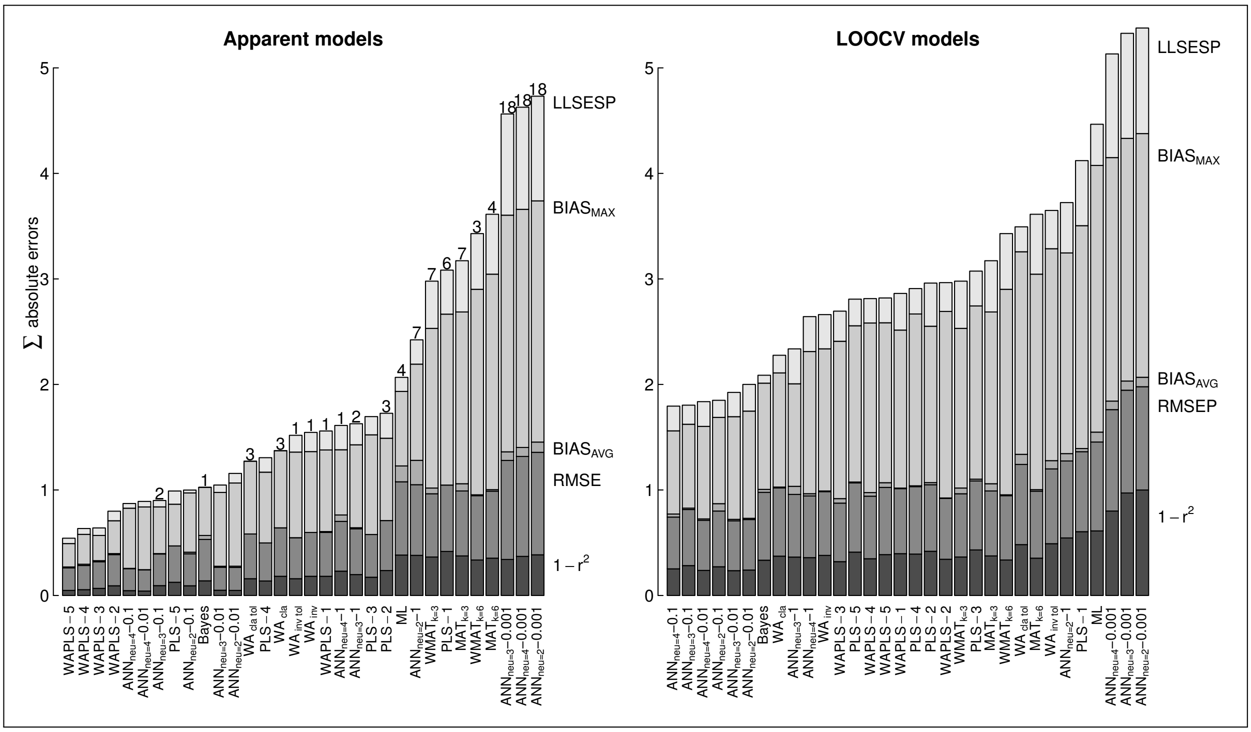


Fig. 3.9.: Transfer models ranked by sum of absolute error values for apparent models and models after leave one out cross-validation (LOOCV) was done. Apparent models are given with numbers of outliers from residual analysis that exceed the interval of $EC_{\log 10}$'s standard deviation (Fig. 3.8 b). Abbreviations of models see on page VI and explained model parameters on page 12.

For evaluating all transfer models of $EC_{\log 10}$, a rank index based on error summation was calculated based on models' parameters before and after LOOCV to reveal suitable transfer functions with low aberrations. In general the correlation values r^2 between observed $EC_{\log 10}$ data and estimations vary from 0.58 to 0.96 in all apparent models and from 0.00 to 0.76 after LOOCV (Fig. 3.7). Considering lowest correlation values, maximum likelihood (ML) model, model one of partial least squares method (PLS–1) with one factor component, artificial neural network models with two hidden neurons and a learning rate of one ($ANN_{neu=2} - 1$) and all ANN models with a learning rate of 0.001 ($ANN_{neu=...} - 0.001$) have lowest correlations followed by all modern analogue models (MAT), i.e. either weighted or unweighted or with either three or six modern analogues. All other model types reveal better performances, of course with nuances in correlation on the one hand and error values on the other (Fig. 3.9).

Another parameter that characterises all calculated transfer models is the linear slope parameter in residual models (LLSESP, Fig. 3.8), which indicates a model to be balanced or not. Low absolute values of LLSESP have models WA_{cla}, $WA_{cla\ tol}$, Bayesian, WAPLS–3/5 and $ANN_{neu=3/4} - 0.1$ with a learning rate of 0.1 and high LLSESP values have all calculated MAT models with values of 0.44 to 0.57.

Sample outliers in residual plots (Fig. 3.8 b) beyond the interval of $EC_{\log 10}$'s standard deviation do not occur in all TF but in some of them. Hereby the following model types reveal no outliers: all $ANN_{neu=...} - 0.01$ and most $ANN_{neu=...} - 0.1$, WAPLS–2-5 and PLS–3-5 models. All other models reveal sample outliers. With one moderate outlier near the bound of $EC_{\log 10}$'s standard deviation there are transfer models: the Bayesian and both WA_{inv} transfer models and with two outliers appears model $ANN_{neu=3} - 0.1$. Among other models with more than two outliers in Figure 3.8 b the ML model shows the highest abbreviation for two distinct sample outliers. These are samples Sic–07 and Sic–13 having almost an aberration of about three scales, i.e. $10^3\ mS \cdot cm^{-1}$. With most outliers within all tested transfer models appear the three $ANN_{neu=...} - 0.001$ having 18 outliers beyond the bound of $EC_{\log 10}$'s standard deviation.

Transfer models in particular are discussed further on page 47.

3.6. Compositional pattern analysis

Beside a statistical formulation of transfer models detailed knowledge of the ecology among chironomids can assist a palaeoenvironmental reconstruction.

Tab. 3.3.: Results of gradient analysis done by Huisman-Olff-Fresco—HOF—models (Huisman et al. 1993) with a minimum frequency of 5, i.e. a taxon occurs in at least 5 samples. Data sorted in descending order after influence of environmental variable in CCA and after HOF model types. Significant model types are indicated by *. Model types are: I = no significant trend; II = sigmoidal trend and maximum = upper bound; III = sigmoidal trend and maximum < upper bound; IV = unimodal response curve; V = skewed response curve. Colours in light grey indicate a frequency < 10. Abbreviations see on pages VI–VIII.

Taxon	n (×-times)	conductivity$_{log 10}$ signficant HOF models I	II	III	IV	optimal Modell	sampling depth signficant HOF models I	II	III	IV	optimal Modell	pH signficant HOF models I	II	III	IV	optimal Modell	water area$_{log 10}$ signficant HOF models I	II	III	IV	optimal Modell
Psecinde	59 (20)	*		*	*	V		*	*		IV			*		I	*				II
sfTanypo	24 (10)	*	*	*	*	V					I					I					I
Psec?sol	128 (19)	*	*	*	*	V		*	*	*	V	*				II		*	*		IV
ChEim1m2	43 (11)		*			IV		*	*	*	V		*	*		IV	*		*		II
Corn?asc	20 (10)		*	*		IV	*	*	*		IV	*				II	*				II
Tany?gra	157 (21)	*	*	*		IV	*	*	*		IV	*				II		*			III
TaCoinde	17 (12)		*	*		IV	*	*			IV	*	*	*		IV		*			III
ChEim1m1	70 (20)		*	*		IV		*	*		IV					I					I
ChEimen1	103 (27)	*	*			IV		*			IV					I					I
Part?pen	52 (15)		*			IV	*	*			IV	*	*			III					I
Partinde	206 (25)		*	*		IV	*		*		II					I	*	*	*		IV
Cricshil	42 (15)		*	*		IV	*		*		II	*				II	*				II
Acri?lon	416 (34)		*	*		IV	*				II	*				II	*				II
Part?dis	33 (10)	*	*			IV					I		*			IV		*			IV
ChEimen2	40 (20)		*			IV					I					I					I
Cricgsy2	47 (14)	*	*	*		IV					I	*				II	*				II
Cricgsy1	60 (16)	*				II		*	*	*	V					I	*				II
Psec?bas	108 (18)	*		*		II	*	*	*	*	III		*	*	*	V					I
trTanyta	483 (46)	*				II					I					I					I
Tany?lap	87 (20)	*				II					I	*				II					I
ChEimen3	36 (15)					I		*	*	*	V					I	*		*		II
ChEiinde	23 (12)					I		*	*		IV					I	*		*		II
Tanyinde	16 (12)					I					II					I	*				II
ChEim2m2	24 (12)					I					I					I					I
sfOrthoc	92 (34)					I					I					I					I
CrOrinde	14 (12)					I					I					I	*				II
trChiron	18 (8)			*	*	V		*	*		IV					I	*				II
Psec?sop	27 (7)		*	*		IV		*	*		IV					I	*		*	*	V
Glypinde	9 (6)		*			IV	*		*		II	*		*		II	*	*			III
ChEim3m3	8 (5)		*	*		IV	*		*		II	*		*		II	*				II
ChEim3m2	5 (5)		*	*		IV	*		*		II	*				II					I
ChEim1m3	18 (9)		*			IV					I			*		I					I
ChEim3m1	9 (5)	*	*	*		IV					I	*				II					I
Psesinde	11 (6)		*	*		IV					I		*			IV					I
Psesind2	21 (6)	*				II	*	*			IV					I	*		*	*	V
ChEim2m1	11 (9)		*			III					I					I					I
Hete?mar	16 (5)	*				II	*	*	*	*	V	*				II		*	*		IV
EuTvinde	12 (5)	*				II	*	*	*		IV	*				II		*			III
Micrinde	26 (5)	*				II	*	*	*	*	III	*	*			IV		*	*		IV
Cricgsyl	8 (6)			*		I		*			IV		*	*		IV	*				II
Acriinde	12 (7)					I					I		*	*		IV	*				II
Corn?scu	7 (6)					I					I					I					I
Proc?cho	11 (9)					I					I					I					I
sfChiron	7 (7)					I			*		I	*				II	*		*	*	V
Procinde	8 (8)					I					I		*	*		IV					I
CoThinde	9 (7)					I					I					I					II
Metr?eur	30 (5)					I					I		*	*	*	V	*		*	*	V

Taxon	n (×-times)	T_{Oct} signficant HOF models I	II	III	IV	optimal Modell	T_{Jul} signficant HOF models I	II	III	IV	optimal Modell	P_{Dec} signficant HOF models I	II	III	IV	optimal Modell	P_{Jan} signficant HOF models I	II	III	IV	optimal Modell
Psecinde	59 (20)					I					I	*				II					I
sfTanypo	24 (10)					I					I					I		*			III
Psec?sol	128 (19)	*				II			*	*	V	*		*	*	V	*				II
ChEim1m2	43 (11)					I					I	*				II	*		*	*	V
Corn?asc	20 (10)		*	*		IV		*	*		IV					I	*	*	*	*	V
Tany?gra	157 (21)		*			III		*		*	III		*	*		IV	*	*	*	*	V
TaCoinde	17 (12)		*			III		*			III		*			IV	*				II
ChEim1m1	70 (20)					I		*	*		IV	*				II					I
ChEimen1	103 (27)					I					I					I					I
Part?pen	52 (15)	*				II	*	*			III		*	*		IV		*			IV
Partinde	206 (25)	*				II	*				II		*			III		*			IV
Cricshil	42 (15)	*				II	*				II		*			III					I
Acri?lon	416 (34)	*	*			IV	*	*			III		*	*		IV		*			IV
Part?dis	33 (10)					I					I					I					I
ChEimen2	40 (20)					I					I					I					I
Cricgsy2	47 (14)					I					I					I					I
Cricgsy1	60 (16)					I					I					I	*	*	*		IV
Psec?bas	108 (18)	*				II					I					I		*			III
trTanyta	483 (46)					I		*		*	III	*		*	*	V					I
Tany?lap	87 (20)	*				II					I					I					I
ChEimen3	36 (15)		*			I					II		*			III		*			IV
ChEiinde	23 (12)					I					I					I				*	I
Tanyinde	16 (12)		*	*		IV		*	*	*	V					I					I
ChEim2m2	24 (12)			*	*	V					I		*	*		IV					I
sfOrthoc	92 (34)					I					I					I					I
CrOrinde	14 (12)					I					I					I					I
trChiron	18 (8)	*		*		II	*				II	*				II	*				II
Psec?sop	27 (7)		*	*		IV	*	*	*	*	V					I					I
Glypinde	9 (6)					I					I	*		*	*	V					I
ChEim3m3	8 (5)		*			III	*	*	*		IV		*	*		IV		*			IV
ChEim3m2	5 (5)	*				II	*	*	*		IV		*	*		IV		*		*	III
ChEim1m3	18 (9)					I		*	*		IV					I	*		*		II
ChEim3m1	9 (5)	*				III	*				II		*	*		IV		*	*		IV
Psesinde	11 (6)		*	*		IV		*	*		IV		*			IV					I
Psesind2	21 (6)		*	*	*	V	*		*	*	V	*		*	*	V		*	*		IV
ChEim2m1	11 (9)					I					I	*		*		II		*	*		IV
Hete?mar	16 (5)	*				II	*	*	*	*	V		*	*	*	V		*	*	*	V
EuTvinde	12 (5)	*				II					I		*	*		IV					I
Micrinde	26 (5)	*				II	*	*	*	*	V	*	*			IV					I
Cricgsyl	8 (6)		*			III					I		*	*	*	V	*	*	*		IV
Acriinde	12 (7)		*	*	*	V		*	*		IV	*	*	*		IV		*	*		IV
Corn?scu	7 (6)					I					I	*	*			IV	*	*			III
Proc?cho	11 (9)					I					I					I		*			III
sfChiron	7 (7)	*		*		II	*	*	*		IV					I					I
Procinde	8 (8)		*	*		IV					I		*	*		IV					I
CoThinde	9 (7)			*		I					I					I	*				II
Metr?eur	30 (5)		*	*	*	V	*	*	*	*	V		*	*	*	III		*	*	*	V

Therefore a number of characterisation techniques were used to find possible groups, correlations or tendencies among found taxa in relation to investigated variables. A gradient analysis was undertaken to test taxa's representation in the data and a cluster analysis was done to find possible groups or overlapping patterns within the cluster results (Fig. 3.15–3.17). Finally the robust NMDS ordination (Minchin 1987) was used to summarise relationships of environmental variables on the one hand (Fig. 3.18, 3.19) and taxa's assigned groups on the other (Fig. A.1–A.8).

3.6.1. Gradient analysis

Using Huisman-Olff-Fresco (HOF) models which are designated by Huisman et al. (1993) belonging to five different model types, they are used to reveal taxon's distribution type regarding an environmental gradient. Hereby taxon's response curve can be skewed (V: ,), unimodal (VI:), sigmoidal (III: , ; II: ,) or has no specific response curve (I:).

From alltogether 97 taxa 47 occur in more than five samples, i.e. their frequency f is greater than five (Tab. 3.3). Taxa with a lower frequency fall out from the analysis even when their abundances are high. To this group with $f < 5$, three abundant taxa can be referred:

Acricotopus indet 1 (f=2, n=75),
Cricotopus salinophilus (f=4, n=131) and
Sergentia longiventris type (f=4, n=82).

Tab. 3.4.: Taxa with HOF models showing mainly an optimum response curve among all environmental variables (types: IV ; , V).

Taxon	Frequency Head capsules
Acricotopus longipalpus type	f=34, n=416
Acricotopus sp.	f=7, n=12
Chironomus/Einfeldia sp. men1 man2	f=11, n=43
Chironomus/Einfeldia sp. men3 man3	f=5, n=8
Corynoneura arctica/scutellata	f=10, n=20
Tanytarsus/Corynocera sp.	f=12, n=17
Tanytarsus gracilentus type	f=21, n=157
Paratanytarsus penicillatus type	f=15, n=52
Psectrocladius sordidellus/limbatellus	f=19, n=128
Psectrocladius sokolovae/pancratovae type	f=7, n=27
Pseudosmittia indet 2	f=6, n=21
Pseudosmittia sp.	f=6, n=11
Metriocnemus eurynotus type	f=5, n=30
Micropsectra sp.	f=5, n=26
Heterotrissocladius marcidus type	f=5, n=16
Cricotopus sylvestris gr.	f=6, n=8

Taxonomic groups on a poor determination level, e.g. at tribe or subfamily level, show generally an indifferent response curve as for instance subfamilies Orthocladiinae, Tanypodinae or genera groups *Cricotopus/Orthocladius* sp. and *Chironomus/Einfeldia* sp. Some taxa that could be assigned to a better taxonomical resolution and a frequency higher than 10 show also indifferent response curves such as *Chironomus/Einfeldia* sp. men2 (man2) and *Paratanytarsus dissimilis* type.

Among all included taxa in gradient analysis, model types are varying regarding each tested environmental parameter. Model types IV and V with an unimodal or skewed-unimodal shape—either left or right-skewed—show that a specimen's response has an optimum within the ascertained data. The number of those optimum curves with a frequency $f \geqslant 10$ for each environmental variable is:

16 for $EC_{\log 10}$,
12 for $\text{depth}_{\text{samples}}$,
8 and 7 respectively for P_{Jan} and P_{Dec},
4 for T_{Jul}, T_{Oct}, pH and
3 for water $\text{area}_{\log 10}$.

With a lower frequency than 10 the number of optimum curves is varying between 6 and 13 in all calculated environmental variables. Regarding HOF model types IV and V there are also 16 taxa that show mainly an optimum response curve for at least four of eight environmental variables (Tab. 3.4).

Model types II and III show an incomplete gradient and vary for each environmental variable with a maximum of 20 taxa for water $\text{area}_{\log 10}$ and a minimum of 9 for EC, sampling depth and P_{Dec} which is closely followed by T_{Jul} and P_{Jan} with 10 taxa.

3.6.2. Cluster analysis

Cluster analysis was used to identify groups in chironomid data by using an appropriate distance measure and cluster method. Testing this by a cophenetic correlation between distance matrix of original data and after processing revealed the average clustering method with Euclidean distance measure to be the best choice. In grouping species according to their weighted average environmental variables the cophenetic correlation is 0.997. For each significant variable obtained from CCA, taxa groups are visualised within NMDS ordination plots (Fig. A.1–A.8). Thereby a high value of cluster's average silhouette width s_{ave}, or cluster's goodness, and a low number of groups was crucial for group rearrangements. The silhouette width s_i ranges from 1 to −1 and means

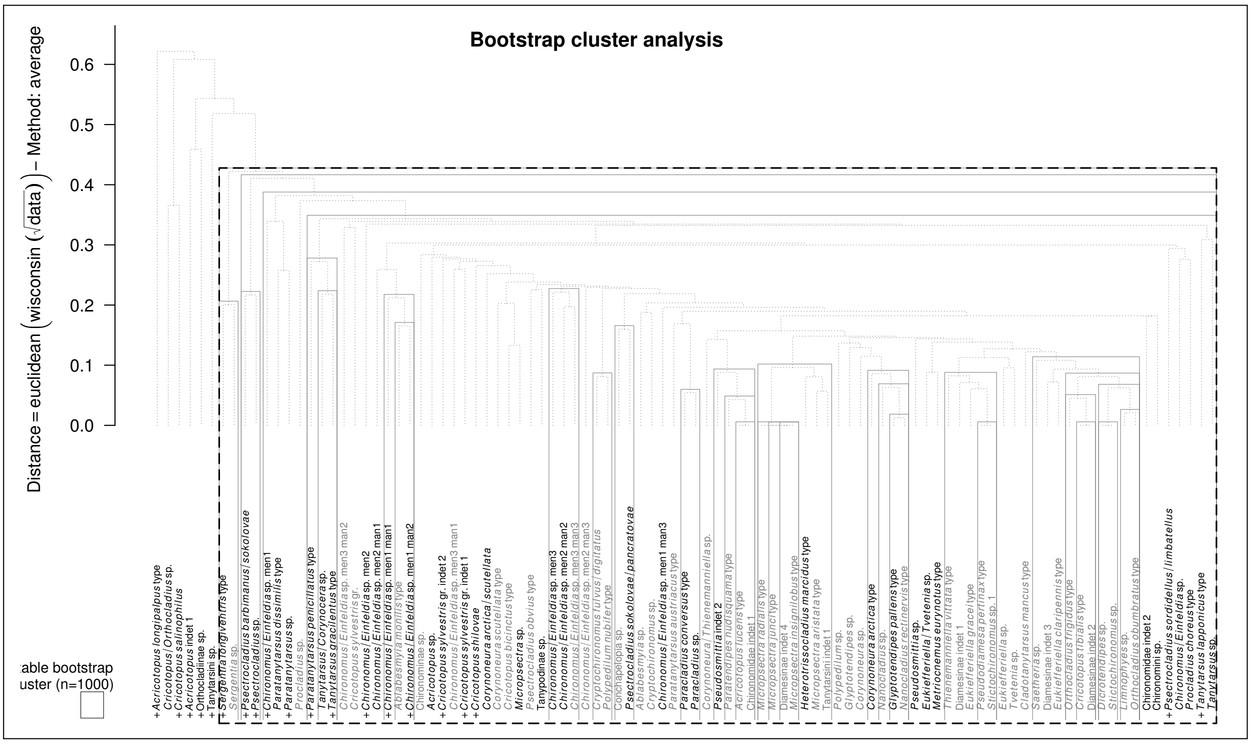


Fig. 3.10.: Cluster tree analysis with stable bootstrap groups of taxa (n=1,000; $p \geqslant 0.95$) calculated with method average. Outermost stable cluster is indicated as bold dashed line; counted head capsules with $5 \leqslant n < 10$ are in light grey, + indicates counts $\geqslant 40$.

for a clustered element:

$$s_i \sim 1 : \text{it fits very good to its group,}$$
$$s_i \sim 0 : \text{it lies between two groups and}$$
$$s_i \sim -1 : \text{it is clustered worst.}$$

Generally clustered taxa fit poorer at their edges of clusters where s_i then decreases. A visual summary for clustered results is given in Figures 3.15 to 3.17 on pages 41–43 with cluster data in the Appendix (Tab. A.1–A.8).

A further method applied in cluster analysis for testing the stability of cluster branches is Bootstrap analysis. This technique revealed for all taxa that most cluster branches are stable at the 95 % level tested with n = 1,000 permutations (Fig. 3.10). Only taxa *Acricotopus longipalpus* type, *Acricotopus* indet 1, Orthocladiinae sp. and Tanytarsini sp. in particular can not be traced back to stable cluster branches.

3.6.2.1. Groups of environmental parameters

Detecting patterns within a huge amount of data is of most interest in analysing taxa comunities. Therefore taxa's data ranges were illustrated with boxplots, additionally with results of cluster analysis. Hereby gradients can be visualised by underlying estimated density curves and in addition results of HOF model types give information about optimal fitted response curves of taxa (Fig. 3.11–3.14).

Electrical conductivity ranged within all data from 0.015 to 130 $\mathrm{mS \cdot cm^{-1}}$ (–1.8–2.1 $_{\log 10}$) and 37 optimal groups were detected regarding weighted average data values with an average cluster silhouette width for all groups of $s_{\text{ave}} = 0.630$ (Tab. A.1). Within this statistically optimal separation many cluster branches contain only one taxon. A more suitable group number for a suboptimal but good

Tab. 3.5.: Data ranges for groups of electrical conductivity with goodness of cluster's group (average silhouette width s_{ave})

group	$\mathrm{mS \cdot cm^{-1}}_{\log 10}$ ($\mathrm{mS \cdot cm^{-1}}$)	goodness s_{ave}	n-taxa
1^{st}:	–1.82 to –0.88 (0.015–0.132)	0.612	30
2^{nd}:	–0.765 to 0.023 (0.172–1.054)	0.561	44
3^{rd}:	0.104 to 0.661 (3.1–4.6)	0.721	16
4^{th}:	1.16 to 1.69 (14.4–62.8)	0.560	5
5^{th}:	2.11 (130.3)	1.000	2

group separation was detected having five groups with a slightly decreased $s_{\text{ave}} = 0.612$. These groups include taxa with very low, low, middle, high and highest EC values (Tab. 3.5). In general many taxa appear within at least 1 logarithmic unit and only a few seem to be tied to narrow EC ranges.

Separation between all five suboptimal groups decreases at their cluster edges with silhouette values s_i around zero or results in negative values for the first two groups. That means no good separation, because taxa at the edges tend to lie in-between two groups as their s_i-values are closer to zero or they tend to belong to other cluster groups. However, affinity to only highest EC values have the two taxa: *Acricotopus lucens* type, with only two head capsules, and *Chironomidae* indet 1 with seven. The fourth group follows with high values and includes three abundant taxa whereat *Cricotopus salinophilus* clusters interjacent (Fig. 3.11 a):

Acricotopus indet 1 (n=75),
Pseudosmittia indet 2 (n=21) and
Cricotopus salinophilus (n=131).

Belonging to the fourth group these taxa tolerate also highest EC values up to $130\,\text{mS}\cdot\text{cm}^{-1}$. *Cricotopus sylvestris* gr. indet 1—a member of the third group—and undetermined Orthocladiinae sp.—a member of the second group—also tolerate highest values. Both were also found at very low values of $0.07\,\text{mS}\cdot\text{cm}^{-1}$. Further abundant taxa within the third group are *Psectrocladius barbimanus/sokolovae* and *Tanytarsus gracilentus* type.

Typical taxa within the second group with low EC values are *Acricotopus longipalpus* type, *Paratanytarsus* sp., indistinguishable Tanytarsini and taxa within *Chironomus/Einfeldia*. Almost all *Chironomus/Einfeldia* without *C./E.* men3 (man1) fit into this group.

In the first group at very low conductivity values occur especially taxa like *Micropsectra* sp., *Sergentia* sp., *Paracladius* sp. and also as an abundant taxon: *Psectrocladius sordidellus/limbatellus*.

At values around 0.3–$3.0\,\text{mS}\cdot\text{cm}^{-1}$ are some frequently found specimens showing more outliers in the boxplot static than other taxa but they belong in some cases to indistinguishable groups due to missing characters for determination except for *Cricotopus shilovae* and *Metriocnemus eurynotus* type.

Tab. 3.6.: Data ranges for groups of pH values with goodness of cluster's group (average silhouette width s_{ave})

group	pH range	goodness s_{ave}	n-taxa
1^{st}:	7.10–7.59	0.669	8
2^{nd}:	7.87–8.56	0.684	30
3^{rd}:	8.70–9.25	0.530	21
4^{th}:	9.32–9.76	0.618	20
5^{th}:	9.89–10.62	0.607	18

Values of pH ranged from 7.1 to 10.8 (Fig. 3.11 b, Tab. A.3) and from weighted average values 36 optimal groups were calculated with an average silhouette width s_{ave} of 0.664. A rather suitable, but statistically less good group separation results in five suboptimal cluster branches with a similar average silhouette value of 0.621 (Tab. 3.6).

Within the entire range of pH most taxa span 2 or 3 pH units but indifferent taxa with wide pH ranges can also be found which cover more than 3 units, especially within the pooled genera of *Chironomus/Einfeldia*.

The fifth group with highest pH values shows HOF model types II and III in which *Tanytarsus gracilentus* type, *Cricotopus shilovae* and *Paratanytarsus penicillatus* type are members with high abundances.

In the fourth group from 9.76 down to 9.32 abundant taxa that are for instance *Acricotopus longipalpus* type and *A.* indet 1, *Psectrocladius barbimanus/-sokolovae* and *Paratanytarsus* sp.

The third group with middle values is characterised by many taxa with the indifferent HOF model type I. Except *C./E.* men3 with all its three mandible types and *C./E.* men1 men2, all other taxa of *Chironomus/Einfeldia* show this HOF model response curve.

HOF models II and III with a left sigmoidal curve dominate the second group in which taxa *Tanytarsus lapponicus* type, *Psectrocladius sordidellus/limbatellus* and *Sergentia longiventris* type are abundant.

Finally in the last group with pH values of 7.59 down to 7.10 cluster taxa *Micropsectra* sp. and *Heterotrissocladius marcidus* type which are less abundant than taxa mentioned for the previous group.

Sampling depth ranged from 0.01 to 39.9 m (Fig. 3.12 a, Tab. A.2) and revealed three distinct optimal groups with shallow, deeper and deepest weighted average values. Hereby decrease counted taxa from group one to group three with deepest values (Tab. 3.7).

Many taxa occur at shallow conditions in the first group from 0.05 to 7.2 m. Having an HOF optimum response curve in that group, some abundant taxa are for instance: *Paratanytarsus penicillatus* type, *Tanytarsus gracilentus* type, *Psectrocladius* sp., *P. sordidellus/limbatellus* and most of *Chironomus/Einfeldia* men1 with its mandible types. Within

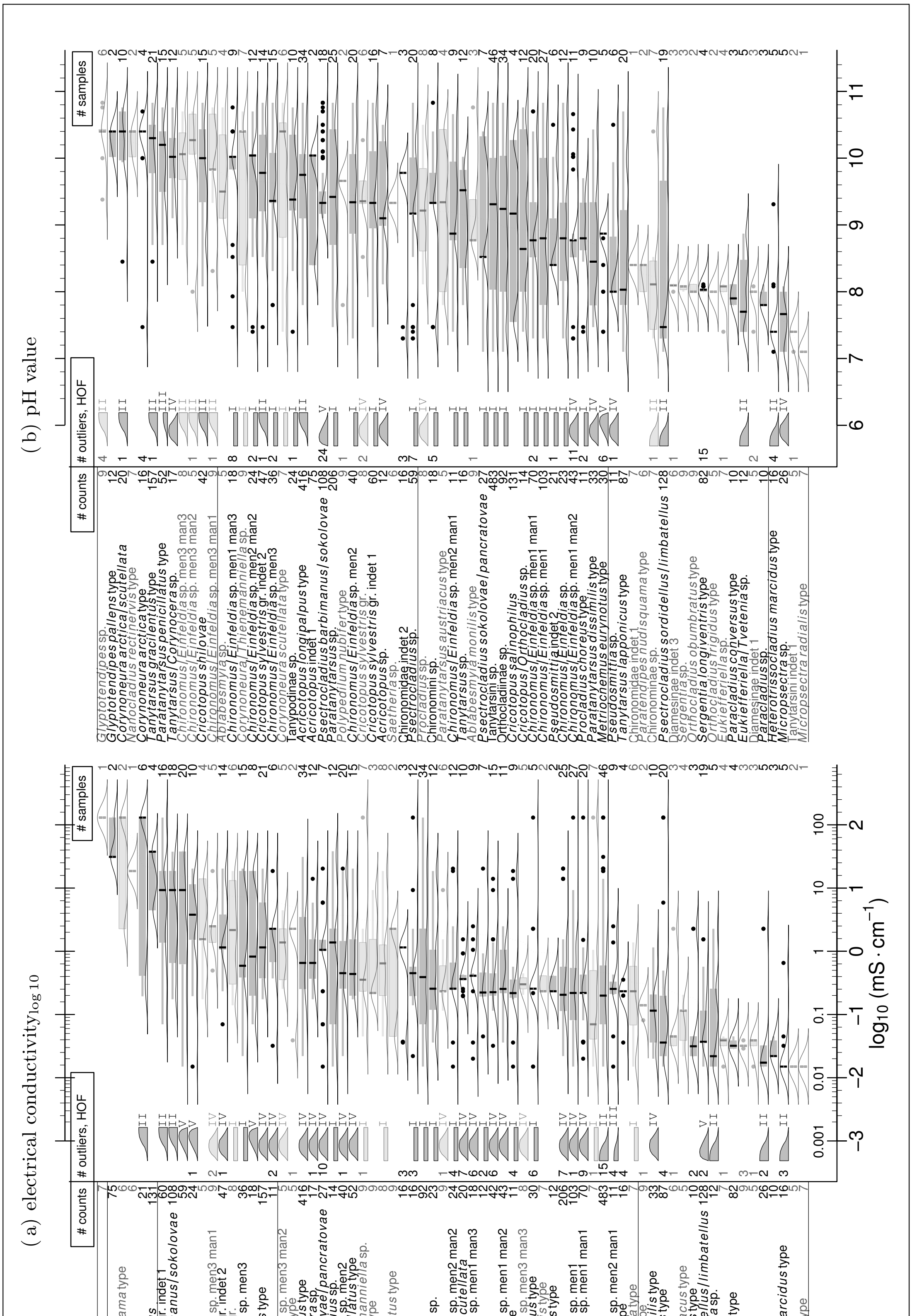


Fig. 3.11.: Boxplots of chironomid taxa versus conductivity$_{\log 10}$ and pH values with estimated Gaussian density lines and added gradient analysis (optimal HOF model types I-V after Huisman et al. 1993). Taxa ordered by their weighted average values (······) from 52 samples; counted head capsules with $5 \leqslant n < 10$ are in light grey; solid line —— separates cluster groups.

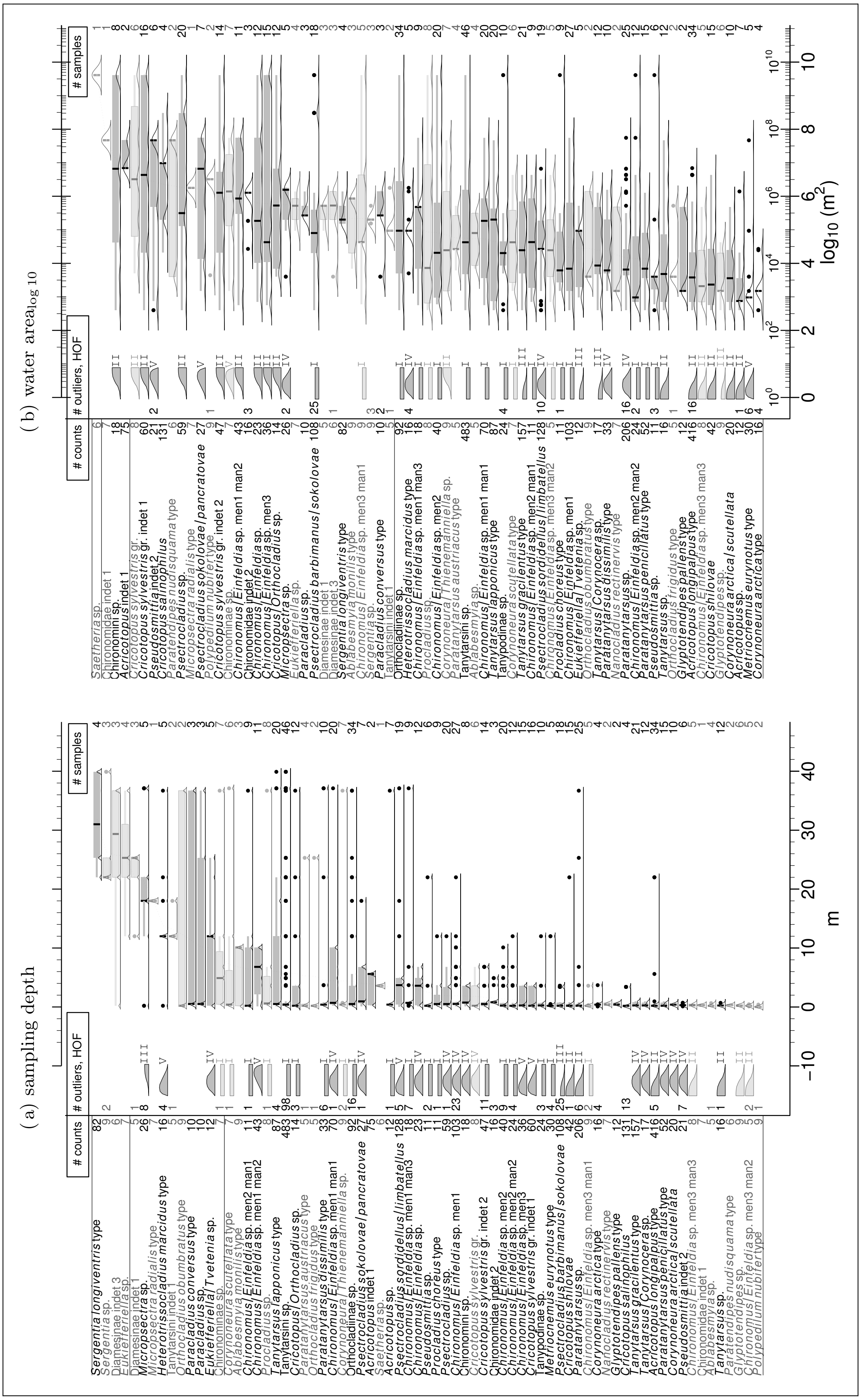


Fig. 3.12.: Boxplots of chironomid taxa versus values of sampling depth and water area$_{\log 10}$ with estimated Gaussian density lines and added gradient analysis (optimal HOF model types I-V after Huisman et al. 1993). Taxa ordered by their weighted average values (······) from 52 samples; counted head capsules with $5 \leqslant n < 10$ are in light grey; solid line —— separates cluster groups.

Tab. 3.7.: Data ranges for groups of sampling depth with goodness of cluster's group (average silhouette width s_{ave})

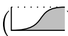
group	depth$_{\text{samples}}$ (m)	goodness s_{ave}	n-taxa
1^{st}:	0.05–7.21	0.802	69
2^{nd}:	8.8–22.0	0.520	18
3^{rd}:	25.3–36.7	0.629	10

this cluster group are also taxa groups which have many boxplot outliers.

The next group with deeper values from 8.8 down to 22.0 m is characterised by less abundant taxa such as *Micropsectra* sp. and *Heterotrissocladius marcidus* type.

At last in the deepest group down to 36.7 m occur in particular *Sergentia* sp. and *Sergentia longiventris* type.

Water area (Fig. 3.12 b, Tab. A.4) ranged from 400 m^2 (2.6$_{\log 10}$) as small ponds up to about 4,100,000,000 m^2 (9.6$_{\log 10}$) as large lakes and revealed 37 groups from an optimal cluster configuration with an average cluster silhouette width of $s_{\text{ave}} = 0.672$. Suboptimal clustering with a lower cluster group's goodness of $s_{\text{ave}}0.503$ results in five groups whereat the first and the last group have only one taxon (Tab. 3.8). These are *Polypedilum* sp. in the first and *Saetheria* sp. in the last group. Beside groups one and five most taxa can be found in general within about four logarithmic units.

The fourth group is dominated by indistinguishable Chironomini and *Acricotopus* indet 1 with HOF model type II ().

Within the third group of 170,000 to 4,600,000 m^2 cluster some taxa with an HOF optimum response curve. These are for instance *Micropsectra* sp. and *Psectrocladius sokolovae/pancratovae*. Some taxa in this group are characterised by HOF model types II and III with a rightshaped sigmoidal curve, which are for instance *Cricotopus sylvestris* group indet 1 and indet 2 or *Psectrocladius* sp. Other abundant taxa are *Cricotopus salinophilus*, *Sergentia longiventris* type and *Psectrocladius barbimanus/sokolovae* that shows the indifferent HOF model type I.

Finally in the second group appear many taxa with the indifferent HOF model type I. Among them are many *Chironomus/Einfeldia* except *C./E.* men3 (man3) and *C./E.* men2 man3. Abundant taxa with an optimum HOF model curve in this group are *Paratanytarsus dissimilis* type, *Psectrocladius sordidellus/limbatellus* and a less abundant taxon *Heterotrissocladius marcidus* type.

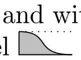
Tab. 3.8.: Data ranges for groups of water area with goodness of cluster's group (average silhouette width s_{ave})

group	water area (m^2)	goodness s_{ave}	n-taxa
1^{st}:	400	0.000	1
2^{nd}:	1,500 to 133,000	0.404	50
3^{rd}:	170,000 to 4,600,000	0.621	40
4^{th}:	13,000,000 to 55,000,000	0.752	5
5^{th}:	4,100,000,000	0.000	1

Mean October air temperature ranged from −2.9 to 9.2 °C (Fig. 3.13 a, Tab. A.5) and results in all together 28 optimal groups with an average silhouette width s_{ave} of 0.682 whereas only 23 of them represent reliable groups with $s_{\text{ave}_i} \geqslant 0.5$. Within October air temperature's range occur many indifferent taxa which are indicated by HOF model type I in Figure 3.13 a. Only a few taxa have optimum HOF model response curves that indicate a taxon to be ecologically stenotherm with a closer temperature range.

All 28 optimal cluster groups were merged to three suboptimal groups for better graphical analysis with an average silhouette width of 0.606 instead of 0.682 (Tab. 3.9 a).

In the third group of 7.2 to 9.2 °C cluster taxa *Micropsectra* sp. and *Heterotrissocladius marcidus* type having their optimum in the upper range indicated by HOF model II. This HOF model type also characterises group two within 6.2 down to 3.4 °C and with abundant taxa like *Tanytarsus lapponicus* type and *Psectrocladius sordidellus/limbatellus*. The only taxon with an optimum curve in this group is *P. sokolovae/pancratovae*.

Down to –2.5 °C, in the first group, taxa appear with wide temperature ranges which are indicated by HOF model I. These are taxa in the merged genus group *Chironomus/Einfeldia*, indistinguishable Orthocladiinae, *Psectrocladius* sp and Tanytarsini. However, abundant taxa with an optimum HOF model response curve are for instance *Acricotopus longipalpus* type, *Chironomus/Einfeldia* men2 man2 and with an optimum in the lower range (HOF model  II) there are taxa *Psectrocladius barbimanus/sokolovae*, *Paratanytarsus penicillatus* type and *Cricotopus shilovae*.

Mean July air temperature ranged from 7.6 to 17.9 °C and results in all together 30 optimal groups with an average silhouette width s_{ave} of 0.640 whereat 21 can be regarded as more reliable groups with a silhouette width of $s_{\text{ave}} \geqslant 0.5$ (Fig. 3.13 b, Tab. A.6). To reveal patterns in graphical analysis all 30 opti-

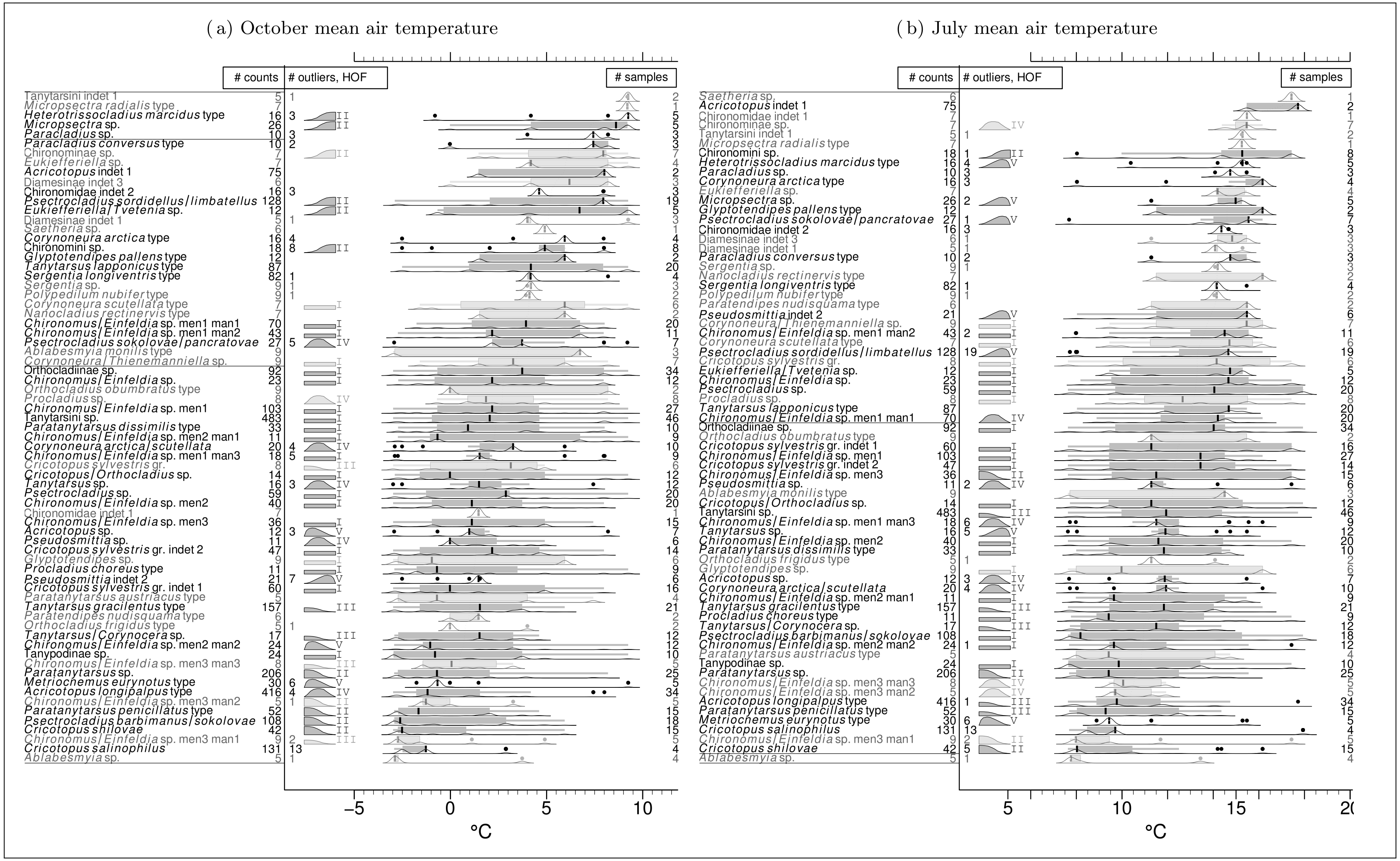


Fig. 3.13.: Boxplots of chironomid taxa versus October and July mean air temperature with estimated Gaussian density lines and added gradient analysis (optimal HOF model types I-V after Huisman et al. 1993). Taxa ordered by their weighted average values (⋯⋯) from 52 samples; counted head capsules with $5 \leqslant n < 10$ are in light grey; solid line —— separates cluster groups.

Tab. 3.9.: Data ranges for groups of October's/July's mean air temperature with goodness of cluster's group (average silhouette width s_{ave}).

(a) October's mean air temperature

group	T $_{\text{Oct}}$ (°C)	goodness s_{ave}	n-taxa
1^{st}:	–2.51 to 3.13	0.561	54
2^{nd}:	3.41 to 6.17	0.632	32
3^{rd}:	7.24 to 9.24	0.748	11

(b) July's mean air temperature

group	T $_{\text{Jul}}$ (°C)	goodness s_{ave}	n-taxa
1^{st}:	8.03 to 8.97	0.662	2
2^{nd}:	9.66 to 12.73	0.512	41
3^{rd}:	13.0 to 17.4	0.602	54

mal groups were merged to three suboptimal groups with their temperature ranges given in Table 3.9 b and with goodness of these three cluster groups of $s_{\text{ave}} = 0.565$. Hereby cluster two taxa with low counted head capsules in group one from 8 to 9 °C which are *Polypedilum* sp. and *Ablabesmyia* sp. Similar to mean October air temperature there are many taxa occurring within wide temperature ranges indicated by HOF model type I in groups two and three. In group two these are the abundant taxa *Psectrocladius barbimanus/sokolovae*, *Chironomus/Einfeldia* men1 and *Cricotopus sylvestris* group indet 1. With an optimum response curve taxa have between 10 and 30 counted head capsules. To these belong for instance *Metriocnemus eurynotus* type and *Corynoneura arctica/scutellata*.

Group three with temperature values up to 17.4° C covers most taxa and beside taxa with wide temperature ranges indicated by HOF model I, most other abundant taxa show an optimum response curve in the upper temperature range, indicated by rightshaped sigmoidal HOF models II or V. To the latter taxa *Psectrocladius sordidellus/limbatellus* and *P. sokolovae/pancratovae* can be referred to and also for instance *Micropsectra* sp. or *Pseudosmittia* indet 2. *Chironomus/Einfeldia* men1 man1 is the only taxon within group three with an non-skewed optimum response curve and high abundance. Further abundant taxa which have a low frequency among all collected samples are *Sergentia longiventris* and *Acricotopus* indet 1.

Mean precipitation of December ranged form 0.2 to 4.1 mm and show the lowest precipitation values within all precipitation data. Two distinct optimal groups with an average silhouette width s_{ave} of 0.665 could be detected with 92 taxa in group one and 5 taxa in group two (Fig. 3.14 a, Tab. A.7). These two groups were subdivided into eight subgroups with a slightly reduced cluster goodness $s_{\text{ave}} = 0.641$ to compare cluster results also with Precipitation of January (Tab. 3.10 a).

In general most taxa occur within a precipitation range of about 2 mm and belong to the first group with lower precipitation values. Within the suboptimal grouping all taxa cluster with positive silhouette values s_i except for *Procladius* sp. with –0.2 in group five and *Acricotopus* indet 1 with $s_i = 0$ being the only taxon in group one.

Group two has five taxa included with two of them having 16 head capsules for Chironomidae indet 1 and *Corynoneura arctica* type. The third group includes some taxa with an optimum HOF model curve. Taxa characterised by this HOF model are for instance *Psectrocladius sordidellus/limbatellus* and *Micropsectra* sp. Going further to group four there are some abundant taxa characterised by the indifferent HOF model type I which is the case for *P. barbimanus/sokolovae* and *Cricotopus sylvestris*

Tab. 3.10.: Data ranges for groups of December's/January's mean precipitation with goodness of cluster's group (average silhouette width s_{ave})

(a) Precipitation of December

group	P $_{\text{Dec}}$ (mm)	goodness s_{ave}	n-taxa
1^{st}	0.402	0.000	1
2^{nd}	0.76 to 0.97	0.691	5
3^{rd}	1.16 to 1.37	0.653	19
4^{th}	1.45 to 1.66	0.682	15
5^{th}	1.73 to 2.10	0.563	37
6^{th}	2.19 to 2.41	0.693	11
7^{th}	2.55 to 2.62	0.877	4
8^{th}	3.17 to 3.40	0.830	5

(b) Precipitation of January

group	P $_{\text{Jan}}$ (mm)	goodness s_{ave}	n-taxa
1^{st}	1.13 to 1.48	0.727	7
2^{nd}	1.76 to 2.01	0.685	7
3^{rd}	2.07 to 2.36	0.670	17
4^{th}	2.42 to 2.75	0.437	17
5^{th}	2.80 to 3.10	0.632	24
6^{th}	3.19 to 3.63	0.515	15
7^{th}	3.77 to 4.06	0.637	5
8^{th}	4.23 to 4.40	0.768	5

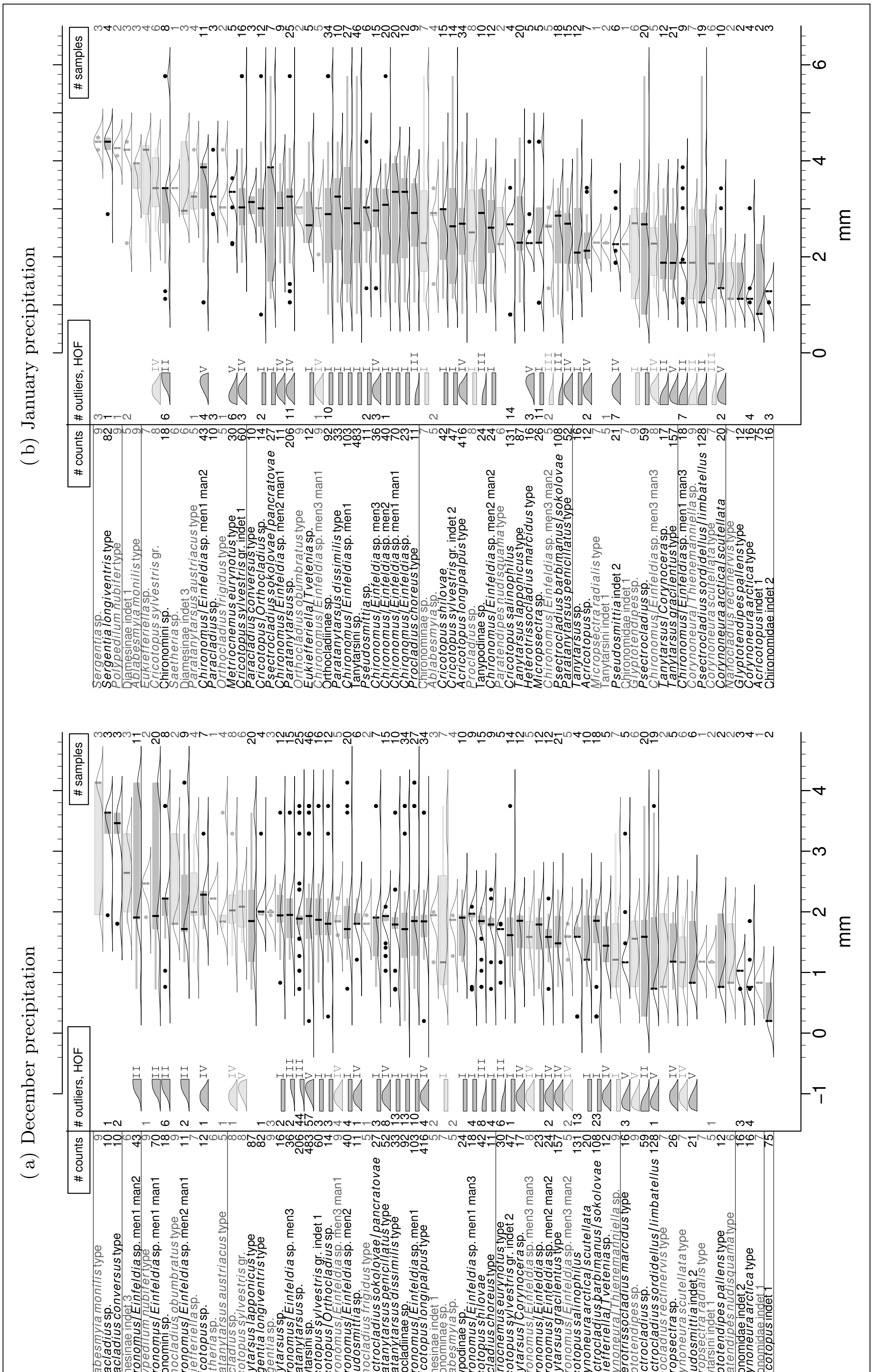


Fig. 3.14.: Boxplots of chironomid taxa versus values of December and January precipitation with estimated Gaussian density lines and added gradient analysis (optimal HOF model types I-V after Huisman et al. 1993). Taxa ordered by their weighted average values (⋯⋯) from 52 samples; counted head capsules with $5 \leqslant n < 10$ are in light grey; solid line —— separates cluster groups.

group indet 2. Abundant taxa with an optimum HOF model response curve are *Tanytarsus gracilentus* type and *Chironomus/Einfeldia* men2 man2. Group five is characterised mainly by HOF model type I to which the following taxa can be referred to with a high number of counted head capsules: *Chironomus/Einfeldia* men1 and men2, Orthocladiinae, *Cricotopus sylvestris* group indet 1 and *Tanytarsus lapponicus* type. However, taxa with an indicated optimum HOF model curve IV or V are *Acricotopus longipalpus* type, *Paratanytarsus penicillatus* type and Tanytarsini but also with a high number of 57 boxplot outliers for this tribe. Group six is dominated by HOF model type II with an optimum in the upper or beyond the upper range of precipitation and for instance taxon *Chironomus/Einfeldia* men1 man2. The only taxon with an optimum curve is *Acricotopus* sp. Finally the last two groups contain only four and five taxa with lower counted head capsules up to 10. The only abundant taxon with HOF model type II as rightshaped sigmoidal curve is *C./E.* men1 man1.

Mean precipitation of January ranged from 0.8 to 5.8 mm and cluster analysis revealed 22 optimal groups with an average silhouette width s_{ave} of 0.621. 13 of these groups can be regarded as more reliable cluster groups with silhouette widths of $s_{ave} \geqslant 0.5$ (Fig. 3.14 b, Tab. A.8). For comparison with precipitation of December all 22 optimal cluster groups were merged into eight suboptimal ones with a slight reduced goodness of cluster fit of $s_{ave} = 0.604$ (Tab. 3.10 b).

Group one with seven taxa includes no taxon with an HOF model type. The only abundant taxon in this group is *Acricotopus* indet 1. In group two all taxa show either a leftshaped sigmoidal HOF model response curve II or III, e.g. for *Psectrocladius sordidellus/limbatellus*, or a left-skewed optimum curve, which is the case for taxon *Corynoneura arctica/scutellata* type. This left-skewed HOF model type was also calculated for *Tanytarsus gracilentus* type, a member of the third group, in which optimum curves are dominating. Going further to group four and five the indifferent HOF model type I is dominating followed by model types having optimum curves. To the indifferent model type in both groups add in taxa within *Chironomus/Einfeldia*, e.g. *C./E.* with mentum types one and two. However, taxa with optimum HOF model types IV and V are *Acricotopus longipalpus* type and *Paratanytarsus penicillatus* type for group four and *Paratanytarsus* sp. with *C./E.* men3 for group five. Group six with 15 taxa is characterised by HOF model types having an optimum curve which is the case for taxa *C./E.* men1 man2 and *Cricotopus sylvestris* gr. indet 1. Finally the last two groups include taxa with low counted head capsules. Only *Sergentia* with *S. longiventris* type is an abundant taxon in the last group.

3.6.2.2. Coinciding patterns within cluster's groups

Regarding all environmental variables it was tried to test cluster analysis also for having possibly coinciding groups across grouping of environmental variables (Fig. 3.15–3.17)

For electrical conductivity (Fig. 3.15) all suboptimal groups without the group of lowest EC data values, i.e. group two up to five with more than about 0.2 mS · cm^{-1}, cluster together with the first group of shallower sampling depths (0.05–7.21 m). And most of these taxa also coincide together with taxa of higher pH values which ranged from 8.7 to 10.6 (Tab. 3.11). Instead taxa of group one with lowest EC values show some coinciding tendencies with groups of other environmental variables (Tab. 3.12). Group one with lowest EC is coinciding more or less with variables that correspond to groups with higher values of depth$_{samples}$, T$_{Oct}$ and T$_{Jul}$, middle values of water area$_{log 10}$ and finally with grouped pH data having lowest values.

Tab. 3.11.: Groups of EC (two up to five) coinciding with other grouped environmental variables

low to highest conductivity	data values of Depth$_{samples}$ (m)	data values of pH
▲	0.05	8.7
	low/shallow	middle to highest
	7.21	10.6

Tab. 3.12.: Group of lowest EC values coinciding with other groups of environmental variables

lowest conductivity	groups in clustering with values: high, highest			middle	low lowest
▼	36.7	9.2	17.4	$10^{7.7}$	8.6
	Depth samples	T$_{Oct}$	T$_{Jul}$	water area	pH
	8.8	3.4	13.0	$10^{5.2}$	7.1

Sampling depth (Fig. 3.16) is related to groups of variables EC$_{log 10}$, water area$_{log 10}$, T$_{Oct}$, T$_{Jul}$ and pH as described correlations above. Coinciding patterns with precipitation data are not clear.

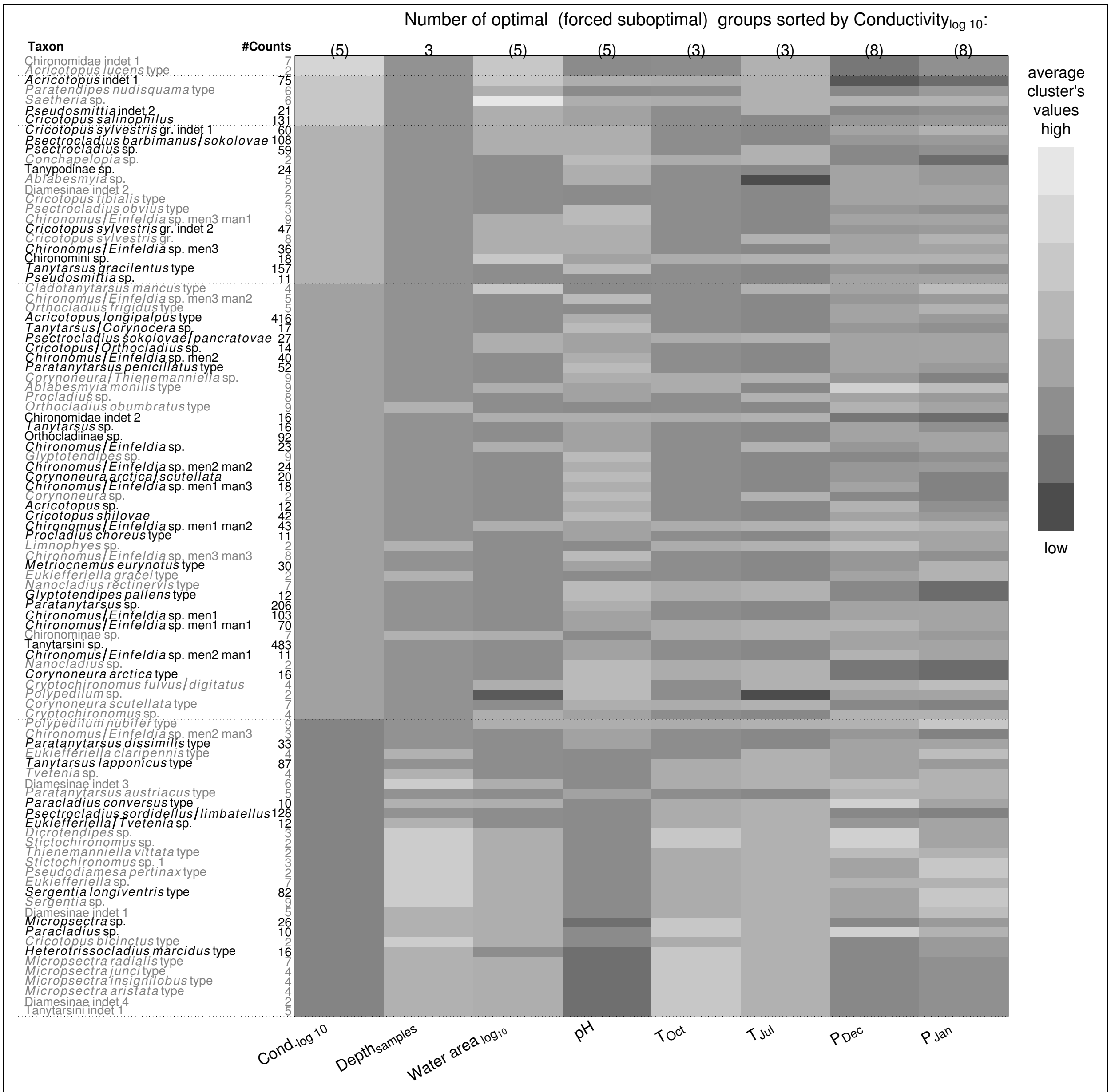


Fig. 3.15.: Results of cluster analysis from scaled and weighted average data values and sorted by conductivity. Number of forced, i.e. suboptimal groups is given in parenthesis.

Temperature data (Fig. 3.17) with variables T_{Oct} and T_{Jul} show similar band patterns but comparing grouped taxa in both temperature data sets they show some displacements. Beside described correlations above only group three with highest October mean air temperature data values (7.2–9.2 °C) has no coinciding pattern with mean July air temperature. All 2 remaining suboptimal groups for T_{Oct} have a similar equivalence in variable T_{Jul}.

Both precipitation data sets of December and January show no clear coinciding band pattern compared to any measured variable but only displaced or shifted relationships that dominate their group comparison. Their band pattern looks comparably, but slightly different grey colours of grouped taxa indicate placements not in the same groups.

3.6.3. Ordination—NMDS

As Nonmetric Multidimensional Scaling is regarded as one of the most robust ordination techniques (Minchin 1987) and not dependent on Euclidean distance measure as in CCA, the Kruskal's NMDS was used to summarise all relationships among taxa. With significant environmental constraints of CCA it was summarised on the one hand (Fig. 3.18, 3.19) and with groups of cluster analysis for each environmen-

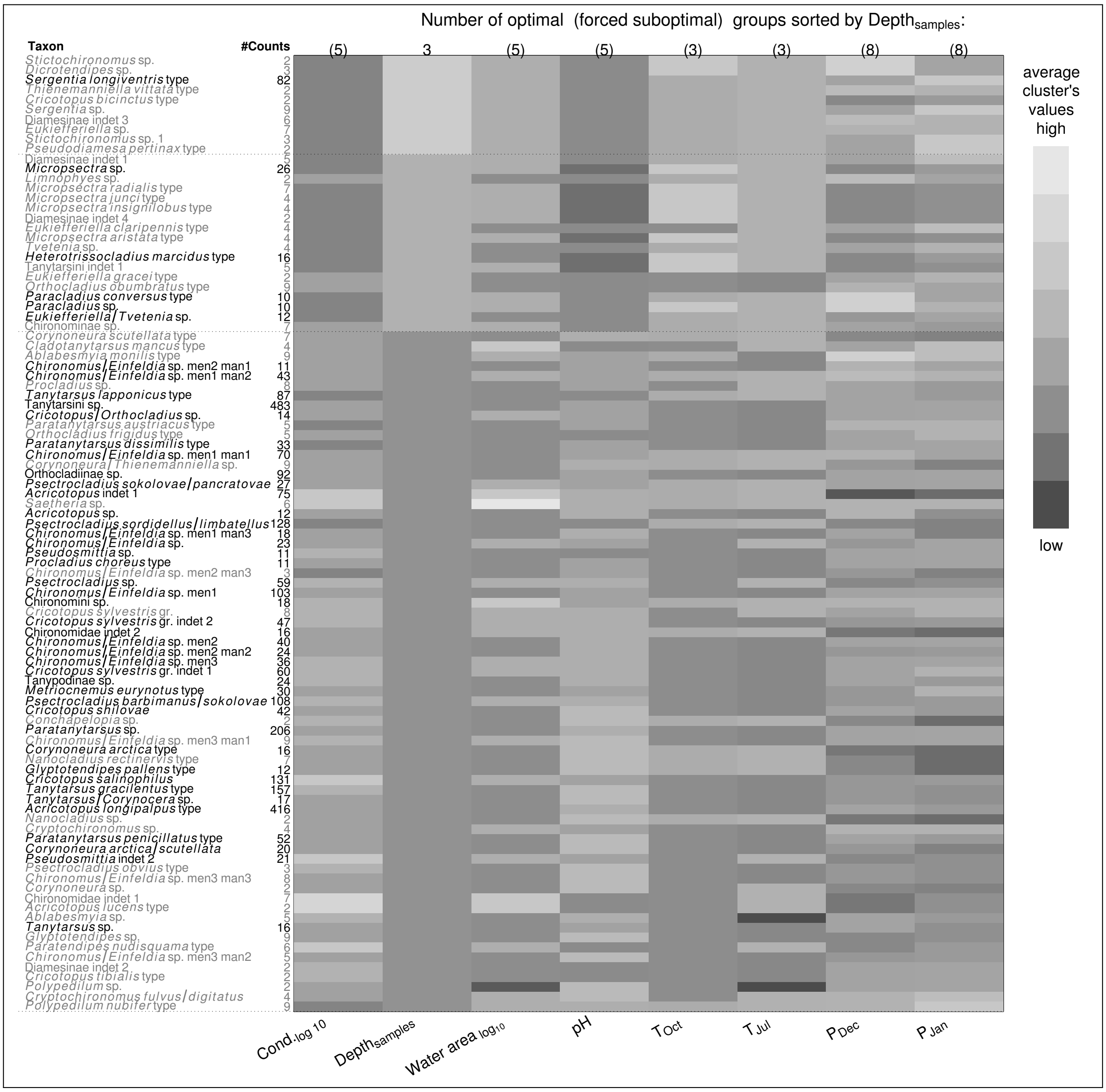


Fig. 3.16.: Results of cluster analysis of scaled and weighted average data values and sorted by sampling depth. Number of forced, i.e. suboptimal groups is given in parenthesis.

tal variable on the other (Fig. A.1–A.8). An optimal NMDS configuration was obtained after 100 calculations and each one with 100 random starts and resulted in a lowest stress value of 25.098 with the distance measure after Raup and Crick (1979).

In general from all six or seven constraints obtained from CCA, four variables fit directly as more or less visible gradients within the 2-dimensional ordination space. These are pH, EC, sampling depth and both temperature data sets. Thereby sampling depth and temperature of October and July are inverse correlated to pH (Fig. 3.18, 3.19):

$$|\,\mathrm{depth}_{\mathrm{samples}}\,| \sim \frac{1}{\mathrm{pH}}$$

$$\mathrm{T}_{\mathrm{Oct/Jul}} \sim \frac{1}{\mathrm{pH}} \text{ and therefore}$$

$$\mathrm{T}_{\mathrm{Oct/Jul}} \sim |\,\mathrm{depth}_{\mathrm{samples}}\,|$$

All these environmental variables show also a statistically significant relation in the two dimensional NMDS configuration. Whereas other variables, i.e. precipitation of December and January, water area and EC, show more complex patterns within the NMDS configuration on the one hand and sites' val-

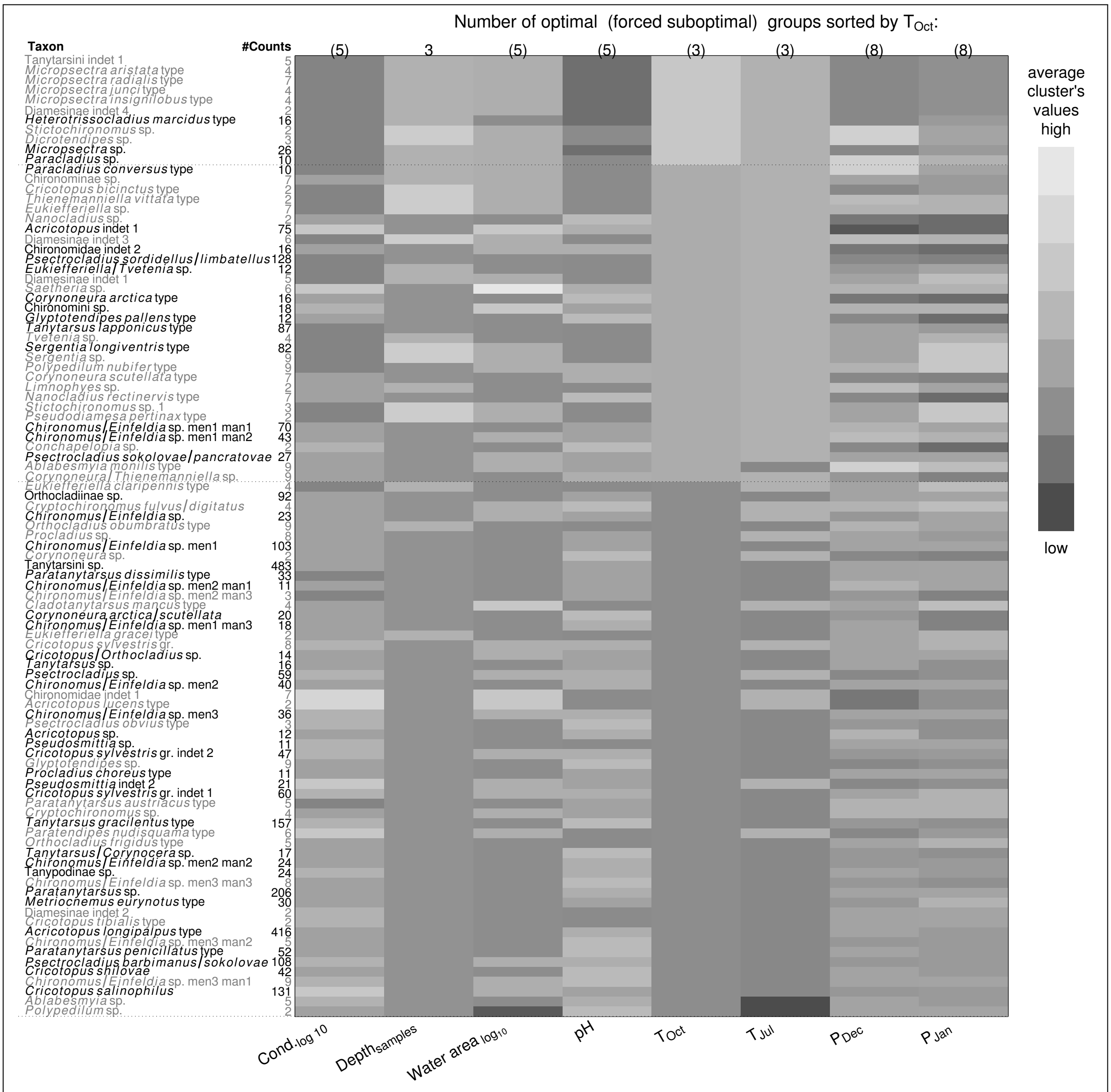


Fig. 3.17.: Results of cluster analysis of scaled and weighted average data values and sorted by mean October air temperature. Number of forced, i.e. suboptimal groups is given in parenthesis.

ues with linear interpolated environmental variables on the other (Fig. A.7, A.8).

Regarding taxa's allocation within the ordination space there seem two main patches: one patch at mean values in the ordination space, i.e. in the middle of NMDS configuration with shallow depths, and the other one spreads at deeper sampling sites also with low values of EC.

Electrical conductivity (Fig. A.1): among the five suboptimal groups most of them plot slightly next to each other and some patterns regarding taxa's data ranges or ecological valences are detectable. The first group with lowest weighted average data values plots as a distinct group and all including taxa have also small data ranges except the taxon *Tanytarsus lapponicus* type. Looking at higher EC values, in the next three groups, there are at least some taxa included having wider EC data ranges.

Within the second group taxa with wide data ranges are fore instance *Metriocnemus eurynotus* type, *Chironomus/Einfeldia* sp. men1 man1 and some taxa groups on a low determination level such as subfamilies Orthocladiinae, Chironominae, *Tanytarsus* sp. or *Corynoneura/Thienemanniella* sp.

The third group includes taxa with moderate data ranges of EC except for *Cricotopus sylvestris*

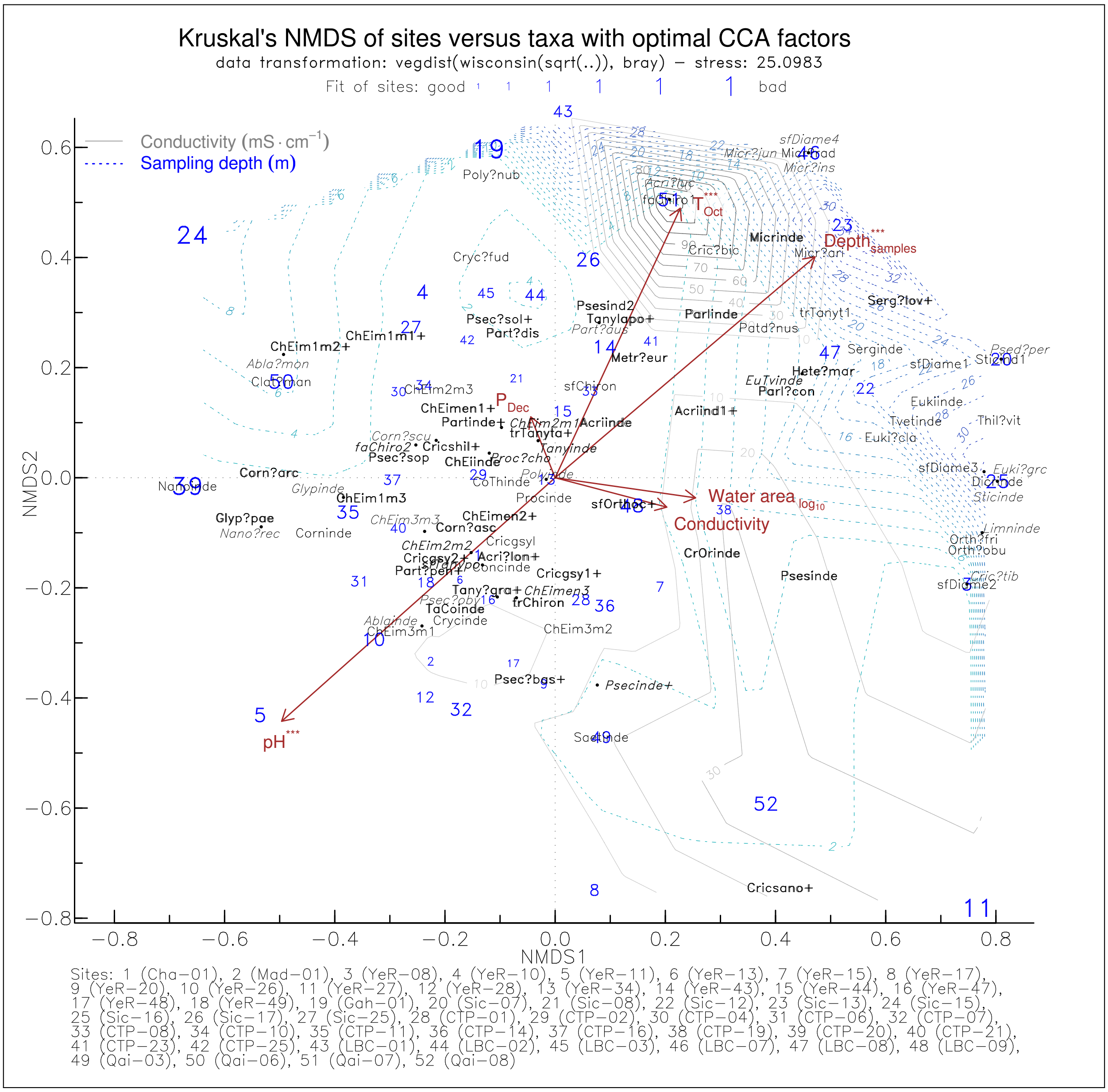


Fig. 3.18.: NMDS of taxa versus sites (blue) with significant environmental factors from optimal CCA model (sampling depth, electrical conductivity, pH value, mean precipitation of December and water area$_{\log 10}$). Arrows indicate factors' tendencies additionally given with significance codes for the tendency according to p–values: $\leqslant 0.001$ ***, $\leqslant 0.01$ **, $\leqslant 0.05$ *. Calculation of isolines for conductivity and sampling depth was done using gridded bivariate interpolation for irregular data from site's values with `interp.old{akima}`. As conductivity is only fitted onto NMDS ordination and to see better biotic–abiotic relationships, measured conductivity values were used instead of log$_{10}$–values (abbreviations see on pages VI–VIII; italic names like *Corn?scu* · are placed by an offset next to their x-y score point; **bold** names indicate a number of head capsules with n $\geqslant$ 10, **bold+** indicates n $\geqslant$ 40; 1 unit = 0.5 distance after Raup and Crick (1979)).

indet 1 with wide ones.

The fourth group with high data values includes also taxa with wider data ranges such as *Pseudosmittia* indet 2, *Paratanytarsus nudisquama* type and *Acricotopus* indet 1.

Finally, the last group with highest data values and only the 2 taxa Chironomidae indet 1 and *Acricotopus lucens* type indicate highest salinity conditions and where only found in sample 51 (Qai-07, lake Xiaochai Damuhu).

Sampling depth (Fig. A.2): Taxa's separation along sampling depth is as well distinctive as for

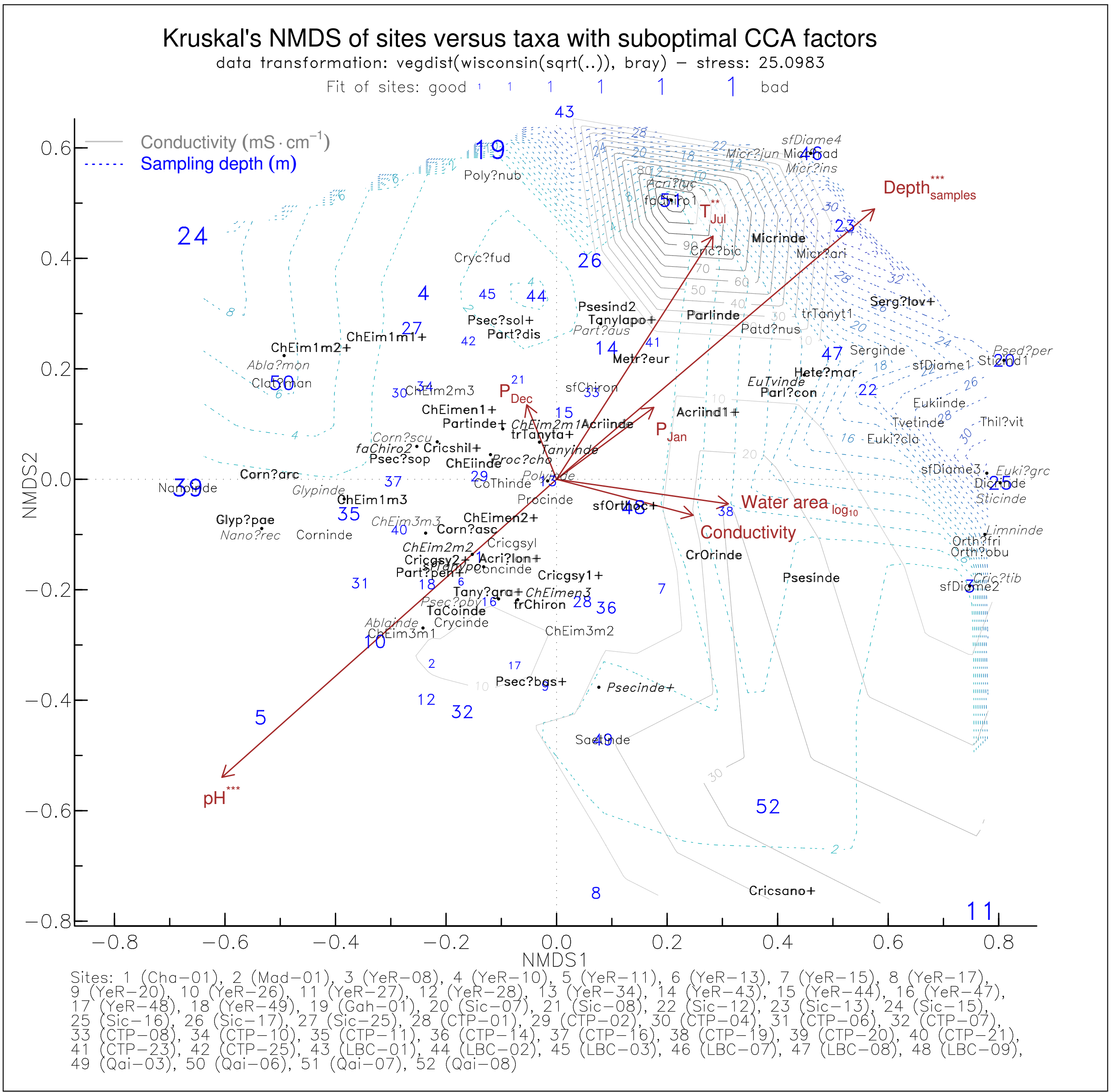


Fig. 3.19.: NMDS of taxa versus sites (blue) with significant environmental factors from CCA but enforced with mean July air temperature. Remaining factors are: sampling depth, electrical conductivity, pH value, mean precipitation of December and January and water area$_{\log 10}$. Arrows indicate factors' tendencies additionally given with significance codes for the tendency according to p–values: $\leqslant 0.001$ ***, $\leqslant 0.01$ **, $\leqslant 0.05$ *. Calculation of isolines for conductivity and sampling depth was done using gridded bivariate interpolation for irregular data from site's values with `interp.old{akima}`. As conductivity is only fitted onto NMDS configuration and to see better biotic–abiotic relationships, measured conductivity values were used instead of $\log_{10}$–values (abbreviations see on pages VI–VIII; italic names like *Corn?scu* · are placed by an offset next to their x-y score point and **bold** names indicate a number of head capsules with n $\geqslant$ 10, **bold+** indicates n $\geqslant$ 40; 1 unit = 0.5 distance after Raup and Crick (1979)).

electrical conductivity with some overlappings. All groups have taxa included with every kind of data range, i.e. with no range of sampling depth up to wide data ranges. For the second group within a weighted average data range of about 8.8 to 22.0 m the taxonomic group Chironominae plot as distinct outlier. All specimens pooled into this non-determinable group indicates that Chironominae's position in ordination space seems not predominated by sampling depth, but by other factors.

pH values (Fig. A.3): clustered taxa regarding weighted average pH values with their five suboptimal groups overlap each other and a gradient can be traced which is indicated also in Figures 3.18 and 3.19. The groups with lower pH values of 7.10 to 7.59 and 7.87 to 8.56 seem to be predominated by taxa having small pH ranges and correspond also with deeper sampling depths. All three remaining groups have mixed compositions regarding pH values. It is also remarkable, that taxa with wider ranges spread out in the middle of NMDS' configuration at average ordination values.

Water area is not plotting as a clear visible gradient (Fig. A.4). Its pattern is more complex, but nevertheless at mean values in the ordination space, i.e. around plot's point of origin, there seem to spread taxa which occur in lakes with lower values of water surfaces. Whereas surrounding these mean ordination values, in marginal regions, there plot sites and taxa having middle and highest data values of water surfaces.

Mean October air temperature data calculated for sites plots as a visible gradient that is also correlated with sampling depth (Fig. 3.18, A.5). This temperature gradient in ordination space is also indicated by the factor-arrow of CCA constraint in Figure 3.18 which is a statistical significant tendency in the two dimensional ordination space. Despite this gradient taxa with smaller temperature ranges plot marginally whereas at average values within the ordination space plot more eurytherm taxa having wider October air temperature ranges. These are for instance taxa belonging to the genera group *Chironomus/Einfeldia*.

Mean July air temperature patterns of sample sites are similar to mean October air temperatures (Fig. A.6) and its tendency calculated from sites in the ordination space is at a statistically significant level as well as for October's air temperature (Fig. 3.19). Associations are similar regarding taxa with wide temperature ranges at average conditions in ordination space and taxa with low temperature ranges at deeper sampling sites in marginal regions of NMDS configuration. Like for October's air temperature, the clustered groups are separated less good.

Mean precipitation of December clusters indifferently in the ordination space and shows a more complex pattern with its eight suboptimal groups because the groups overlap each other notably (Fig. A.7). Group eight with highest precipitation values corresponds to group two for an optimal clustering and all other suboptimal groups correspond to group one for an optimal clustering. Furthermore the short factor-arrow in Figure 3.18 is not statistically significant in the two dimensional NMDS ordination space.

Precipitation of January is similar to December regarding complex site patterns but is resulting in different groups. Generally all subgroups show no specific allocation patterns within ordination's space.

4. Discussion

Analysis of all available environmental variables by CCA revealed an obvious gradient of electrical conductivity ($EC_{\log 10}$) and therefore also salinity within all 52 lakes from the Tibetan Plateau. This gradient was used to develop numerous transfer models for providing tools to reconstruct palaeoenvironmental conditions. Furthermore it was tried to test for other environmental gradients detected by CCA, but sampling depth, as the second important factor in CCA, resulted in too weak transfer models with a high root mean square error of prediction (RMSEP) of ± 7.2 m in a best WAPLS–1 model. Therefore all following transfer models are discussed more in detail for the only suitable variable $EC_{\log 10}$.

4.1. Transfer models

Comparing objectively all methods, the calculated rankindex based on summarised error values is useful (Fig. 3.9, p. 29), but both results from apparent and LOOCV models must be taken into account for a suitable decision of a good transfer model. The following order tries to summarise model types based only on rank index:

apparent: WAPLS–5 $>$ $ANN_{neu=4}$–0.1/0.01 $>$ PLS–5 $\gtrapprox$ Bayesian $>$ $WA_{cla+tol}$ $>$ $WA_{inv+tol}$ $>$ ML $>$ W/MAT

LOOCV: $ANN_{neu=...}$ – 0.1/0.01 $>$ Bayesian $>$ WA_{cla} $>$ WA_{inv} $\gtrapprox$ WAPLS–3 $>$ PLS–5 $>$ $W/MAT_{k=3}$ $>$ $WA_{.../tol}$ $>$ $ANN_{neu=...}$ – 0.001

Beside this rankindex, the linear least squares error slope parameter (LLSESP) from a linear regression line in residual plots can be considered as a more important error value beside all other ones because it detects whether a model is balanced or not. Therefore it illustrates over- or underestimation at margins of the EC gradient. In almost all models an overestimation of lower values and underestimation of higher ones can be observed (Fig. 3.8, p. 28) which is described also as the edge effect (Frey and Deevey 1998). The only well balanced model for the apparent and LOOCV models is the Bayesian model which is followed by WA_{cla}, $ANN_{neu=4}$ – 0.1 and WAPLS–3. However, most unbalanced models are the $ANN_{neu=...}$ – 0.001 models with a learning rate of 0.001, the W/MAT models and PLS–1.

4.1.1. Maximum likelihood (ML)

Beginning with poor fitting models to well fitting models the ML approach fits very poor as it shows two distinct ML-specific outliers of four outliers all together. These two outliers have a model aberration about three scales, i.e. $10^3\,\mathrm{mS \cdot cm^{-1}}$ which are samples Sic–07 and Sic–13 with very low measured EC values and dominated by *Sergentia longiventris* type (Fig. 3.2, p. 21). Removing these samples from model calculation excludes the two taxa *Pseudodiamesa pertinax* type and *Stictochironomus* sp. 1 with very low counted head capsules. Removing all four outliers rules out four additional taxa: *Cricotopus tibialis* type, Diamesinae indet 2, *Eukiefferiella gracei* type and *Orthocladius frigidus* type and yields a well inferring model (* in Table 4.1). Being adjusted this corrected model performs similarly to well fitting models like Bayesian, ANN, WAPLS–3 or PLS–5 and it is then also a well balanced model with a lower absolute LLSESP (Tab. 4.1). These

Tab. 4.1.: Comparison of ML models with and excluding outliers* (ML-specific sample outliers: Sic–07, Sic–13 and sample outliers occurring also in W/MAT models: YeR–08, YeR–20). Boxes indicate values.

	ML	ML*	ML_{LOOCV}	ML^{*}_{LOOCV}
r^2	0.617	0.924	0.388	0.688
RMSE(P)	0.694	0.294	0.842	0.567
$Bias_{avg}$	0.150	−0.023	0.094	−0.109
$Bias_{max}$	−0.849	−0.251	−2.527	−2.524
LLSESP	0.133	−0.037	0.390	0.225

ML-specific outliers are difficult to interpret. Both distinct outlier samples are dominated by the abundant taxon *Sergentia longiventris* type but other samples are composed similarly which have also a low Rényi_∞ diversity and do not appear as sample-outliers (Fig. 3.2, p. 21). In contrast outliers three and four, YeR–08 and YeR–20, are composed more diverse with EC values of 2.27 and $0.65\,\mathrm{mS \cdot cm^{-1}}$, whereat YeR–20 is the most diverse sample with highest Rényi_∞ diversity. Both are also outliers in MAT models.

Compared to related literature data ML models perform generally well (Zhang et al. 2007; Eggermont et al. 2006, Tab. A.13, p. 150) with r^2_{LOOCV} of 0.8 and RMSEP of 0.30–0.37 but show also a slight under- or overestimation at marginal values of either a salinity or conductivity gradient.

4.1.2. Modern analogue technique (MAT)

Best results were obtained with the dissimilarity measure of Bray and Curtis (1957) whereas the popular squared Chord distance results generally in slight weaker correlation values of r^2. A suitable decision of k results in three or six modern analogues for both model variants. For $k = 3$ and $k = 6$ results are similar compared to each other but the models have a lower r^2 in the unweighted model variant of $0.625_{k=3}$ and $0.646_{k=6}$ compared to the weighted model with r^2 of $0.635_{k=3}$ and $0.664_{k=6}$.

In general the weighted version fits better than the unweighted one but both tend to be strongly unbalanced for all numbers of k modern analogues whereat the absolute LLSESP rises by including more analogues into the model. With six or three modern analogues LLSESP varies between 0.447 and 0.567 (Fig. 3.8 a, p. 28) and among all transfer models these are the highest LLSESP. Therefore MAT models underestimate high measured values and overestimate lower ones. This tendency can be detected also by other published models for chironomids (Zhang et al. 2007; Eggermont et al. 2006).

MAT models in this study show the highest number of outliers, which vary between three and four for $k = 3$ and with seven for $k = 6$. MAT-specific outliers (Mad–01, Qai–07, YeR–27, CTP–14) are samples with high $\text{conductivity}_{\log 10}$ values of 5.8 to $130\,\text{mS} \cdot \text{cm}^{-1}$ and are difficult to interpret. Hereby outliers YeR–27 and CTP–14 are dominated by one taxon which are *Cricotopus salinophilus* and *Tanytarsus gracilentus* type respectively. All other outliers are more divers. Finally, a further sample outlier YeR–48 occurs also in two other transfer models (WA, $\text{ANN}_{\text{neu}=3} - 0.1$). This sample was assigned to a mean Rényi_∞ diversity and has a dominant taxon: *Acricotopus longipalpus* type (Fig. 3.2, p. 21).

4.1.3. Weighted averaging (WA)

Results of weighted averaging show wide variations whereat classical models fit better then inverse WA models if no outliers are taken into account. Calculation with tolerance downweighting seems to improve the apparent models in Figure 3.7 on page 27, but for the LOOCV procedure the models without tolerance downweighting are better. Regarding possible outliers WA_{cla} has three: two less diverse samples (YeR–17, CTP–19) and a more diverse one (YeR–48) with a mean diversity within all Rényi_∞ values. In contrast WA_{inv} reveals only one outlier (YeR–48) near the lower bound of $\text{EC}_{\log 10}$'s standard deviation (Fig. 3.8, p. 28).

A general improvement by tolerance downweighting seems not the case. It seems to be confirmed by results of a chironomid water surface–temperature transfer model by Walker et al. (1997) whereas the chironomid–salinity model by Zhang et al. (2007) or the diatom–pH transfer model by Marchetto (1994) yield reversed results and models without tolerance downweighting are better. In addition an improvement depends also on the kind of species data transformation. The chironomid–salinity model by Heinrichs et al. (2001) shows that non transformed species data are improved by tolerance downweighting whereas a square root transformation lets worsen performances of tolerance downweighted models. The same variants can be observed for inverse and classical deshrinking.

4.1.4. Partial least squares (PLS)

As this technique accumulates taxon-site variances to independent hypothetical components it yields better fits if more components are added. Actually for apparent and LOOCV models a five component model (PLS–5) shows best results having also lowest error values. In general this method fits well as it has also no outliers but shows tendencies to underestimate high EC values and overestimate lower ones. This tendency occurs also in two other published transfer models for salinity and conductivity by Zhang et al. (2007) and Eggermont et al. (2006).

4.1.5. Weighted averaging partial least squares (WAPLS)

Similar to PLS the best apparent model has five components whereas LOOCV reveals a WAPLS–3 model being the best one. Summarising LOOCV and apparent results, a three component model seems a compromise because components three to four are composed similarly in the apparent models whereas the three component LOOCV model has lowest error values and WAPLS–5 is then overfitted with a lower RMSE but an increased RMSEP. This method shows also no outliers beyond the interval of $\text{EC}_{\log 10}$'s standard deviation and fits well. It shows only slightly under- and overestimation in the apparent model and higher ones after LOOCV is done as the LLSESP indicates. Other published transfer models show a similar under- and overestimation at margins of environmental gradients (Zhang et al. 2007; Eggermont et al. 2006; ter Braak and Juggins 1993)

4.1.6. Artificial neural network (ANN)

A wide range of well and poor fitting model results is covered by ANN models that depends on different model settings. Considering the number of hidden neurons three or four reveal good fits whereas two hidden neurons yield generally weaker results. Very low learning rates (e.g. 0.001) and high ones (e.g. 1.0) cause poorer fits as well but a learning rate about 0.01 results in well fitting models.

Showing no sample outliers the best models are almost all $ANN_{neu=...} - 0.1/0.01$ except $ANN_{neu=3} - 0.1$ with two outliers (YeR–17, YeR–48).

Regarding the indicated under- and overestimation of inferred values by LLSESP results are similar to WAPLS: slightly apparent aberrations and higher aberrations shown by LOOCV. Compared to literature this tendency occurs also for instance in a diatom-based pH transfer model by Racca et al. (2001).

Altogether this method fits very well, when optimal learning rate and optimal number of hidden neurons are applied in calculating ANN transfer models.

4.1.7. Bayesian models

Among all transfer models the Bayesian model is balanced very well even when LOOCV is applied. Although the model fits well there appears a sample outlier next to the upper bound of EC's standard deviation: sample LBC–09 with a low measured conductivity value of $0.07\,\mathrm{mS}\cdot\mathrm{cm}^{-1}$ and the highest amount of undefined Tanytarsini. However, this outlier is specific to the Bayesian model and difficult to classify as it does not appear in other transfer models.

All in all the Bayesian approach yields one of the best balanced transfer models as it calculates high correlation values for the apparent model on the one hand and on the other it has comparatively low error values and a very low value for LLSESP. Therefore inferring estimations from measured conductivity values with the Bayesian approach yields good suitable results. In literature this model reveals also very low LLSESP values with for instance 0.0035 (Holden et al. 2008) because this approach enables to tune the model by suitable settings of species response curve variables (Tab. 2.1, p. 17). This is not possible by all the other model types except for the ANN model approach. Nevertheless a drawback in this model type is setting up suitable parameters to let calculate good SRC and tune the model, because it is timeconsuming and depends also on variable's data range.

Summarising all models regarding the calculated rank index and a well balanced inferring based on apparent and LOOCV model parameters, a corrected ranking can be stated as follows:
Bayes $\approx$ $ANN_{neu=3/4} - 0.1/0.01$ $\approx$ WAPLS–3 $>$ PLS–5 $\gtrapprox$ $WA_{cla+inv}$ $\gtrapprox$ $WA_{...tol}$ $>$ W/MAT $>$ ML.

4.1.8. Transfer models in literature

Compared to literature data related to conductivity or salinity transfer models there are a number of well performing models (Tab. A.13, p. 150): ML, WAPLS followed by WA models (Zhang et al. 2007; Eggermont et al. 2006; Yang et al. 2003; Walker et al. 1995). In this study these transfer functions perform well too except for ML–specific outliers. However, all models in this study show lower correlation values than other published transfer models related to salinity or conductivity for Chironomidae. Values of r^2_{LOOCV} are reduced for instance by about 0.100–0.150 among most model types like (WA)PLS and $WA_{inv/cla}$. Trying to improve therefore transfer models in this study by removing samples with higher aberrations indicated by LOOCV procedure yield correlation values of r^2_{LOOCV} reduced by only 0.050 with values around 0.750. But this removes from models the three taxa *Acricotopus* indet 1, *Acricotopus lucens* type and Chironomidae indet 1 which are all found in most saline lakes. Improving hence performances of transfer models in this way might be appropriate when reconstructed conductivity values are lower than in the whole training data set or when ruled out taxa do not occur in sediment cores. Then accuracy of transfer models can be improved by calculating without the most saline samples (YeR–48, CTP–19, Qai–07). However, on the other hand apparent models like WAPLS, PLS and most ANN show no outliers beyond the interval of $EC_{\log 10}$'s standard deviation. A simple exclusion was therefore considered as not being worthwhile.

Another possibility to enhance transfer models remains to improve the resolution of EC's gradient in the upper range beyond about $3{,}000\,\mu\mathrm{S}\cdot\mathrm{cm}^{-1}$ by including additional samples. Furthermore increasing the number of counted head capsules should also enhance model's performances. In this study the minimum count of head capsules was 50 which is stated being the lowermost bound by Larocque (2001, at least 50) or Quinlan and Smol (2001, 40 to 50). Beside this minimum count Heiri and Lotter (2001) have pointed out that the RMSE can be reduced furthermore when counted head capsules reach about 100 and thus results are more precise. An increase of head capsules should then also affect and enhance results for HOF gradient analysis revealing more model types showing optimum curves. By improving transfer models' results it is also crucial if samples are taken from littoral or profundal regions. For instance to develop transfer models for inferring sampling depth models can be improved by sample an onshore-offshore gradient (Eggermont et al. 2007) and more samples are needed from multiple, within-lake sampling sites to improve performances of statistics (Kurek and Cwynar 2009).

4.1.8.1. Chironomid conductivity or salinity transfer models

As shown before there exist other transfer models for conductivity or salinity which were publish by Zhang et al. (2007) for the Tibetan Plateau, Eggermont et al. (2006) for Africa and Heinrichs et al. (2001) and Walker et al. (1995) for Canada. Especially the transfer model by Zhang et al. (2007) was tried to compare more closely in Table A.14 on page 153.

As taxonomic determination of chironomids is generally difficult by ending often at genus level, it is complicate to compare results of Zhang et al. (2007) as it means to adjust 23 taxa to 97 taxa from this study and resolve taxonomic differences. Zhang et al. (2007) don't report higher taxonomic groups like indeterminable Tanytarsina, Chironomini or even common taxa like *Chironomus plumosus* type and therefore a comparison is rather difficult for calculated weighted average conductivity values. This issue is further complicated by the other fact of different sampling sites. In Zhang et al. (2007) all samples are taken along a geographical gradient from NE to SW, whereas samples in this study cover a triangular area within almost the same geographical region spanning from N to SE and SW (Fig. 2.1, p. 7). Additionally the analysed conductivity gradient is not the same: 0.40 to 94.31 $\mathrm{mS \cdot cm^{-1}}$ by Zhang et al. (2007) vs. 0.015 to 130.3 $\mathrm{mS \cdot cm^{-1}}$ in this study. Nevertheless a comparison was tried in Tables A.14 and A.15 by estimating TDS values from measured salinity using the following formula without intercept:

$$\text{TDS} = 0.6735395 \cdot \text{conductivity} \qquad (4.1)$$

with $r^2_{\text{adj}} = 0.996$. This comparison shows a sparse conformity to Zhang et al. (2007) for more or less 6 of 23 taxa reported in Zhang et al. (2007). In decreasing order of conformity they can be listed with their percent-difference as follows:
Cladotanytarsus mancus type (2.1 %), *Cricotopus sylvestris* gr. indet 2 (2.5 %) and with a percent-aberration below 50 there are taxa *Cricotopus shilovae* (−25.8 %), all *Ablabesmyia* taxa (33.7 %), *Cricotopus sylvestris* gr. (34.3 %) and all *Paratanytarsus* taxa (−49.88 %). Hereby corresponds *Cricotopus shilovae* to *Euryhapsis* sp., and *Tanytarsus gracilentus* type together with *Tanytarsus/Corynocera* sp. is suggested to correspond to Zhang et al. (2007) reported *Corynocera oliveri* type as its morphological characters are almost equal (see taxa list notes on page 143). The highest difference results in *Cricotopus sylvestris* gr. indet 1 (assumed 13,900 vs. 3,300 $\mathrm{mg \cdot l^{-1}}$ by Zhang et al. 2007) and *Tanytarsus* sp. (3,600 vs. 780 $\mathrm{mg \cdot l^{-1}}$). High differences occur also for *Psectrocladius sordidellus/limbatellus* that is calculated by Zhang et al. (2007) with about 10,000 $\mathrm{mg \cdot l^{-1}}$ but Vallenduuk et al. (1997) state it as being only occaisional present in oligohaline waters (300–3,000 $\mathrm{mg \cdot l^{-1}}$ chloride).

Most differences in TDS optima are high and estimated values in this study are lower than reported by Zhang et al. (2007). This indicates for the described EC gradient in this study to follow a left skewed curve or the gradients in both studies are skewed and need to be adjusted by adding more samples or it might be worthwhile fusing both data sets. The latter one was tried but didn't succeed as Dr. Zhang did not answer to my requests nor was the help by other scientific colleagues successful.

Comparing groups in this study and by Zhang et al. (2007) three groups were stated by Zhang et al. (2007): one group dominating at highest TDS values of $> 10,000\,\mathrm{mg \cdot l^{-1}}$, a second one between 3,000 and 10,000 $\mathrm{mg \cdot l^{-1}}$ and a third group in more freshwater lakes with TDS values $< 2,500\,\mathrm{mg \cdot l^{-1}}$. Following equation 4.1 for estimating salinity values, in this study groups separate similarly as Table 4.2 indicates. Boundaries of $\approx 3,000$ and $\approx 10,000\,\mathrm{mg \cdot l^{-1}}$ coincide approximately with this study. Although

Tab. 4.2.: Data ranges for estimated salinity based on groups of electrical conductivity (eq. 4.1, Tab. 3.5) with goodness of cluster's group (average silhouette width s_{ave})

group	$\mathrm{mg \cdot l^{-1}}$	goodness s_{ave}	n-taxa
1^{st}:	10 to 89	0.612	30
2^{nd}:	116 to 710	0.561	44
3^{rd}:	2,088 to 3,098	0.721	16
4^{th}:	9,699 to 42,298	0.560	5
5^{th}:	87,762	1.000	2

investigations by Eggermont et al. (2006) can hardly be compared taxonomically due to the different chironomid fauna in African lakes, they show a similar biologically important freshwater–saline transition between $\approx 1,000$ and $\approx 3,000\,\mathrm{mg \cdot l^{-1}}$. According to Hammer (1986) $3,000\,\mathrm{mg \cdot l^{-1}}$ distinguishes saline lakes more or less as a boundary and data from this study, by Zhang et al. (2007) and Eggermont et al. (2006) coincide with Hammer (1986). However, investigations by Walker et al. (1995) for Canada state four groups based on visual inspection of faunal composition without the boundary of $3,000\,\mathrm{mg \cdot l^{-1}}$ but similar ones compared to this study: < 110, $< 1,300$, $< 10,000$ and $< 400,000\,\mathrm{mg \cdot l^{-1}}$. Beside the different approach to group data visually on the one hand and mathematically in this study on the other some boundaries are traceable which are $\approx 3,000$ and $\approx 10,000\,\mathrm{mg \cdot l^{-1}}$.

Comparing results of these chironomid-salinity/conductivity transfer models it can be assumed that other climatic variables, such as temperature, become less important for chironomid comunities on the Tibetan Plateau. For instance in Zhang et al. (2007) temperature (T_{Jul}) was not significant in explaining chironomid distribution within CCA but sampling depth and pH values. This is similar to this study and in the African transfer model conductivity was the only factor explaining chironomids' distribution pattern.

4.1.8.2. Other taxonomic groups

Looking further to transfer models published for other taxonomic groups related to conductivity/salinity from the Tibetan Plateau, for ostracods Mischke et al. (2007) can be referred to and for diatoms Yang et al. (2003, 2004). Within nearly the same conductivity gradient the ostracod transfer model performs slightly better with r^2_{LOOCV} of 0.710 for a WAPLS–1 model compared to r^2_{LOOCV} of 0.679 and a WAPLS–3 model in this study. The diatom transfer model by Yang et al. (2003) has among all conductivity transfer models the highest correlation value r^2_{LOOCV} of 0.920 (WAPLS–2) and the lowest RMSEP of 0.220 reported for a data range of $0.119–116.5\,\mathrm{mS \cdot cm^{-1}}$ (Tab. A.13). Diatoms are therefore more exact salinity indicators as also stated by Walker et al. (1995) in reconstructing lake conditions and can give more accurate results than the ostracod or the chironomid transfer models. But the latter models can be useful where diatoms are not preserved abundantly or additional verification and tests are required in reconstructing past conditions. Furthermore there exist also transfer models attained from pollen and spores to reconstruct climate variables such as temperature and precipitation (e.g. Herzschuh et al. 2009; Zhu et al. 2008; Li et al. 2007). For these transfer models annual precipitation yields highest correlation values followed by T_{Jul} whereat these models seem to be restricted to atmospheric variables such as precipitation and temperature. As preserved pollen in lake sediments cover a more or less wide catchment area this approach has of course an advantage for climate reconstructions, whereas the fossil limnic organisms represent lake's history more locally. In concert of all preserved organic fossils, past conditions can be reconstructed appropriately as each taxonomic group has its strengths and weaknesses.

4.1.8.3. Choice of transfer models: general aspects

Among different model types used in literature and available by computer software, the WAPLS is in most cases the model of choice. But this model—likewise (W)MAT, PLS and ML—calculates often a slight over-/underestimation of low/high inferred values as for instance also in Eggermont et al. (2006), Mischke et al. (2007), Zhang et al. (2007) and probably this issue is accumulating in (W)MAT models. The only model that seems to handle this is the Bayesian model approach by Holden et al. (2008). Generally it gives comparable results to established model types as (WA)PLS, ML, WA and it has also been shown that a Bayesian approach reduces bias and increases slightly the predictive power of inferences (Holden et al. 2008; Vasko et al. 2000). This model approach is generally more balanced as the LLSESP indicates and has then also significant consequences, because extreme values are likely to be represented more accurately in reconstructed data (Vasko et al. 2000). Finding hereby appropriate model settings by an appending LOOCV procedure may be the only time consuming task.

Beside this recommended model approach, ANN models fit best excluding the problem of over-/underestimation. This best fit can be attributed to the model structure itself as a back-propagation model is able to learn any pattern perfectly (Malmgren and Nordlund 1997) but tends then to overfit. That is, while the model is trained with the data, RMSE and RMSEP are normally decreasing and from the point where the RMSE decreases and RMSEP increases, overfitting is generally indicated (Racca and Racca 2005; e.g. WAPLS–5 model in this study). This tendency is tried to eliminate in the program PaleoNet by stopping further learning processes beyond the described point of overfitting and thus only LOOCV procedures reveal appropriate ANN models. Testing ANN in future for reconstructions among different taxonomic groups will show whether attained model settings in this study can be considered as generally good settings, i.e. with learning rates 0.01/0.1 and a number of hidden neurons of three or four. By varying ANN models' settings it may be also possible to influence results of LLSESP, but it could not be tested in this study.

4.2. Environmental variables

4.2.1. Main factors: ordination—CCA

Main environmental factors that compose or can describe a taxonomic community are of basic interest in developing a suitable transfer model and it was shown that only electrical conductivity yields significant transfer models. However, beside EC other environmental variables influence also the chironomid community even though they are not convincing enough to establish transfer models. These were sampling depth, mean air temperature of October or July, pH value, water $\mathrm{area}_{\log 10}$ and mean precipitation of December or January more or less in descending order of their influence in chironomids' community.

In both calculated CCA models it was shown that the composition in ordination space on axes one and two is similar regarding the influence of constraints upon these axes (Tab. 3.1 b, p. 26). On the first axis in both models predominate environmental variables $EC_{\log 10}$, sampling depth and pH value. However, on axis two sampling depth and water area are dominating in both models. Therefore axis two describes rather lake morphology and axis one chemical conditions. Using the technique of CCA, plotted correlations of environmental variables give the main information which can be easily seen when two factor arrows point into the same direction or point to opposite directions. Hereby a correlation becomes less strong, when two factor arrows tend to be related orthographically to each other and it is zero when they are related exactly orthographically. Taking this into account there are some correlations among CCA's constraints—the deeper the sample in a lake, the lower was pH-value:

$$|\,\mathrm{depth}_{\mathrm{samples}}\,| \sim \frac{1}{\mathrm{pH}}$$

Similar but with less correlation: the deeper the sample, the lower was the measured electrical conductivity (Fig. 3.5, 3.6):

$$|\,\mathrm{depth}_{\mathrm{samples}}\,| \sim \frac{1}{\mathrm{EC}_{\log 10}} \quad \text{and therefore}$$
$$\mathrm{pH} \sim \mathrm{EC}_{\log 10}$$

Electrical conductivity is also inverse related to mean precipitation of December and January:

$$\mathrm{P}_{\mathrm{Dec}}, \mathrm{P}_{\mathrm{Jan}} \sim \frac{1}{\mathrm{EC}_{\log 10}}$$

As the latter two factors are correlated to axis one it is also possible to interpret axis one as pointing to dryness.

Differences occur in particular on axis three which points also to climatic parameters like CCA constraints precipitation and temperature beside the pH value. Despite differences on axes two and three (Fig. A.9–A.12) correlations along axis three spreads similar in both models with inverse proportionality for both temperatures:

$$\mathrm{P}_{\mathrm{Dec}} \sim \frac{1}{\mathrm{T}_{\mathrm{Oct}}}, \frac{1}{\mathrm{T}_{\mathrm{Jul}}}$$

The additional variable $\mathrm{P}_{\mathrm{Jan}}$ in the suboptimal model plots different and is scarcely correlated to water $\mathrm{area}_{\log 10}$ and $\mathrm{T}_{\mathrm{Jul}}$. Therefore including $\mathrm{P}_{\mathrm{Jan}}$ results in slightly other, but similar plots. $\mathrm{P}_{\mathrm{Jan}}$ is then of course the most different factor on axis three as it is also additional in the suboptimal model but $\mathrm{T}_{\mathrm{Jul}}$ seems to replace the position of $\mathrm{T}_{\mathrm{Oct}}$ in the optimal model.

The precipitation having lowest values was considered by CCA in both models as explaining variable among others but it is difficult to interpret its significance or biological aspects. However, relationships to other variables indicate that precipitation values may be interpreted as dryness, because the lowest precipitation of all months is observed in December, and also January shows the second lowest precipitation values. Furthermore there is a correlation between EC and January/December precipitation: the lower precipitation the higher are conductivity values. All in all these facts indicate dryness but the precipitation gradient is probably too short to indicate also moisture. Hereby the relationship to water area that might indicate involved evaporation processes is not clear. Using for instance Kendall's τ robust correlation coefficient to test this relationship, there is no significant correlation traceable of precipitation data and water area, but an inverse correlation of conductivity and precipitation throughout the year. Furthermore during the monsoon season a direct correlation of precipitation and temperature data is traceable which indicates possibly evaporation processes involved. Therefore these facts contribute to interpret precipitation data in CCA as dryness rather than moisture.

4.3. Chironomid taxa

4.3.1. Outline analysis

As Rohlf and Archie (1984) pointed out that outline analysis based on elliptic Fourier coefficients is the most generally useful and powerful method (Haines and Crampton 2000) that saves the investigator from having to worry about aligning the images in a standard fashion it was also used in this study to examine related taxa to *Psectrocladius barbimanus*. It was shown that tested specimens fit close to *P. barbimanus* type from Brooks et al. (2007). Nevertheless other described *P. barbimanus* taxa from Tang (2006) and Makarchenko and Makarchenko (1999) plot aside when arranged in a distance matrix based on Riemannian shape distance ρ. Some of the following detected influences in outline analysis may account for these facts. One of the most important fact is the resolution at outline edges in images. This was tried to eliminate by using at least 800 points during capturing the chain code. But even when the accuracy in capturing is eliminated the resolution of printed images and provided by the drawer or author still remains and influences also shape's accuracy of a described taxon. Images of Makarchenko and Makarchenko (1999) are less accurate then in Brooks et al. (2007) or Tang (2006). For this purpose Haines and Crampton (2000) describe a method for reducing noise in captured outlines and applying this technique to outline data of *Psectrocladius* results were almost equal, probably because the pixel noise

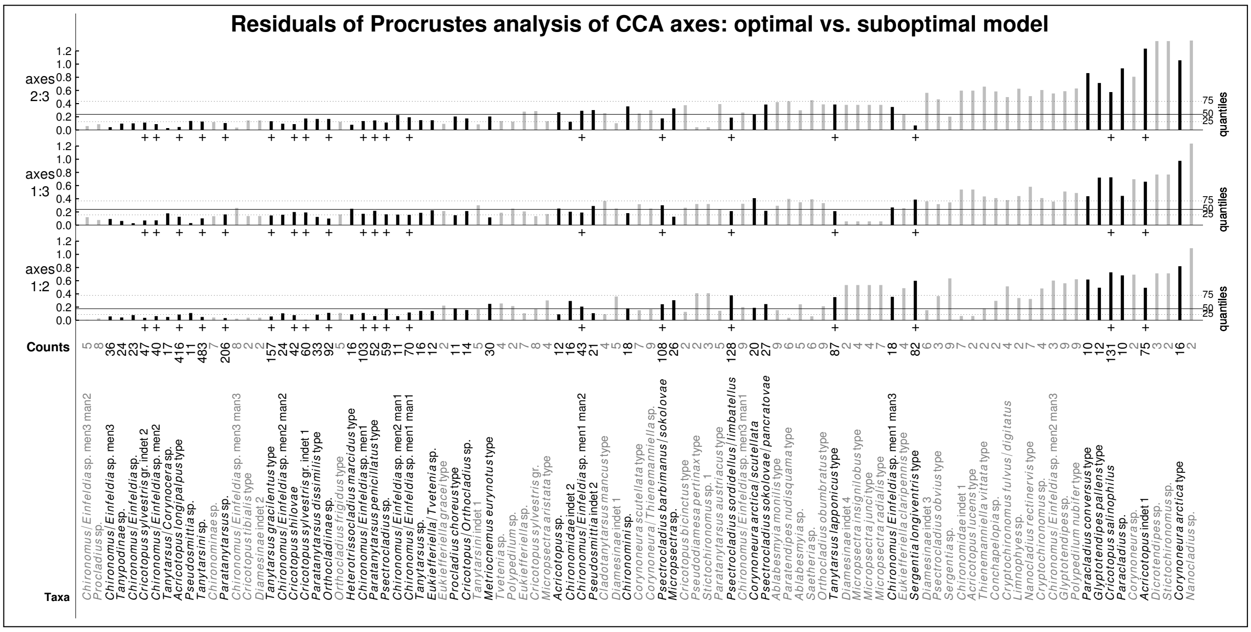


Fig. 4.1.: CCA models compared by Procladius analysis: Procrustes residuals shown for each taxon from optimal T_{Oct} and suboptimal T_{Jul} model. Grey bars and names indicate head capsule counts < 10 and + indicates counts ⩾ 40.

of captured outlines was manually smoothed using the graphic program GIMP. However, in general these smoothed outlines should be used and can be recommended as they are captured also faster than by a manual smoothing by hand.

As second important factor the 3D shape of menta was detected. That is, whether the mentum was actually flattened at the moment of drawing or not which results often in a reduced symmetry of menta when it was not flattened. In a first approach it was also tried to include the submental setation but it was inappropriate due to non-symmetry in many compared specimens because not all menta were completely flattened when illustrated.

Whether small differences between normalised and not normalised outline data are at a significant level could not be tested but it seems that normalised outlines provide a better separation.

Similar to Scott et al. (1985) it can be summarised that outline analysis on the one hand can support determination a lot because it is able to find similar specimens rather quickly and objectively. On the other hand it should be based on mean outline shapes of more than one specimen to eliminate slight different morphological variations for a described taxon. Determination based only on one particular feature of a specimen requires additional characteristics to find out to which taxon a specimen belongs to.

4.3.2. Ecological patterns

Uncovering main environmental factors raises also the question of capabilities in indication according to environmental conditions for a benthic chironomid community on the Tibetan Plateau. Calculated weighted average parameters for each taxon in the Appendix on pages 71–110 combined with cluster group analysis give detailed information. Another possibility is the comparison of both CCA ordinations by Procrustes analysis and it was shown that both models do not differ significantly. Nevertheless residuals from a CCA comparison might indicate slight preferences of taxa either for T_{Jul} or T_{Oct} as these variables separate both models. However, this seems not the case. Comparing both ordinations, taxa's residuals are small (Fig. 4.1) and therefore positions of taxa in ordination space are not strongly affected by calculating CCA models with T_{Jul} instead of T_{Oct}. Only a few taxa show changes by having high Procrustes residuals. Those affected taxa with higher abundances are *Cricotopus salinophilus* and *Acricotopus* indet 1, both group members of high conductivity and lower precipitation values which lets assume a relationship to dryness. Even when dryness might be indicated by these taxa temperature data show different ranges: *Acricotopus* indet 1 indicates warmer conditions (T_{Jul}: 13.0 to 17.4 °C, T_{Oct}: 7.2 to 9.2° C) whereas *Cricotopus salinophilus* indicates colder conditions (T_{Jul}: 9.7 to 12.7 °C, T_{Oct}: –2.5 to 3.1° C). Taxa of *Paracladius* show also high residuals and even a tendency to higher temperatures but in contrast to the previous two taxa it is not clustered into groups of low precipitations or higher electrical

(a) Rescaled values of January/December precipitation gradient

(b) Rescaled values of July/October air temperature gradient

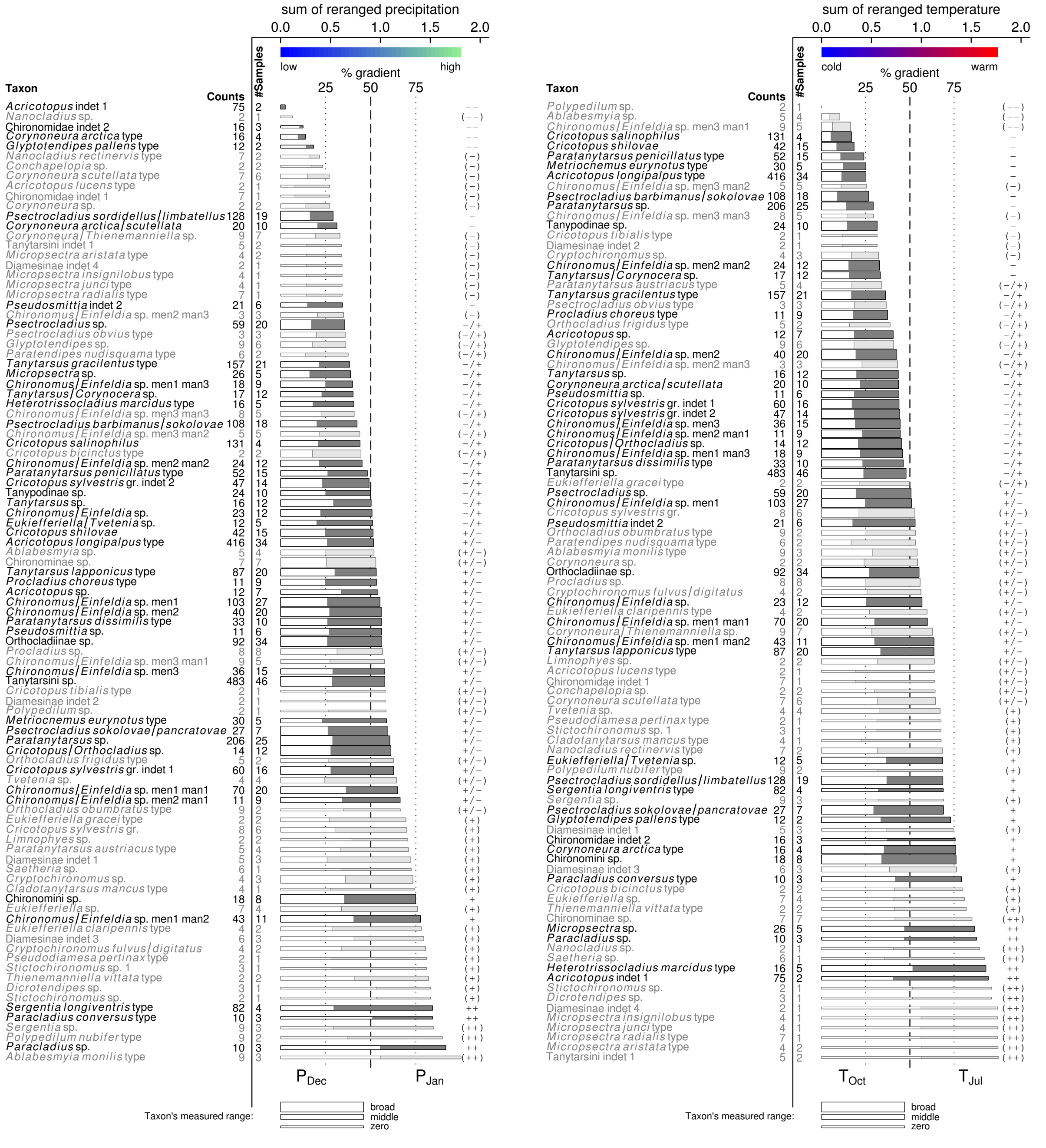
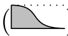
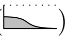


Fig. 4.2.: Taxa's affinities to environmental gradients based on rescaled weighted average values of associated measured precipitation and temperature data. Rescaling was done to the interval $[0, 1]$ for each variable separately and a categorised tendency for a taxon is given having seven possible levels from $--$ to $++$. Grey colours and tendency in parenthesis is indicating counting values below 10 head capsules. Data ranges are: T_{Jul} 7.63 to 17.93 °C, T_{Oct} −2.98 to 9.25 °C, P_{Dec} 0.20 to 4.13 mm and P_{Jan} 0.80 to 5.76 mm.

conductivities.

Further patterns were traced using HOF gradient analysis together with all significant environmental variables (Tab. 3.3, p. 30) and some taxa showed unimodal optimum response curves that matter for indication (Tab. 3.4, p. 31). Comparing all environmental variables obtained from CCA the gradient analysis coincides with results from correspondence analysis as it is also based on a model description that assumes unimodal optimum response curves. Therefore it is evident that the less influence for a CCA constraint was calculated, the lower is the number of HOF models showing skewed or symmetric optimum response curves. Other HOF models especially models II () and III () indicate too little counts of head capsules as sampled data ranges start from very low values, e.g. for conductivity and sampling depth. This is the case e.g. for *Tanytarsus lapponicus* type, *Paratanytarsus dissimilis* type regarding electrical conductivity or *Acricotopus longipalpus* type regarding sampling depth.

For the purpose of summarising ecological patterns of taxa in this study it was tried to review literature data (Tab. A.9, A.15) together with illustrated gradients of calculated temperatures and precipitations (Fig. 4.2). Hereby different taxonomic levels cause problems tracing indication as comparison with literature data often includes different numbers of taxa and different taxonomic levels: for instance comparing a genus level with morphotype level or for some taxa only rare detailed data are available. Especially for *Chironomus/Einfeldia* a comparison with literature data reveals a wide variety of ecological responses because more than one taxon has to be considered in comparison and additionally some taxa within *Chironomus* are known to be eurybiont.

A comparison of salinity/conductivity literature data in Table A.15 on page 154 illustrates this issue by showing only a few consonances for some taxa found at low values, e.g. for *Sergentia* sp. *Eukiefferiella* sp. and *Heterotrissocladius marcidus* type. All other taxa listed in Table A.15 show higher differences and sometimes an incomplete sampled gradient seems to be indicated (e.g. Rossaro et al. 2004). For instance taxon *Tanytarsus gracilentus* is known to live also at higher salinities (Walker et al. 1995; Paasivirta 1972; Brodersen et al. 2004) but Rossaro et al. (2004) record *T. gracilentus* with a mean of $90.54 \pm 9.59\,\mu\mathrm{S}\cdot\mathrm{cm}^{-1}$ (72–109, n=11) which indicates insufficient data. Despite these differences some preferences of taxa are traceable.

As stated above precipitation data in concert with electrical conductivity are likely to be interpreted as dryness but not as moisture the opposite side of this gradient. Dry and warm conditions—i.e. with high salinities and temperatures but low precipitation values—are indicated by taxa *Acricotopus* indet 1 and Chironomidae indet 1. High salinity/conductivity is also indicated by *Cricotopus salinophilus* but it indicates likewise colder temperatures. Taxa which are known to tolerate also high salinity values or with intermediate to high salinity values are *Cricotopus sylvestris* gr. (especially *C. sylvestris* gr. indet 1), *Tanytarsus gracilentus* and *Psectrocladius* sp. with *Psectrocladius barbimanus/-sokolovae*. Hereby *Tanytarsus gracilentus* has probably the widest range for conductivity values as it is known from moderate high conductivities (Walker 1987, 4,000 to $12{,}000\,\mu\mathrm{S}\cdot\mathrm{cm}^{-1}$) as well as from oligotrophic arctic and subarctic lakes (Paasivirta 1972; Rossaro et al. 2004, 2006; Ekrem and Halvorsen 2007). In contrast to these taxa *Sergentia longiventris* type and *Paracladius* with *P. conversus* type are known to be restricted to limnic, oligotrophic conditions.

Looking further to temperature preferences and comparing data from low land and mountain areas it is likely to assume a temperature shift in gradients due to different ranges of temperature in these regions. This means, a taxon indicating intermediate temperatures for low land regions can indicate for a mountain area relatively warmer conditions and this complicates therefore comparison with literature data. However, cold temperatures are indicated by *Cricotopus salinophilus* and *C. shilovae* with only a few compareable data available. Moderate cold temperatures are indicated by *Metriocnemus eurynotus* type (e.g. Rossaro et al. 2004, 2006), *Acricotopus longipalpus* type, *Psectrocladius barbimanus/sokolovae* and possibly *Paratanytarsus penicillatus* type. *P. penicillatus* type is also known from warmer conditions (Brooks et al. 2007) and has being stated by Ilyashuk and Ilyashuk (2007) having a broader range of thermal tolerances. For *Paratanytarsus* also a variety of temperature preferences is recorded. In this study a tendency to intermediate and colder conditions can be found which coincides with Ilyashuk et al. (2005) but it is also considered by Larocque (2008) having a warm optimum. These differences are likely to lead back to variant sampled locations. Warm conditions instead are indicated by *Acricotopus* indet 1, *Heterotrissocladius marcidus* type—confirmed also by literature data—and *Micropsectra* sp. that has also been shown to include taxa showing preferences for colder conditions. Relatively warm conditions are furthermore indicated by *Sergentia longiventris* type which coincides also with literature data (Larocque 2008; Brooks et al. 2007). Another taxon that seems also point to warmer temperatures is *Paracladius* but it has a lower number of counted head capsules and is known to indicate intermediate to colder conditions (Brooks et al. 2007).

Regarding sampling depth taxa in this study coincide mainly with literature data. For deep conditions *Micropsectra*, *Sergentia* with *S. longiventris* type are typical and for moderate depths for instance *Heterotrissocladius marcidus* type, *Paracladius*, *Tanytarsus lapponicus* type and *Paratanytarsus dissimilis* type. Many Tanytarsini are known to live in the profundal, whereat in this study most of them indicate moderate depth values and cluster in group two but cover also a wider range down to deepest conditions. This is the case e.g. for *Paratanytarsus* and *Tanytarsus gracilentus*. In contrast to literature data the abundant taxon *Tanytarsus gracilentus* in this study indicates littoral conditions as a member of group one and Paasivirta (1972) found it in several depths but concentrated at 0.2 to 0.6 m whereas Lindegaard (1992) report it from 2–6 down to 20–114 m. Paasivirta (1972) report *T. gracilentus* to be also a pioneer species and in this study *T. gracilentus* was found in relatively small water bodies between 10,000 and 100,000 m^2 which confirm Paasivirta's observations and suggest to be *T. gracilentus* also a coloniser in temporary pools. The same is also reported in literature for *Paratanytarsus penicillatus* and it was also found in this study mainly in water bodies of about 10,000 m^2. Similar patterns can be traced for *Acricotopus longipalpus* type: found only in the littoral of relatively small lakes and also with a wide pH range of 7.8 to 10.8 which covers almost the whole sampled pH range in this study. A wide pH range can often be observed in temporary pools due to low buffering capacities in the water body.

Evaluating pH values is difficult as only a few data are available and furthermore most chironomids tend to be intermediate with a more or less wide pH range and only a few taxa tolerate extreme values (Armitage et al. 1995). Wide pH ranges are known for instance from taxa among *Chironomus* (Armitage et al. 1995), *Procladius* (Il'yashuk and Il'yashuk 2000; Brodin 1986; Henrikson et al. 1982) and *Psectrocladius sordidellus* (Berezina 2001; Brooks and Birks 2000). This more or less unspecific behaviour to pH is also reported by Mousavi (2002) who found no correlation between pH and species richness or abundance. However, intermediate to low pH values seem indicated by *Tanytarsus lapponicus* type as it was found by Ekrem and Halvorsen (2007) in recovering acidified lakes. *Micropsectra* shows the same tendency as it is also known from oligotrophic lakes (Sæther 1979) which have often a pH around 7–8 or below.

Reviewing finally water area is a difficult task, because almost no further data in literature are available except verbal descriptions of habitats. The only pattern that seems traceable is for taxa *Tanytarsus gracilentus*, *Paratanytarsus penicillatus* type and *Acricotopus longipalpus* type mentioned above indicating smaller possibly temporary pools. A difficulty in comparing data of water area is also that taxa inhabiting littoral zones are not strictly restricted to water area and they can appear in large lakes or small ones. Lake morphology is often correlated to water area because deep lakes are often large lakes and flat ones are often smaller. Taxa that are known to inhabit deep lakes, e.g. *Sergentia longiventris* type, may therefore be restricted to large lakes.

4.3.3. Discrepancies reported for the Tibetan Plateau

Not found in this study but found by Zhang et al. (2007) are the following four taxa: *Zalutschia* sp., *Psectrocladius calcaratus* type, *Psectrocladius* sp3 and *Corynoneura lacustris* type. Hereby *Psectrocladius* sp3 is suggested to correspond probably to one of *P. litofilus* or *P. limbatellus* based on the described more prominent middle teeth and is suggested to be matched probably in this study by the declared group of *P. sordidellus/limbatellus* but not clearly separable, if no whole larvae can be compared or if middle teeth of menta are slightly worn. All in all most taxa found by Zhang et al. (2007) were also found in this study but it is not clear why common taxa such as *Chironomus plumosus* type or higher taxonomic groups such as Tanytarsini are not mentioned by Zhang et al. (2007).

However, some reported species types in this study seem also new or less known to China. These are *Cricotopus salinophilus* Zinchenko et al. (2009), *Cricotopus shilovae* Zelentsov (1989) that can be easily confused with *Brillia* or *Euryhapsis* but is well separable by submental setation. Sæther (pers. comm.) also mentioned that the adults of *Cricotopus shilovae* are possibly identical to *C. (I.) perniger* (Zetterstedt, 1850). Furthermore less known to China are *Micropsectra aristata* type, described from Europe, and *Acricotopus longipalpus* type that is reported from Pamir region (Zelentsov 1989) and Nepal (Reiss 1968). These findings need further collected adults for confirmation especially for the latter two taxa. The indeterminable taxa *Acricotopus* indet 1 and Chironomidae indet 2 may correspond to one of adult *Acricotopus* taxa described in Zhang and Wang (2004) but need further clarification in the future as well as all other indeterminable specimens. For taxon Tanytarsini indet 1 it is remarkable that it occurs in the NMDS plots near *Micropsectra* taxa and may contribute to Torbjørn Ekrem's comment to be possibly a *Micropsectra* although it has a *Tanytarsus*-like mandible.

Summarising these differences, taxonomic resolution seems still one major issue (Brooks 2006) that reduces accuracy in attained data. Because a low taxonomical resolution yields less accurate ecological data which reduces then inferences and the power of indication as well. On the part of taxonomic resolution it was tried in this study to enhance this as much as possible but it remains still an issue addressed to future research.

5. Concluding remarks

Transfer models developed in this study are able to reconstruct conductivity or salinity inferences from the Tibetan Plateau. Among them more focus should be given to Bayesian and ANN models beside the well established ones as these model types performing equally or even better and in case of the Bayesian model it seems to handle over- or underestimation at variable's abiotic gradient which is also described as the edge effect (Frey and Deevey 1998). Thereby a ranking was detected as follows: Bayes $\approx$ $\text{ANN}_{\text{neu}=3/4} - 0.1/0.01 \approx$ WAPLS–3 $>$ PLS–5 $\gtrapprox$ $\text{WA}_{\text{cla+inv}} \gtrapprox \text{WA}_{\ldots\text{tol}}$ $>$ W/MAT $>$ ML. Additionally these models are suggested to be improved by counting more head capsules with about 100 as suggested by Heiri and Lotter (2001) to get more precise optimum curves for taxa although the minimum count of 50 is generally accepted as lowest limit (Larocque 2001; Quinlan and Smol 2001). The other possibility is suggested by using 50 head capsules and use more samples obtained from sampled within-lake gradients (Kurek and Cwynar 2009). Thereby Huisman-Olff-Fresco—HOF—models developed by Huisman et al. (1993) can assist and provide information about significant optima or less good data gradients represented by taxa. To improve conductivity/salinity models developed in this study one possible step might be to fuse data of Zhang et al. (2007) with data from this study but thereby taxonomic differences have to be resolved as good as possible. On the part of taxonomic determination it was tried to improve this by the developed interactive Chironomid Identification Program CHIP. Additionally outline analysis was successfully applied to shapes of menta. Using normalised elliptical Fourier Analysis for outlining images can give a great advantage for determination as decisions in determination can be made more objectively. Looking forward, outline analysis can possibly separate also halves of menta if a database of half menta is established and furthermore outlines should be improved also by noise reduction techniques as described by Haines and Crampton (2000).

Finally I can still agree with Stephen Brooks' remark in Brooks (2006): "Future developments are required to (a) further reduce the errors in chironomid-temperature inference models, (b) further improve taxonomic resolution of sub-fossil chironomids, (c) produce additional regional training sets".

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A. Appendix

Tab. A.1.: Results of clustered taxa regarding weighted average electrical conductivity$_{\log 10}$ ($mS \cdot cm^{-1}$) with 37 optimal groups (——) and cluster's average silhouette width $s_{ave} = 0.630$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Values of s_i are indicated by horizontal boxes; data sorted by their weighted average $\log_{10}$ values; for multiple measured values, the data range is given; - - - - = 5 suboptimal groups ($s_{ave} = 0.612$). Note that order of weighted$\{\log_{10}\} \neq$ weighted$\{10^{\log_{10}}\}$.

			cluster's silhouette width		conductivity
taxon (counts)	shortened	cluster	s_i	average s_{ave}	$\log_{10}$ x (10^x) in $mS \cdot cm^{-1}$
Tanytarsini indet 1 (n=5)	trTanyt1	1	1.000	1.000	-1.824 (0.015)
Diamesinae indet 4 (n=2)	sfDiame4	1	1.000	1.000	-1.824 (0.015)
Micropsectra aristata type (n=4)	Micr?ari	1	1.000	1.000	-1.824 (0.015)
Micropsectra insignilobus type (n=4)	Micr?ins	1	1.000	1.000	-1.824 (0.015)
Micropsectra junci type (n=4)	Micr?jun	1	1.000	1.000	-1.824 (0.015)
Micropsectra radialis type (n=7)	Micr?rad	1	1.000	1.000	-1.824 (0.015)
Heterotrissocladius marcidus type (n=16)	Hete?mar	2	0.000	0.000	-1.671: -1.824 to -0.1844 (0.058: 0.015 to 0.654)
Cricotopus bicinctus type (n=2)	Cric?bic	3	0.601	0.709	-1.597: -1.699 to -1.495 (0.026: 0.02 to 0.032)
Paracladius sp. (n=10)	Parlinde	3	0.793	0.709	-1.571: -1.658 to -1.347 (0.028: 0.022 to 0.045)
Micropsectra sp. (n=26)	Micrinde	3	0.731	0.709	-1.564: -1.824 to 0.356 (0.193: 0.015 to 2.27)
Diamesinae indet 1 (n=5)	sfDiame1	4	0.648	0.756	-1.509: -1.824 to -1.409 (0.033: 0.015 to 0.039)
Sergentia sp. (n=9)	Serginde	4	0.825	0.756	-1.495: -1.538 to -1.409 (0.032: 0.029 to 0.039)
Sergentia longiventris type (n=82)	Serg?lov	4	0.834	0.756	-1.486: -1.538 to -1.347 (0.033: 0.029 to 0.045)
Eukiefferiella sp. (n=7)	Eukiinde	4	0.719	0.756	-1.475: -1.824 to -1.347 (0.035: 0.015 to 0.045)
Pseudodiamesa pertinax type (n=2)	Psed?per	5	0.750	0.500	-1.409 (0.039)
Stictochironomus sp. 1 (n=3)	Sticind1	5	0.750	0.500	-1.409 (0.039)
Thienemanniella vittata type (n=2)	Thil?vit	5	0.000	0.500	-1.378: -1.409 to -1.347 (0.042: 0.039 to 0.045)
Stictochironomus sp. (n=2)	Sticinde	6	1.000	1.000	-1.347 (0.045)
Dicrotendipes sp. (n=3)	Dicrinde	6	1.000	1.000	-1.347 (0.045)

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Tab. A.1 (continued): taxa cluster regarding weighted average electrical conductivity; - - - - = 5 suboptimal groups ($s_{ave} = 0.612$) and —— = 37 optimal groups ($s_{ave} = 0.630$). Note that order of weighted$\{\log_{10}\} \neq$ weighted$\{10^{\log_{10}}\}$.

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	conductivity $\log_{10}$ x (10^x) in $mS \cdot cm^{-1}$
Eukiefferiella/Tvetenia sp. (n=12)	EuTvinde	7	0.000	0.000	-1.272: -1.824 to 0.356 (0.267: 0.015 to 2.27)
Psectrocladius sordidellus/limbatellus (n=128)	Psec?sol	8	0.814	0.793	-1.175: -1.824 to 0.1886 (0.128: 0.015 to 1.544)
Paracladius conversus type (n=10)	Parl?con	8	0.772	0.793	-1.162: -1.658 to 0.356 (0.478: 0.022 to 2.27)
Paratanytarsus austriacus type (n=5)	Part?aus	9	0.191	0.362	-1.127: -1.658 to -0.6882 (0.099: 0.022 to 0.205)
Diamesinae indet 3 (n=6)	sfDiame3	9	0.567	0.362	-1.112: -1.495 to 0.356 (0.411: 0.032 to 2.27)
Tvetenia sp. (n=4)	Tvetinde	9	0.600	0.362	-1.093: -1.824 to 0.356 (0.589: 0.015 to 2.27)
Tanytarsus lapponicus type (n=87)	Tany?lap	9	0.090	0.362	-1.073: -1.824 to 2.115 (4.683: 0.015 to 130.3)
Eukiefferiella claripennis type (n=4)	Euki?cla	10	0.000	0.000	-1.032: -1.495 to 0.356 (0.591: 0.032 to 2.27)
Paratanytarsus dissimilis type (n=33)	Part?dis	11	0.000	0.000	-0.984: -1.699 to 0.06108 (0.184: 0.02 to 1.151)
Chironomus/Einfeldia sp. men2 man3 (n=3)	ChEim2m3	12	0.395	0.509	-0.919: -1.432 to -0.3872 (0.187: 0.037 to 0.41)
Polypedilum nubifer type (n=9)	Poly?nub	12	0.623	0.509	-0.880: -1.092 to -0.8539 (0.133: 0.081 to 0.14)
- - - -					
Cryptochironomus sp. (n=4)	Crycinde	13	0.535	0.333	-0.765: -1.155 to -0.3872 (0.207: 0.07 to 0.41)
Corynoneura scutellata type (n=7)	Corn?scu	13	0.130	0.333	-0.732: -1.824 to 0.1396 (0.434: 0.015 to 1.379)
Polypedilum sp. (n=2)	Polyinde	14	0.745	0.753	-0.701 (0.199)
Cryptochironomus fulvus/digitatus (n=4)	Cryc?fud	14	0.796	0.753	-0.698: -0.8539 to -0.2291 (0.252: 0.14 to 0.59)
Corynoneura arctica type (n=16)	Corn?arc	14	0.719	0.753	-0.680: -1.444 to -0.4498 (0.224: 0.036 to 0.355)
Nanocladius sp. (n=2)	Nanoinde	15	0.597	0.597	-0.633 (0.233)
Chironomus/Einfeldia sp. men2 man1 (n=11)	ChEim2m1	15	0.746	0.597	-0.617: -1.824 to 0.395 (0.524: 0.015 to 2.483)
Tanytarsini sp. (n=483)	trTanyta	15	0.746	0.597	-0.613: -1.824 to 2.115 (1.974: 0.015 to 130.3)

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Tab. A.1 (continued): taxa cluster regarding weighted average electrical conductivity; - - - - = 5 suboptimal groups ($s_{ave} = 0.612$) and —— = 37 optimal groups ($s_{ave} = 0.630$). Note that order of weighted$\{\log_{10}\} \neq$ weighted$\{10^{\log_{10}}\}$.

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	conductivity $\log_{10}$ x (10^x) in $mS \cdot cm^{-1}$
Chironominae sp. (n=7)	sfChiron	15	0.677	0.597	-0.607: -1.824 to 2.115 (18.822: 0.015 to 130.3)
Chironomus/Einfeldia sp. men1 man1 (n=70)	ChEim1m1	15	0.220	0.597	-0.595: -1.699 to 2.115 (2.182: 0.02 to 130.3)
Chironomus/Einfeldia sp. men1 (n=103)	ChEimen1	16	0.507	0.451	-0.578: -1.824 to 2.115 (1.788: 0.015 to 130.3)
Paratanytarsus sp. (n=206)	Partinde	16	0.680	0.451	-0.571: -1.658 to 1.307 (0.981: 0.022 to 20.3)
Glyptotendipes pallens type (n=12)	Glyp?pae	16	0.167	0.451	-0.551: -0.6326 to -0.3872 (0.292: 0.233 to 0.41)
Nanocladius rectinervis type (n=7)	Nano?rec	17	0.835	0.806	-0.527: -0.6326 to -0.3872 (0.309: 0.233 to 0.41)
Eukiefferiella gracei type (n=2)	Euki?grc	17	0.856	0.806	-0.526: -1.409 to 0.356 (1.154: 0.039 to 2.27)
Metriocnemus eurynotus type (n=30)	Metr?eur	17	0.868	0.806	-0.523: -1.824 to 2.115 (4.708: 0.015 to 130.3)
Chironomus/Einfeldia sp. men3 man3 (n=8)	ChEim3m3	17	0.667	0.806	-0.514: -0.6882 to -0.3497 (0.317: 0.205 to 0.447)
Limnophyes sp. (n=2)	Limninde	18	0.164	0.615	-0.495: -1.347 to 0.356 (1.157: 0.045 to 2.27)
Procladius choreus type (n=11)	Proc?cho	18	0.784	0.615	-0.476: -1.824 to 1.27 (3.132: 0.015 to 18.6)
Chironomus/Einfeldia sp. men1 man2 (n=43)	ChEim1m2	18	0.785	0.615	-0.472: -1.444 to 0.395 (0.534: 0.036 to 2.483)
Cricotopus shilovae (n=42)	Cricshil	18	0.728	0.615	-0.469: -1.495 to 1.146 (0.949: 0.032 to 14)
Acricotopus sp. (n=12)	Acriinde	19	0.549	0.617	-0.439: -1.347 to 1.307 (1.987: 0.045 to 20.3)
Corynoneura sp. (n=2)	Corninde	19	0.740	0.617	-0.431: -0.6326 to -0.2291 (0.411: 0.233 to 0.59)
Chironomus/Einfeldia sp. men1 man3 (n=18)	ChEim1m3	19	0.745	0.617	-0.430: -1.699 to 0.395 (0.576: 0.02 to 2.483)
Corynoneura arctica/scutellata (n=20)	Corn?asc	19	0.434	0.617	-0.403: -0.71 to 0.1886 (0.458: 0.195 to 1.544)
Chironomus/Einfeldia sp. men2 man2 (n=24)	ChEim2m2	20	0.734	0.572	-0.361: -1.824 to 1.307 (2.080: 0.015 to 20.3)
Glyptotendipes sp. (n=9)	Glypinde	20	0.737	0.572	-0.360: -0.9393 to 0.968 (1.408: 0.115 to 9.29)
Chironomus/Einfeldia sp. (n=23)	ChEiinde	20	0.246	0.572	-0.326: -1.444 to 1.27 (3.590: 0.036 to 18.6)

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Tab. A.1 (continued): taxa cluster regarding weighted average electrical conductivity; - - - - = 5 suboptimal groups ($s_{ave} = 0.612$) and —— = 37 optimal groups ($s_{ave} = 0.630$). Note that order of weighted$\{\log_{10}\} \neq$ weighted$\{10^{\log_{10}}\}$.

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	conductivity $\log_{10}$ x (10^x) in $mS \cdot cm^{-1}$
Orthocladiinae sp. (n=92)	sfOrthoc	21	0.000	0.000	-0.281: -1.824 to 2.115 (5.620: 0.015 to 130.3)
Tanytarsus sp. (n=16)	Tanyinde	22	0.414	0.711	-0.237: -1.658 to 2.115 (9.154: 0.022 to 130.3)
Chironomidae indet 2 (n=16)	faChiro2	22	0.783	0.711	-0.220: -1.444 to 0.06108 (0.942: 0.036 to 1.151)
Orthocladius obumbratus type (n=9)	Orth?obu	22	0.827	0.711	-0.212: -1.347 to 0.356 (1.528: 0.045 to 2.27)
Procladius sp. (n=8)	Procinde	22	0.797	0.711	-0.207: -1.347 to 1.27 (2.873: 0.045 to 18.6)
Ablabesmyia monilis type (n=9)	Abla?mon	22	0.736	0.711	-0.204: -0.6596 to 0.968 (2.382: 0.219 to 9.29)
Corynoneura/Thienemanniella sp. (n=9)	CoThinde	23	0.564	0.679	-0.163: -1.347 to 2.115 (15.051: 0.045 to 130.3)
Paratanytarsus penicillatus type (n=52)	Part?pen	23	0.667	0.679	-0.158: -0.7595 to 1.307 (1.959: 0.174 to 20.3)
Chironomus/Einfeldia sp. men2 (n=40)	ChEimen2	23	0.748	0.679	-0.132: -1.658 to 1.307 (3.798: 0.022 to 20.3)
Cricotopus/Orthocladius sp. (n=14)	CrOrinde	23	0.737	0.679	-0.132: -1.824 to 1.582 (7.409: 0.015 to 38.2)
Psectrocladius sokolovae/-pancratovae (n=27)	Psec?sop	24	0.830	0.858	-0.065: -1.824 to 1.307 (2.179: 0.015 to 20.3)
Tanytarsus/Corynocera sp. (n=17)	TaCoinde	24	0.888	0.858	-0.053: -0.7595 to 1.146 (2.108: 0.174 to 14)
Acricotopus longipalpus type (n=416)	Acri?lon	24	0.857	0.858	-0.050: -1.658 to 1.493 (2.675: 0.022 to 31.1)
Orthocladius frigidus type (n=5)	Orth?fri	25	0.691	0.806	0.003: -1.409 to 0.356 (1.824: 0.039 to 2.27)
Chironomus/Einfeldia sp. men3 man2 (n=5)	ChEim3m2	25	0.870	0.806	0.020: -0.5952 to 0.6484 (1.742: 0.254 to 4.45)
Cladotanytarsus mancus type (n=4)	Clat?man	25	0.856	0.806	0.023 (1.054)
Pseudosmittia sp. (n=11)	Psesinde	26	0.000	0.000	0.104: -1.495 to 1.27 (3.095: 0.032 to 18.6)
Tanytarsus gracilentus type (n=157)	Tany?gra	27	0.755	0.766	0.181: -0.7595 to 1.307 (3.706: 0.174 to 20.3)
Chironomini sp. (n=18)	trChiron	27	0.837	0.766	0.190: -1.155 to 1.27 (8.458: 0.07 to 18.6)
Chironomus/Einfeldia sp. men3 (n=36)	ChEimen3	27	0.707	0.766	0.209: -1.658 to 1.307 (7.265: 0.022 to 20.3)

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Tab. A.1 (continued): taxa cluster regarding weighted average electrical conductivity; - - - - = 5 suboptimal groups ($s_{\text{ave}} = 0.612$) and —— = 37 optimal groups ($s_{\text{ave}} = 0.630$). Note that order of weighted$\{\log_{10}\} \neq$ weighted$\{10^{\log_{10}}\}$.

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	cluster's silhouette width average s_{ave}	conductivity $\log_{10}$ x (10^x) in $\text{mS} \cdot \text{cm}^{-1}$
Cricotopus sylvestris gr. (n=8)	Cricgsyl	28	0.921	0.917	0.286: -0.8539 to 1.27 (6.616: 0.14 to 18.6)
Cricotopus sylvestris gr. indet 2 (n=47)	Cricgsy2	28	0.914	0.917	0.291: -1.155 to 1.307 (5.050: 0.07 to 20.3)
Chironomus/Einfeldia sp. men3 man1 (n=9)	ChEim3m1	29	0.423	0.701	0.335: -0.3054 to 1.27 (3.703: 0.495 to 18.6)
Psectrocladius obvius type (n=3)	Psec?obv	29	0.796	0.701	0.353: -0.4295 to 1.307 (7.395: 0.372 to 20.3)
Cricotopus tibialis type (n=2)	Cric?tib	29	0.818	0.701	0.356 (2.27)
Diamesinae indet 2 (n=2)	sfDiame2	29	0.818	0.701	0.356 (2.27)
Ablabesmyia sp. (n=5)	Ablainde	29	0.647	0.701	0.380: -0.7595 to 1.146 (6.246: 0.174 to 14)
Tanypodinae sp. (n=24)	sfTanypo	30	0.841	0.851	0.458: -1.824 to 1.307 (7.012: 0.015 to 20.3)
Conchapelopia sp. (n=2)	Concinde	30	0.861	0.851	0.475: 0.1798 to 0.7694 (3.697: 1.513 to 5.88)
Psectrocladius sp. (n=59)	Psecinde	31	0.000	0.000	0.592: -1.824 to 1.575 (15.142: 0.015 to 37.6)
Psectrocladius barbimanus/-sokolovae (n=108)	Psec?bas	32	0.324	0.460	0.633: -0.7595 to 1.575 (13.221: 0.174 to 37.6)
Cricotopus sylvestris gr. indet 1 (n=60)	Cricgsy1	32	0.597	0.460	0.661: -1.155 to 2.115 (20.702: 0.07 to 130.3)
Cricotopus salinophilus (n=131)	Cricsano	33	0.000	0.000	1.159: 0.6484 to 1.582 (22.803: 4.45 to 38.2)
Pseudosmittia indet 2 (n=21)	Psesind2	34	0.879	0.886	1.258: -0.7122 to 2.115 (87.000: 0.194 to 130.3)
Saetheria sp. (n=6)	Saetinde	34	0.892	0.886	1.270 (18.6)
Paratendipes nudisquama type (n=6)	Patd?nus	35	0.000	0.000	1.529: 0.356 to 2.115 (87.623: 2.27 to 130.3)
Acricotopus indet 1 (n=75)	Acriind1	36	0.000	0.000	1.692: 1.493 to 2.115 (62.844: 31.1 to 130.3)
Acricotopus lucens type (n=2)	Acri?luc	37	1.000	1.000	2.115 (130.3)
Chironomidae indet 1 (n=7)	faChiro1	37	1.000	1.000	2.115 (130.3)

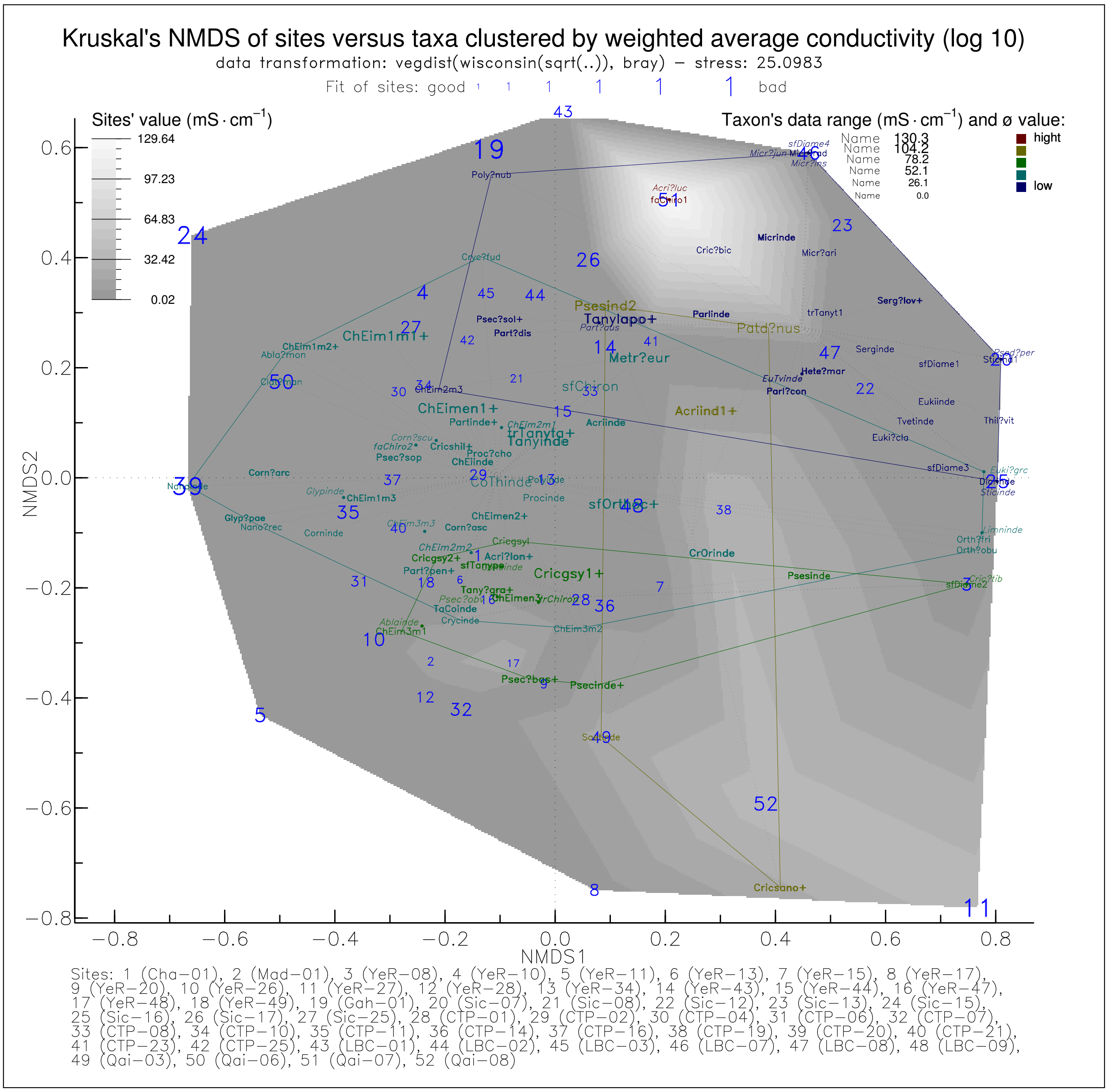

Fig. A.1.: NMDS ordination of taxa versus sites with cluster groups regarding taxa's weighted average electrical conductivity ($mS \cdot cm^{-1}$) for all together 37 optimal groups with an average cluster silhouette width $s_{ave} = 0.630$. Plotted groups are merged to 5 suboptimal groups with $s_{ave} = 0.612$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Environmental variable is given as grey scale image calculated as a linear fit from sites' values instead of logarithmic transformed values to see better abiotic–biotic relationships. Numeric results see Table A.1 and abbreviations see on pages VI–VIII (*italic* names like *Corn?scu* · are placed by an offset next to their x-y score point; **bold** names indicate a number of head capsules with n ⩾ 10 and **bold+** indicates n ⩾ 40; 1 unit = 0.5 distance after Raup and Crick (1979)).

Tab. A.2.: Results of clustered taxa regarding weighted average sampling depth (m) with 3 optimal groups (——) and cluster's average silhouette width $s_{ave} = 0.731$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Values of s_i are indicated by horizontal boxes; data sorted by their weighted average values; for multiple measured values, the data range is given.

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	cluster's silhouette width average s_{ave}	$depth_{samples}$ in m
Polypedilum nubifer type (n=9)	Poly?nub	1	0.861	0.802	0.05 : 0.01 to 0.40
Cryptochironomus fulvus/digitatus (n=4)	Cryc?fud	1	0.861	0.802	0.06 : 0.01 to 0.20
Polypedilum sp. (n=2)	Polyinde	1	0.863	0.802	0.10
Cricotopus tibialis type (n=2)	Cric?tib	1	0.869	0.802	0.20
Diamesinae indet 2 (n=2)	sfDiame2	1	0.869	0.802	0.20
Chironomus/Einfeldia sp. men3 man2 (n=5)	ChEim3m2	1	0.870	0.802	0.23 : 0.10 to 0.45
Paratendipes nudisquama type (n=6)	Patd?nus	1	0.872	0.802	0.27 : 0.20 to 0.30
Glyptotendipes sp. (n=9)	Glypinde	1	0.872	0.802	0.27 : 0.10 to 0.40
Tanytarsus sp. (n=16)	Tanyinde	1	0.872	0.802	0.28 : 0.01 to 0.70
Ablabesmyia sp. (n=5)	Ablainde	1	0.873	0.802	0.29 : 0.20 to 0.65
Acricotopus lucens type (n=2)	Acri?luc	1	0.873	0.802	0.30
Chironomidae indet 1 (n=7)	faChiro1	1	0.873	0.802	0.30
Corynoneura sp. (n=2)	Corninde	1	0.873	0.802	0.30 : 0.20 to 0.40
Chironomus/Einfeldia sp. men3 man3 (n=8)	ChEim3m3	1	0.874	0.802	0.33 : 0.10 to 0.70
Psectrocladius obvius type (n=3)	Psec?obv	1	0.875	0.802	0.33 : 0.10 to 0.65
Pseudosmittia indet 2 (n=21)	Psesind2	1	0.875	0.802	0.35 : 0.10 to 0.70
Corynoneura arctica/scutellata (n=20)	Corn?asc	1	0.876	0.802	0.39 : 0.10 to 0.70
Paratanytarsus penicillatus type (n=52)	Part?pen	1	0.876	0.802	0.40 : 0.10 to 0.95
Cryptochironomus sp. (n=4)	Crycinde	1	0.876	0.802	0.40 : 0.20 to 0.70
Nanocladius sp. (n=2)	Nanoinde	1	0.876	0.802	0.40
Acricotopus longipalpus type (n=416)	Acri?lon	1	0.877	0.802	0.42 : 0.10 to 22.00
Tanytarsus/Corynocera sp. (n=17)	TaCoinde	1	0.877	0.802	0.42 : 0.10 to 0.95
Tanytarsus gracilentus type (n=157)	Tany?gra	1	0.877	0.802	0.45 : 0.10 to 0.95
Cricotopus salinophilus (n=131)	Cricsano	1	0.877	0.802	0.45 : 0.05 to 3.40
Glyptotendipes pallens type (n=12)	Glyp?pae	1	0.878	0.802	0.50 : 0.40 to 0.70
Nanocladius rectinervis type (n=7)	Nano?rec	1	0.878	0.802	0.53 : 0.40 to 0.70
Corynoneura arctica type (n=16)	Corn?arc	1	0.879	0.802	0.57 : 0.10 to 3.70
Chironomus/Einfeldia sp. men3 man1 (n=9)	ChEim3m1	1	0.879	0.802	0.59 : 0.20 to 3.60
Paratanytarsus sp. (n=206)	Partinde	1	0.879	0.802	0.72 : 0.01 to 36.70
Conchapelopia sp. (n=2)	Concinde	1	0.880	0.802	0.80 : 0.65 to 0.95

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Tab. A.2 (continued): taxa cluster regarding weighted average sampling depth; —— = 3 optimal groups ($s_{\text{ave}} = 0.731$).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	$\text{depth}_{\text{samples}}$ in m
Cricotopus shilovae (n=42)	Cricshil	1	0.880	0.802	0.80 : 0.10 to 22.00
Psectrocladius barbimanus/-sokolovae (n=108)	Psec?bas	1	0.879	0.802	0.95 : 0.10 to 3.60
Metriocnemus eurynotus type (n=30)	Metr?eur	1	0.879	0.802	1.00 : 0.20 to 12.00
Tanypodinae sp. (n=24)	sfTanypo	1	0.879	0.802	1.09 : 0.10 to 12.00
Cricotopus sylvestris gr. indet 1 (n=60)	Cricgsy1	1	0.879	0.802	1.12 : 0.01 to 3.60
Chironomus/Einfeldia sp. men3 (n=36)	ChEimen3	1	0.878	0.802	1.20 : 0.10 to 3.60
Chironomus/Einfeldia sp. men2 man2 (n=24)	ChEim2m2	1	0.877	0.802	1.25 : 0.10 to 12.00
Chironomus/Einfeldia sp. men2 (n=40)	ChEimen2	1	0.875	0.802	1.37 : 0.10 to 10.10
Chironomidae indet 2 (n=16)	faChiro2	1	0.873	0.802	1.49 : 0.80 to 4.90
Cricotopus sylvestris gr. indet 2 (n=47)	Cricgsy2	1	0.871	0.802	1.63 : 0.10 to 6.80
Cricotopus sylvestris gr. (n=8)	Cricgsyl	1	0.867	0.802	1.82 : 0.01 to 6.80
Chironomini sp. (n=18)	trChiron	1	0.866	0.802	1.84 : 0.10 to 3.60
Chironomus/Einfeldia sp. men1 (n=103)	ChEimen1	1	0.864	0.802	1.91 : 0.10 to 22.00
Psectrocladius sp. (n=59)	Psecinde	1	0.864	0.802	1.93 : 0.10 to 12.00
Chironomus/Einfeldia sp. men2 man3 (n=3)	ChEim2m3	1	0.864	0.802	1.93 : 0.20 to 4.90
Procladius choreus type (n=11)	Proc?cho	1	0.861	0.802	2.00 : 0.20 to 12.00
Pseudosmittia sp. (n=11)	Psesinde	1	0.842	0.802	2.52 : 0.20 to 22.00
Chironomus/Einfeldia sp. (n=23)	ChEiinde	1	0.825	0.802	2.90 : 0.10 to 6.80
Chironomus/Einfeldia sp. men1 man3 (n=18)	ChEim1m3	1	0.814	0.802	3.15 : 0.20 to 37.10
Psectrocladius sordidellus/limbatellus (n=128)	Psec?sol	1	0.800	0.802	3.41 : 0.01 to 37.10
Acricotopus sp. (n=12)	Acriinde	1	0.799	0.802	3.43 : 0.10 to 36.70
Saetheria sp. (n=6)	Saetinde	1	0.789	0.802	3.60
Acricotopus indet 1 (n=75)	Acriind1	1	0.769	0.802	3.90 : 0.30 to 5.60
Psectrocladius sokolovae/pancratovae (n=27)	Psec?sop	1	0.762	0.802	4.00 : 0.10 to 18.00
Orthocladiinae sp. (n=92)	sfOrthoc	1	0.734	0.802	4.38 : 0.10 to 36.70
Corynoneura/Thienemanniella sp. (n=9)	CoThinde	1	0.731	0.802	4.42 : 0.20 to 36.70
Chironomus/Einfeldia sp. men1 man1 (n=70)	ChEim1m1	1	0.729	0.802	4.44 : 0.20 to 37.10
Paratanytarsus dissimilis type (n=33)	Part?dis	1	0.718	0.802	4.57 : 0.20 to 37.10
Orthocladius frigidus type (n=5)	Orth?fri	1	0.654	0.802	5.22 : 0.20 to 25.30

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Tab. A.2 (continued): taxa cluster regarding weighted average sampling depth; —— = 3 optimal groups ($s_{ave} = 0.731$).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	depth$_{samples}$ in m
Paratanytarsus austriacus type (n=5)	Part?aus	1	0.647	0.802	5.28 : 0.20 to 25.30
Cricotopus/Orthocladius sp. (n=14)	CrOrinde	1	0.599	0.802	5.69 : 0.05 to 36.70
Tanytarsini sp. (n=483)	trTanyta	1	0.598	0.802	5.70 : 0.01 to 39.90
Tanytarsus lapponicus type (n=87)	Tany?lap	1	0.553	0.802	6.04 : 0.10 to 39.90
Procladius sp. (n=8)	Procinde	1	0.535	0.802	6.16 : 0.20 to 36.70
Chironomus/Einfeldia sp. men1 man2 (n=43)	ChEim1m2	1	0.533	0.802	6.18 : 0.10 to 10.10
Chironomus/Einfeldia sp. men2 man1 (n=11)	ChEim2m1	1	0.494	0.802	6.43 : 0.10 to 36.70
Ablabesmyia monilis type (n=9)	Abla?mon	1	0.434	0.802	6.78 : 0.10 to 10.10
Cladotanytarsus mancus type (n=4)	Clat?man	1	0.430	0.802	6.80
Corynoneura scutellata type (n=7)	Corn?scu	1	0.349	0.802	7.21 : 0.20 to 37.10
Chironominae sp. (n=7)	sfChiron	2	−0.006	0.520	8.80 : 0.30 to 36.70
Eukiefferiella/Tvetenia sp. (n=12)	EuTvinde	2	0.292	0.520	10.01 : 0.20 to 25.30
Paracladius sp. (n=10)	Parlinde	2	0.332	0.520	10.22 : 0.50 to 36.70
Paracladius conversus type (n=10)	Parl?con	2	0.494	0.520	11.30 : 0.20 to 36.70
Orthocladius obumbratus type (n=9)	Orth?obu	2	0.608	0.520	12.37 : 0.20 to 36.70
Eukiefferiella gracei type (n=2)	Euki?grc	2	0.639	0.520	12.75 : 0.20 to 25.30
Tanytarsini indet 1 (n=5)	trTanyt1	2	0.668	0.520	13.20 : 12.00 to 18.00
Heterotrissocladius marcidus type (n=16)	Hete?mar	2	0.697	0.520	13.81 : 0.20 to 36.70
Tvetenia sp. (n=4)	Tvetinde	2	0.732	0.520	14.88 : 0.20 to 25.30
Micropsectra aristata type (n=4)	Micr?ari	2	0.735	0.520	15.00 : 12.00 to 18.00
Eukiefferiella claripennis type (n=4)	Euki?cla	2	0.721	0.520	16.55 : 0.20 to 22.00
Diamesinae indet 4 (n=2)	sfDiame4	2	0.656	0.520	18.00
Micropsectra insignilobus type (n=4)	Micr?ins	2	0.656	0.520	18.00
Micropsectra junci type (n=4)	Micr?jun	2	0.656	0.520	18.00
Micropsectra radialis type (n=7)	Micr?rad	2	0.656	0.520	18.00
Limnophyes sp. (n=2)	Limninde	2	0.613	0.520	18.45 : 0.20 to 36.70
Micropsectra sp. (n=26)	Micrinde	2	0.179	0.520	21.35 : 0.20 to 37.10
Diamesinae indet 1 (n=5)	sfDiame1	2	0.029	0.520	21.98 : 12.00 to 25.30
Pseudodiamesa pertinax type (n=2)	Psed?per	3	0.548	0.629	25.30
Stictochironomus sp. 1 (n=3)	Sticind1	3	0.548	0.629	25.30
Eukiefferiella sp. (n=7)	Eukiinde	3	0.592	0.629	25.71 : 12.00 to 36.70

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Tab. A.2 (continued): taxa cluster regarding weighted average sampling depth; —— = 3 optimal groups ($s_{\text{ave}} = 0.731$).

taxon (counts)		shortened	cluster	cluster's silhouette width s_i	average s_{ave}	$\text{depth}_{\text{samples}}$ in m
Diamesinae indet 3	(n=6)	sfDiame3	3	0.592 ☐	0.629 ☐	25.72 : 0.20 to 36.70
Sergentia sp.	(n=9)	Serginde	3	0.627 ☐	0.629 ☐	26.34 : 22.00 to 39.90
Cricotopus bicinctus type	(n=2)	Cric?bic	3	0.710 ☐	0.629 ☐	29.55 : 22.00 to 37.10
Thienemanniella vittata type	(n=2)	Thil?vit	3	0.716 ☐	0.629 ☐	31.00 : 25.30 to 36.70
Sergentia longiventris type	(n=82)	Serg?lov	3	0.707 ☐	0.629 ☐	32.00 : 22.00 to 39.90
Dicrotendipes sp.	(n=3)	Dicrinde	3	0.625 ☐	0.629 ☐	36.70
Stictochironomus sp.	(n=2)	Sticinde	3	0.625 ☐	0.629 ☐	36.70

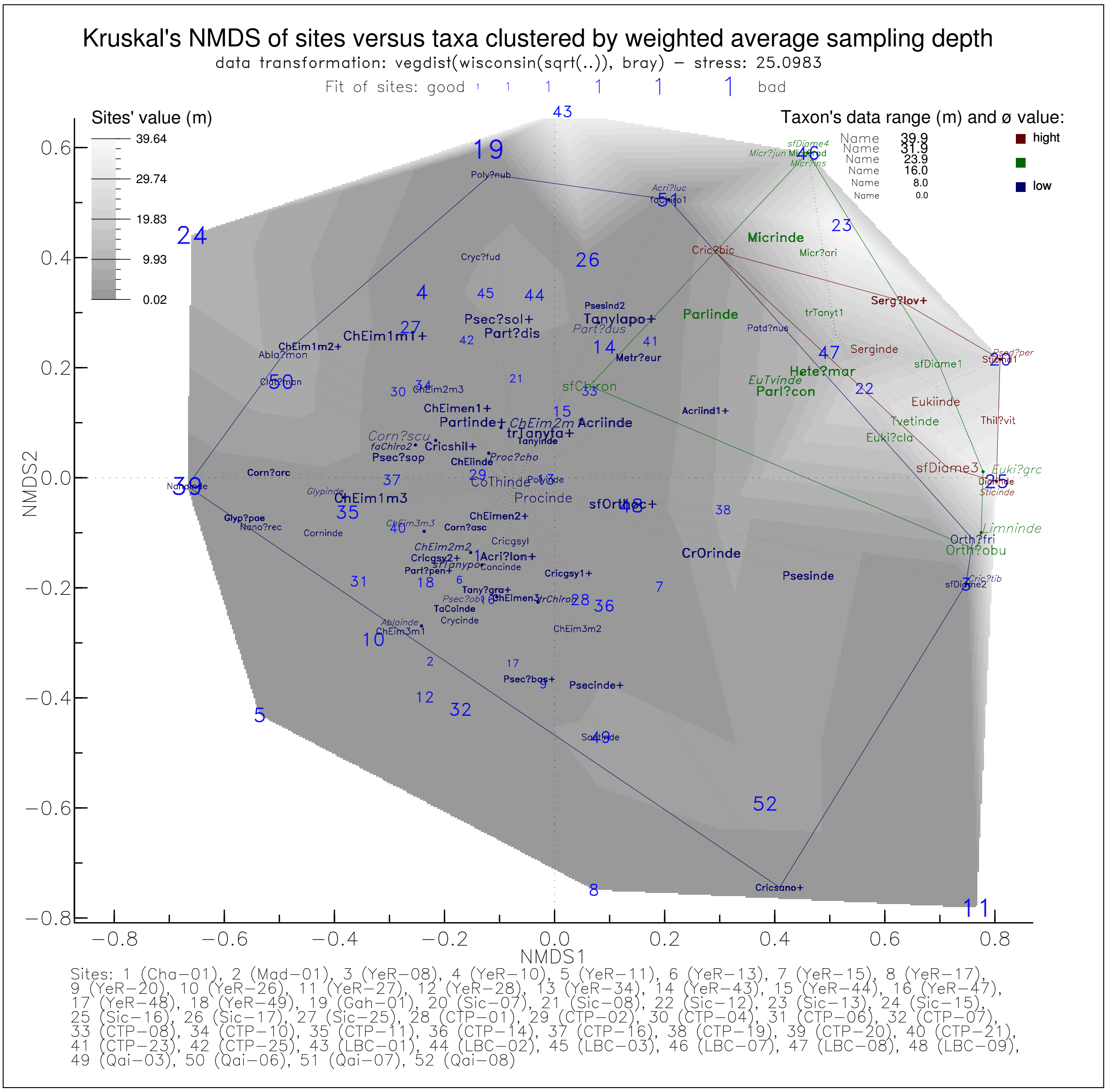

Fig. A.2.: NMDS ordination of taxa versus sites with cluster groups regarding taxa's weighted average sampling depth (m) from sites for all together 3 optimal groups and an average cluster silhouette width $s_{\text{ave}} = 0.731$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Environmental variable is given as grey scale image calculated as a linear fit from sites' values. Numeric results see Table A.2 and abbreviations see on pages VI–VIII (*italic* names like *Corn?scu* · are placed by an offset next to their x-y score point; **bold** names indicate a number of head capsules with n ⩾ 10 and **bold+** indicates n ⩾ 40; 1 unit = 0.5 distance after Raup and Crick (1979)).

Tab. A.3.: Results of clustered taxa regarding weighted average pH value with 36 optimal groups (——) and cluster's average silhouette width $s_{ave} = 0.664$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Values of s_i are indicated by horizontal boxes; data sorted by their weighted average values; for multiple measured values, the data range is given; - - - - = 5 suboptimal groups ($s_{ave} = 0.621$).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	cluster's silhouette width average s_{ave}	pH value
Diamesinae indet 4 (n=2)	sfDiame4	1	1.000	1.000	7.10
Micropsectra insignilobus type (n=4)	Micr?ins	1	1.000	1.000	7.10
Micropsectra junci type (n=4)	Micr?jun	1	1.000	1.000	7.10
Micropsectra radialis type (n=7)	Micr?rad	1	1.000	1.000	7.10
Micropsectra aristata type (n=4)	Micr?ari	2	0.000	0.000	7.25 : 7.10 to 7.40
Tanytarsini indet 1 (n=5)	trTanyt1	3	0.000	0.000	7.34 : 7.10 to 7.40
Micropsectra sp. (n=26)	Micrinde	4	0.935	0.937	7.57 : 7.10 to 8.08
Heterotrissocladius marcidus type (n=16)	Hete?mar	4	0.939	0.937	7.59 : 7.10 to 9.31
Tvetenia sp. (n=4)	Tvetinde	5	0.694	0.617	7.87 : 7.40 to 8.08
Paracladius sp. (n=10)	Parlinde	5	0.740	0.617	7.88 : 7.80 to 8.11
Diamesinae indet 1 (n=5)	sfDiame1	5	0.739	0.617	7.90 : 7.40 to 8.08
Eukiefferiella/Tvetenia sp. (n=12)	EuTvinde	5	0.540	0.617	7.92 : 7.40 to 8.87
Paracladius conversus type (n=10)	Parl?con	5	0.373	0.617	7.93 : 7.80 to 8.11
Eukiefferiella sp. (n=7)	Eukiinde	6	0.524	0.844	7.97 : 7.40 to 8.11
Cricotopus tibialis type (n=2)	Cric?tib	6	0.904	0.844	8.00
Diamesinae indet 2 (n=2)	sfDiame2	6	0.904	0.844	8.00
Eukiefferiella gracei type (n=2)	Euki?grc	6	0.904	0.844	8.00
Orthocladius frigidus type (n=5)	Orth?fri	6	0.904	0.844	8.00
Pseudodiamesa pertinax type (n=2)	Psed?per	6	0.904	0.844	8.00
Stictochironomus sp. 1 (n=3)	Sticind1	6	0.904	0.844	8.00
Cricotopus bicinctus type (n=2)	Cric?bic	6	0.806	0.844	8.01 : 7.93 to 8.08
Sergentia longiventris type (n=82)	Serg?lov	7	0.137	0.485	8.03 : 8.00 to 8.11
Orthocladius obumbratus type (n=9)	Orth?obu	7	0.436	0.485	8.04 : 8.00 to 8.11
Limnophyes sp. (n=2)	Limninde	7	0.756	0.485	8.06 : 8.00 to 8.11
Thienemanniella vittata type (n=2)	Thil?vit	7	0.756	0.485	8.06 : 8.00 to 8.11
Eukiefferiella claripennis type (n=4)	Euki?cla	7	0.715	0.485	8.06 : 8.00 to 8.08
Sergentia sp. (n=9)	Serginde	7	0.715	0.485	8.06 : 8.00 to 8.08
Diamesinae indet 3 (n=6)	sfDiame3	7	−0.122	0.485	8.08 : 8.00 to 8.11

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Tab. A.3 (continued): taxa cluster regarding weighted average pH value; - - - - = 5 suboptimal groups ($s_{ave} = 0.621$) and —— = 36 optimal groups ($s_{ave} = 0.664$).

taxon (counts)	shortened	cluster	Cluster's silhouette width s_i	Cluster's silhouette width average s_{ave}	pH value
Dicrotendipes sp. (n=3)	Dicrinde	8	1.000	1.000	8.11
Stictochironomus sp. (n=2)	Sticinde	8	1.000	1.000	8.11
Psectrocladius sordidellus/limbatellus (n=128)	Psec?sol	9	0.692	0.723	8.22 : 7.10 to 10.76
Chironominae sp. (n=7)	sfChiron	9	0.783	0.723	8.23 : 7.30 to 10.40
Paratendipes nudisquama type (n=6)	Patd?nus	9	0.695	0.723	8.27 : 8.00 to 8.40
Acricotopus lucens type (n=2)	Acri?luc	10	0.858	0.772	8.40
Chironomidae indet 1 (n=7)	faChiro1	10	0.858	0.772	8.40
Tanytarsus lapponicus type (n=87)	Tany?lap	10	0.602	0.772	8.44 : 7.10 to 10.70
Cladotanytarsus mancus type (n=4)	Clat?man	11	0.625	0.675	8.52
Pseudosmittia sp. (n=11)	Psesinde	11	0.726	0.675	8.56 : 8.00 to 10.50
Metriocnemus eurynotus type (n=30)	Metr?eur	12	0.798	0.772	8.70 : 7.40 to 8.87
Paratanytarsus dissimilis type (n=33)	Part?dis	12	0.746	0.772	8.72 : 7.47 to 10.43
Procladius choreus type (n=11)	Proc?cho	13	0.875	0.866	8.79 : 7.40 to 9.70
Chironomus/Einfeldia sp. men1 man2 (n=43)	ChEim1m2	13	0.857	0.866	8.80 : 7.30 to 10.66
Chironomus/Einfeldia sp. (n=23)	ChEiinde	14	0.172	0.359	8.83 : 7.30 to 10.83
Pseudosmittia indet 2 (n=21)	Psesind2	14	0.547	0.359	8.86 : 8.40 to 10.50
Chironomus/Einfeldia sp. men1 (n=103)	ChEimen1	15	0.676	0.709	8.92 : 7.30 to 10.83
Chironomus/Einfeldia sp. men1 man1 (n=70)	ChEim1m1	15	0.738	0.709	8.93 : 7.30 to 10.70
Cricotopus/Orthocladius sp. (n=14)	CrOrinde	15	0.741	0.709	8.93 : 7.40 to 10.76
Cricotopus salinophilus (n=131)	Cricsano	15	0.743	0.709	8.96 : 7.55 to 10.27
Orthocladiinae sp. (n=92)	sfOrthoc	15	0.645	0.709	8.97 : 7.10 to 10.83
Tanytarsini sp. (n=483)	trTanyta	16	0.980	0.980	9.08 : 7.10 to 10.83
Psectrocladius sokolovae/pancratovae (n=27)	Psec?sop	16	0.980	0.980	9.09 : 7.10 to 10.40
Cryptochironomus sp. (n=4)	Crycinde	17	0.573	0.558	9.12 : 7.47 to 10.02
Ablabesmyia monilis type (n=9)	Abla?mon	17	0.665	0.558	9.13 : 8.77 to 10.76
Tanytarsus sp. (n=16)	Tanyinde	17	0.437	0.558	9.15 : 7.80 to 10.02

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Tab. A.3 (continued): taxa cluster regarding weighted average pH value; - - - - = 5 suboptimal groups ($s_{\text{ave}} = 0.621$) and —— = 36 optimal groups ($s_{\text{ave}} = 0.664$).

taxon (counts)	shortened	cluster	Cluster's silhouette width s_i	Cluster's silhouette width average s_{ave}	pH value
Chironomus/Einfeldia sp. men2 man1 (n=11)	ChEim2m1	18	0.790	0.833	9.19 : 7.40 to 10.66
Paratanytarsus austriacus type (n=5)	Part?aus	18	0.866	0.833	9.20 : 7.80 to 10.43
Chironomini sp. (n=18)	trChiron	18	0.842	0.833	9.20 : 7.47 to 10.83
Procladius sp. (n=8)	Procinde	19	0.867	0.874	9.24 : 8.11 to 10.50
Chironomus/Einfeldia sp. men2 man3 (n=3)	ChEim2m3	19	0.882	0.874	9.25 : 7.30 to 10.43
Psectrocladius sp. (n=59)	Psecinde	20	0.755	0.711	9.32 : 7.30 to 10.83
Chironomidae indet 2 (n=16)	faChiro2	20	0.825	0.711	9.33 : 7.30 to 9.78
Saetheria sp. (n=6)	Saetinde	20	0.813	0.711	9.33
Acricotopus sp. (n=12)	Acriinde	20	0.450	0.711	9.35 : 8.11 to 10.50
Cricotopus sylvestris gr. indet 1 (n=60)	Cricgsy1	21	0.000	0.000	9.39 : 7.47 to 10.83
Cricotopus sylvestris gr. (n=8)	Cricgsyl	22	0.455	0.624	9.43 : 8.52 to 10.27
Chironomus/Einfeldia sp. men2 (n=40)	ChEimen2	22	0.706	0.624	9.44 : 7.30 to 10.83
Polypedilum nubifer type (n=9)	Poly?nub	22	0.760	0.624	9.45 : 7.80 to 9.66
Paratanytarsus sp. (n=206)	Partinde	22	0.574	0.624	9.46 : 7.47 to 10.83
Psectrocladius barbimanus/-sokolovae (n=108)	Psec?bas	23	0.988	0.988	9.52 : 9.10 to 10.83
Acricotopus indet 1 (n=75)	Acriind1	23	0.988	0.988	9.52 : 8.40 to 10.04
Acricotopus longipalpus type (n=416)	Acri?lon	24	0.601	0.658	9.56 : 7.80 to 10.83
Tanypodinae sp. (n=24)	sfTanypo	24	0.715	0.658	9.57 : 7.40 to 10.76
Corynoneura scutellata type (n=7)	Corn?scu	25	0.553	0.553	9.62 : 7.40 to 10.83
Chironomus/Einfeldia sp. men3 (n=36)	ChEimen3	25	0.681	0.553	9.62 : 7.80 to 10.83
Cricotopus sylvestris gr. indet 2 (n=47)	Cricgsy2	25	0.495	0.553	9.65 : 7.47 to 10.83
Chironomus/Einfeldia sp. men2 man2 (n=24)	ChEim2m2	25	0.482	0.553	9.65 : 7.40 to 10.70
Corynoneura/Thienemanniella sp. (n=9)	CoThinde	26	0.450	0.543	9.68 : 8.00 to 10.70
Chironomus/Einfeldia sp. men1 man3 (n=18)	ChEim1m3	26	0.636	0.543	9.70 : 7.47 to 10.76
Ablabesmyia sp. (n=5)	Ablainde	27	0.000	0.000	9.76 : 9.10 to 10.76
Chironomus/Einfeldia sp. men3 man1 (n=9)	ChEim3m1	28	0.698	0.632	9.89 : 8.31 to 10.76
Cricotopus shilovae (n=42)	Cricshil	28	0.567	0.632	9.91 : 8.08 to 10.83

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Tab. A.3 (continued): taxa cluster regarding weighted average pH value; - - - - = 5 suboptimal groups ($s_{ave} = 0.621$) and —— = 36 optimal groups ($s_{ave} = 0.664$).

taxon (counts)	shortened	cluster	Cluster's silhouette width s_i	average s_{ave}	pH value
Chironomus/Einfeldia sp. men3 man2 (n=5)	ChEim3m2	29	0.567	0.735	9.94 : 8.00 to 10.70
Cryptochironomus fulvus/digitatus (n=4)	Cryc?fud	29	0.833	0.735	9.95 : 9.66 to 10.83
Chironomus/Einfeldia sp. men3 man3 (n=8)	ChEim3m3	29	0.806	0.735	9.96 : 8.70 to 10.70
Tanytarsus/Corynocera sp. (n=17)	TaCoinde	30	0.482	0.588	9.99 : 9.10 to 10.76
Polypedilum sp. (n=2)	Polyinde	30	0.668	0.588	10.00
Paratanytarsus penicillatus type (n=52)	Part?pen	30	0.613	0.588	10.02 : 8.70 to 10.76
Tanytarsus gracilentus type (n=157)	Tany?gra	31	0.789	0.761	10.12 : 8.45 to 10.83
Psectrocladius obvius type (n=3)	Psec?obv	31	0.733	0.761	10.13 : 9.94 to 10.35
Corynoneura arctica type (n=16)	Corn?arc	32	0.000	0.000	10.19 : 7.47 to 10.70
Nanocladius rectinervis type (n=7)	Nano?rec	33	0.306	0.552	10.24 : 10.02 to 10.40
Corynoneura arctica/scutellata (n=20)	Corn?asc	33	0.681	0.552	10.27 : 8.45 to 10.76
Glyptotendipes pallens type (n=12)	Glyp?pae	33	0.668	0.552	10.27 : 10.02 to 10.40
Conchapelopia sp. (n=2)	Concinde	34	0.870	0.872	10.32 : 10.30 to 10.35
Glyptotendipes sp. (n=9)	Glypinde	34	0.875	0.872	10.33 : 9.38 to 10.83
Nanocladius sp. (n=2)	Nanoinde	35	0.000	0.000	10.40
Corynoneura sp. (n=2)	Cornsinde	36	0.000	0.000	10.62 : 10.40 to 10.83

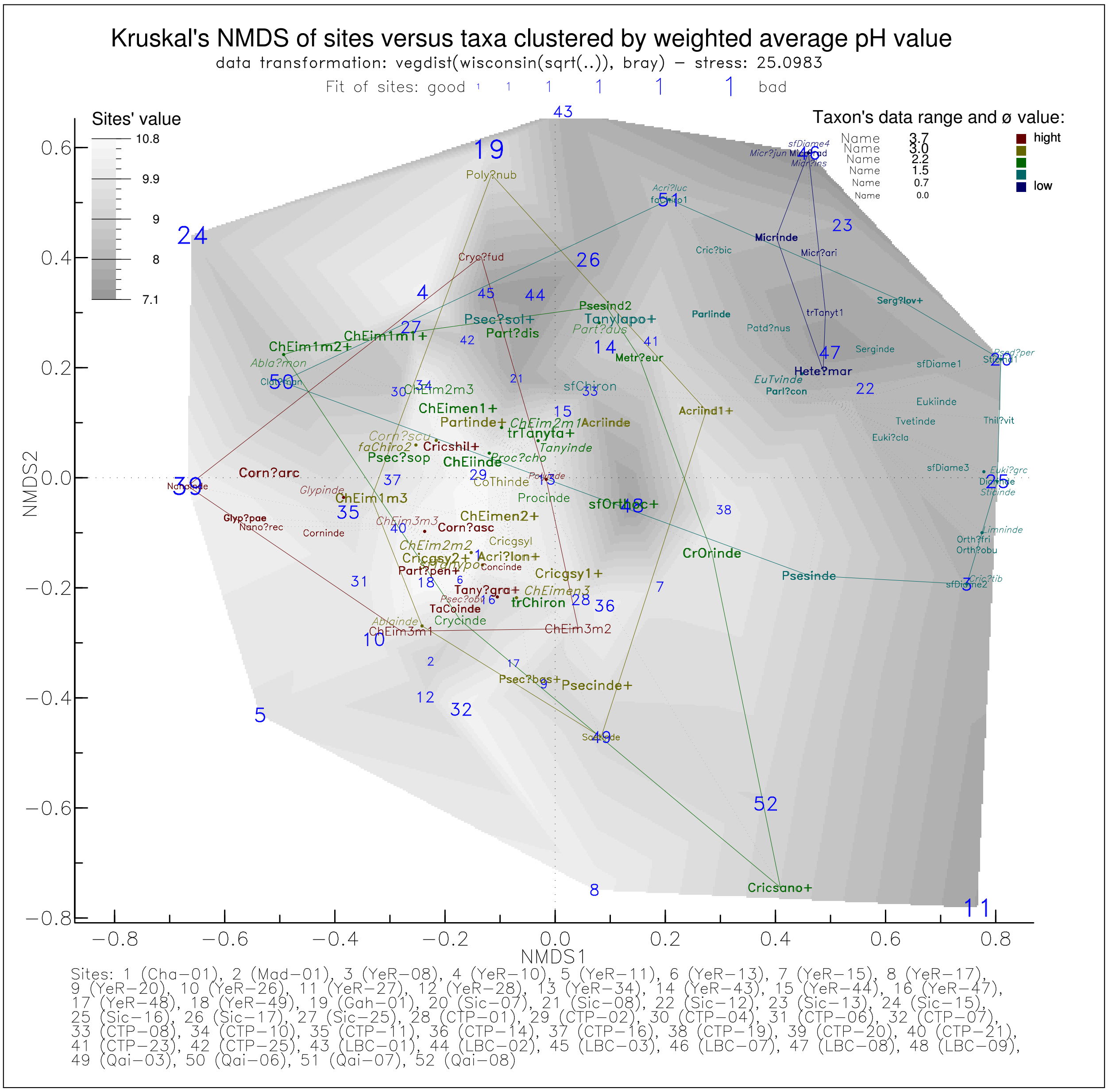

Fig. A.3.: NMDS ordination of taxa versus sites with cluster groups regarding taxa's weighted average pH values from sites for all together 36 optimal groups and average cluster silhouette width $s_{\text{ave}} = 0.664$ for each group. Plotted groups are merged to 5 suboptimal groups with $s_{\text{ave}} = 0.621$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Environmental variable is given as grey scale image calculated as a linear fit from sites' values. Numeric results see Table A.3 and abbreviations see on pages VI–VIII (*italic* names like *Corn?scu* · are placed by an offset next to their x-y score point; **bold** names indicate a number of head capsules with n ⩾ 10 and **bold+** indicates n ⩾ 40; 1 unit = 0.5 distance after Raup and Crick (1979)).

Tab. A.4.: Results of clustered taxa regarding weighted average water area$_{\log 10}$ (m^2) with 37 optimal groups (——) and cluster's average silhouette width $s_{ave} = 0.672$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Values of s_i are indicated by horizontal boxes; data sorted by their weighted average $\log_{10}$ values; for multiple measured values, the data range is given; - - - - = 5 suboptimal groups ($s_{ave} = 0.503$). Note that order of weighted$\{\log_{10}\} \neq$ weighted$\{10^{\log_{10}}\}$.

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	cluster's silhouette width average s_{ave}	water area $\log_{10}$ x (10^x) in m^2
Polypedilum sp. (n=2)	Polyinde	1	0.000	0.000	2.602 (400)
Nanocladius sp. (n=2)	Nanoinde	2	0.000	0.000	3.176 (1500)
Corynoneura arctica type (n=16)	Corn?arc	3	0.000	0.000	3.259: 2.602 to 4.429 (4391 : 400 to 2.69×10^4)
Metriocnemus eurynotus type (n=30)	Metr?eur	4	0.345	0.474	3.320: 2.983 to 7.669 (1.56×10^6 : 962 to 4.67×10^7)
Acricotopus sp. (n=12)	Acriinde	4	0.604	0.474	3.360: 2.602 to 6.143 (1.19×10^5 : 400 to 1.39×10^6)
Corynoneura arctica/scutellata (n=20)	Corn?asc	5	0.905	0.916	3.595: 2.602 to 5.681 (3.26×10^4 : 400 to 4.80×10^5)
Cricotopus tibialis type (n=2)	Cric?tib	5	0.945	0.916	3.602 (4000)
Diamesinae indet 2 (n=2)	sfDiame2	5	0.945	0.916	3.602 (4000)
Glyptotendipes sp. (n=9)	Glypinde	5	0.868	0.916	3.612: 2.602 to 4.628 (1.14×10^4 : 400 to 4.25×10^4)
Cricotopus shilovae (n=42)	Cricshil	6	0.524	0.680	3.675: 2.602 to 6.637 (1.55×10^5 : 400 to 4.33×10^6)
Chironomus/Einfeldia sp. men3 man3 (n=8)	ChEim3m3	6	0.756	0.680	3.694: 2.752 to 5.681 (6.73×10^4 : 565 to 4.80×10^5)
Psectrocladius obvius type (n=3)	Psec?obv	6	0.774	0.680	3.701: 2.849 to 4.321 (1.01×10^4 : 706 to 2.10×10^4)
Acricotopus longipalpus type (n=416)	Acri?lon	6	0.663	0.680	3.735: 2.602 to 6.839 (1.99×10^5 : 400 to 6.91×10^6)
Corynoneura sp. (n=2)	Corninde	7	0.000	0.000	3.902: 3.176 to 4.628 (2.20×10^4 : 1500 to 4.25×10^4)

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Tab. A.4 (continued): taxa cluster regarding weighted average water area; - - - - = 5 suboptimal groups (s_{ave} = 0.503) and —— = 37 optimal groups (s_{ave} = 0.672). Note that order of weighted{$\log_{10}$} $\neq$ weighted{$10^{\log_{10}}$}.

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	cluster's silhouette width average s_{ave}	water area $\log_{10}$ x (10^{x}) in m^2
Glyptotendipes pallens type (n=12)	Glyp?pae	8	0.687	0.677	4.011: 3.176 to 5.681 (1.61×10^5 : 1500 to 4.80×10^5)
Orthocladius frigidus type (n=5)	Orth?fri	8	0.798	0.677	4.025: 3.602 to 5.717 (1.07×10^5 : 4000 to 5.21×10^5)
Tanytarsus sp. (n=16)	Tanyinde	8	0.766	0.677	4.042: 2.602 to 7.669 (3.17×10^6 : 400 to 4.67×10^7)
Pseudosmittia sp. (n=11)	Psesinde	8	0.456	0.677	4.069: 2.602 to 9.613 (3.73×10^8 : 400 to 4.10×10^9)
Paratanytarsus penicillatus type (n=52)	Part?pen	9	0.874	0.814	4.139: 2.602 to 6.105 (1.12×10^5 : 400 to 1.27×10^6)
Chironomus/Einfeldia sp. men2 man2 (n=24)	ChEim2m2	9	0.874	0.814	4.139: 2.849 to 9.613 (1.74×10^8 : 706 to 4.10×10^9)
Paratanytarsus sp. (n=206)	Partinde	9	0.694	0.814	4.165: 2.602 to 7.742 (5.36×10^5 : 400 to 5.53×10^7)
Nanocladius rectinervis type (n=7)	Nano?rec	10	0.000	0.000	4.250: 3.176 to 5.681 (2.07×10^5 : 1500 to 4.80×10^5)
Paratanytarsus dissimilis type (n=33)	Part?dis	11	0.817	0.796	4.373: 3.176 to 6.193 (2.57×10^5 : 1500 to 1.56×10^6)
Tanytarsus/Corynocera sp. (n=17)	TaCoinde	11	0.775	0.796	4.388: 2.602 to 6.105 (2.43×10^5 : 400 to 1.27×10^6)
Orthocladius obumbratus type (n=9)	Orth?obu	12	0.815	0.796	4.449: 3.602 to 6.143 (4.66×10^5 : 4000 to 1.39×10^6)
Eukiefferiella/Tvetenia sp. (n=12)	EuTvinde	12	0.827	0.796	4.450: 2.983 to 5.717 (1.08×10^5 : 962 to 5.21×10^5)
Chironomus/Einfeldia sp. men1 (n=103)	ChEimen1	12	0.746	0.796	4.473: 2.602 to 7.742 (5.36×10^6 : 400 to 5.53×10^7)

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Tab. A.4 (continued): taxa cluster regarding weighted average water area; - - - - = 5 suboptimal groups (s_{ave} = 0.503) and ——— = 37 optimal groups (s_{ave} = 0.672). Note that order of weighted{$\log_{10}$} ≠ weighted{$10^{\log_{10}}$}.

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	water area $\log_{10}$ x (10^x) in m^2
Procladius choreus type (n=11)	Proc?cho	13	0.746	0.643	4.556: 3.176 to 9.613 (3.73×10^8 : 1500 to 4.10×10^9)
Chironomus/Einfeldia sp. men3 man2 (n=5)	ChEim3m2	13	0.747	0.643	4.556: 2.849 to 6.637 (9.12×10^5 : 707 to 4.33×10^6)
Psectrocladius sordidellus/limbatellus (n=128)	Psec?sol	13	0.746	0.643	4.576: 2.602 to 6.821 (2.84×10^5 : 400 to 6.62×10^6)
Chironomus/Einfeldia sp. men2 man1 (n=11)	ChEim2m1	13	0.688	0.643	4.583: 2.849 to 6.637 (6.90×10^5 : 707 to 4.33×10^6)
Tanytarsus gracilentus type (n=157)	Tany?gra	13	0.288	0.643	4.600: 2.602 to 6.637 (4.46×10^5 : 400 to 4.33×10^6)
Corynoneura scutellata type (n=7)	Corn?scu	14	0.819	0.819	4.638: 3.176 to 6.637 (8.62×10^5 : 1500 to 4.33×10^6)
Tanypodinae sp. (n=24)	sfTanypo	14	0.821	0.819	4.638: 2.602 to 9.613 (3.42×10^8 : 400 to 4.10×10^9)
Tanytarsus lapponicus type (n=87)	Tany?lap	14	0.850	0.819	4.650: 2.602 to 7.669 (2.05×10^6 : 400 to 4.67×10^7)
Eukiefferiella gracei type (n=2)	Euki?grc	14	0.787	0.819	4.659: 3.602 to 5.717 (2.63×10^5 : 4000 to 5.21×10^5)
Chironomus/Einfeldia sp. men1 man1 (n=70)	ChEim1m1	15	0.858	0.861	4.734: 2.752 to 7.742 (2.62×10^6 : 565 to 5.53×10^7)
Ablabesmyia sp. (n=5)	Ablainde	15	0.867	0.861	4.734: 3.840 to 5.497 (1.45×10^5 : 6923 to 3.14×10^5)
Tanytarsini sp. (n=483)	trTanyta	15	0.883	0.861	4.747: 2.602 to 9.613 (2.72×10^7 : 400 to 4.10×10^9)
Paratanytarsus austriacus type (n=5)	Part?aus	15	0.837	0.861	4.756: 3.789 to 5.717 (1.70×10^5 : 6157 to 5.21×10^5)

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Tab. A.4 (continued): taxa cluster regarding weighted average water area; - - - - = 5 suboptimal groups (s_{ave} = 0.503) and —— = 37 optimal groups (s_{ave} = 0.672). Note that order of weighted$\{\log_{10}\} \neq$ weighted$\{10^{\log_{10}}\}$.

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	water area $\log_{10}$ x (10^x) in m^2
Corynoneura/Thienemanniella sp. (n=9)	CoThinde	16	0.549	0.737	4.850: 3.176 to 7.669 (5.88×10^6 : 1500 to 4.67×10^7)
Limnophyes sp. (n=2)	Limninde	16	0.772	0.737	4.873: 3.602 to 6.143 (6.97×10^5 : 4000 to 1.39×10^6)
Eukiefferiella claripennis type (n=4)	Euki?cla	16	0.805	0.737	4.879: 3.602 to 5.304 (1.52×10^5 : 4000 to 2.02×10^5)
Conchapelopia sp. (n=2)	Concinde	16	0.829	0.737	4.888: 3.934 to 5.843 (3.52×10^5 : 8595 to 6.96×10^5)
Tvetenia sp. (n=4)	Tvetinde	16	0.829	0.737	4.899: 3.602 to 5.717 (2.05×10^5 : 4000 to 5.21×10^5)
Chironomus/Einfeldia sp. men2 (n=40)	ChEimen2	16	0.733	0.737	4.921: 2.778 to 9.613 (5.16×10^8 : 600 to 4.10×10^9)
Procladius sp. (n=8)	Procinde	16	0.642	0.737	4.931: 2.602 to 9.613 (5.20×10^8 : 400 to 4.10×10^9)
Chironomus/Einfeldia sp. men1 man3 (n=18)	ChEim1m3	17	0.845	0.831	5.056: 2.752 to 7.742 (3.40×10^6 : 565 to 5.53×10^7)
Heterotrissocladius marcidus type (n=16)	Hete?mar	17	0.817	0.831	5.066: 3.701 to 6.250 (2.81×10^5 : 5027 to 1.78×10^6)
Orthocladiinae sp. (n=92)	sfOrthoc	18	0.952	0.953	5.121: 2.602 to 9.613 (1.42×10^8 : 400 to 4.10×10^9)
Chironomus/Einfeldia sp. men2 man3 (n=3)	ChEim2m3	18	0.954	0.953	5.124: 4.424 to 5.681 (2.30×10^5 : 2.65×10^4 to 4.80×10^5)
Tanytarsini indet 1 (n=5)	trTanyt1	19	0.526	0.320	5.228: 4.972 to 6.250 (4.31×10^5 : 9.37×10^4 to 1.78×10^6)
Paracladius conversus type (n=10)	Parl?con	19	0.114	0.320	5.277: 3.602 to 6.143 (5.52×10^5 : 4000 to 1.39×10^6)

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Tab. A.4 (continued): taxa cluster regarding weighted average water area; - - - - = 5 suboptimal groups (s_{ave} = 0.503) and —— = 37 optimal groups (s_{ave} = 0.672). Note that order of weighted{$\log_{10}$} $\neq$ weighted{$10^{\log_{10}}$}.

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	water area $\log_{10}$ x (10^x) in m^2
Sergentia sp. (n=9)	Serginde	20	0.812	0.873	5.325: 5.189 to 5.717 (2.27×10^5 : 1.55×10^5 to 5.21×10^5)
Chironomus/Einfeldia sp. men3 man1 (n=9)	ChEim3m1	20	0.910	0.873	5.337: 2.778 to 9.613 (4.57×10^8 : 600 to 4.10×10^9)
Ablabesmyia monilis type (n=9)	Abla?mon	20	0.896	0.873	5.339: 3.840 to 5.933 (5.77×10^5 : 6923 to 8.57×10^5)
Sergentia longiventris type (n=82)	Serg?lov	21	0.241	0.272	5.394: 5.189 to 6.143 (2.98×10^5 : 1.55×10^5 to 1.39×10^6)
Diamesinae indet 3 (n=6)	sfDiame3	21	0.302	0.272	5.440: 3.602 to 6.143 (7.63×10^5 : 4000 to 1.39×10^6)
Diamesinae indet 1 (n=5)	sfDiame1	22	0.398	0.422	5.485: 4.972 to 5.717 (3.72×10^5 : 9.37×10^4 to 5.21×10^5)
Psectrocladius barbimanus/sokolovae (n=108)	Psec?bas	22	0.445	0.422	5.527: 2.602 to 9.613 (2.11×10^8 : 400 to 4.10×10^9)
Cryptochironomus sp. (n=4)	Crycinde	23	0.558	0.765	5.577: 4.903 to 6.821 (1.81×10^6 : 8.00×10^4 to 6.62×10^6)
Paracladius sp. (n=10)	Parlinde	23	0.828	0.765	5.600: 5.428 to 6.143 (5.18×10^5 : 2.68×10^5 to 1.39×10^6)
Micropsectra aristata type (n=4)	Micr?ari	23	0.846	0.765	5.611: 4.972 to 6.250 (9.37×10^5 : 9.37×10^4 to 1.78×10^6)
Eukiefferiella sp. (n=7)	Eukiinde	23	0.830	0.765	5.614: 4.972 to 6.143 (6.17×10^5 : 9.37×10^4 to 1.39×10^6)
Pseudodiamesa pertinax type (n=2)	Psed?per	24	0.609	0.702	5.717 (5.21×10^5)
Stictochironomus sp. 1 (n=3)	Sticind1	24	0.609	0.702	5.717 (5.21×10^5)
Cricotopus bicinctus type (n=2)	Cric?bic	24	0.799	0.702	5.749: 5.304 to 6.193 (8.80×10^5 : 2.02×10^5 to 1.56×10^6)
Micropsectra sp. (n=26)	Micrinde	24	0.810	0.702	5.753: 3.602 to 6.250 (1.16×10^6 : 4000 to 1.78×10^6)
Cricotopus/Orthocladius sp. (n=14)	CrOrinde	24	0.776	0.702	5.775: 3.602 to 9.613 (3.17×10^8 : 4000 to 4.10×10^9)

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Tab. A.4 (continued): taxa cluster regarding weighted average water area; - - - - = 5 suboptimal groups (s_{ave} = 0.503) and —— = 37 optimal groups (s_{ave} = 0.672). Note that order of weighted{$\log_{10}$} $\neq$ weighted{$10^{\log_{10}}$}.

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	water area $\log_{10}$ x (10^x) in m^2
Chironomus/Einfeldia sp. men3 (n=36)	ChEimen3	24	0.762	0.702	5.778: 2.752 to 9.613 (1.14×10^9 : 565 to 4.10×10^9)
Chironomus/Einfeldia sp. (n=23)	ChEiinde	24	0.546	0.702	5.802: 2.849 to 9.613 (7.23×10^8 : 707 to 4.10×10^9)
Chironomidae indet 2 (n=16)	faChiro2	25	0.515	0.450	5.895: 4.429 to 6.105 (1.06×10^6 : 2.69×10^4 to 1.27×10^6)
Thienemanniella vittata type (n=2)	Thil?vit	25	0.527	0.450	5.930: 5.717 to 6.143 (9.56×10^5 : 5.21×10^5 to 1.39×10^6)
Chironomus/Einfeldia sp. men1 man2 (n=43)	ChEim1m2	25	0.307	0.450	5.939: 2.752 to 7.742 (1.59×10^7 : 565 to 5.53×10^7)
Chironominae sp. (n=7)	sfChiron	26	0.758	0.774	5.970: 3.176 to 7.742 (1.58×10^7 : 1500 to 5.53×10^7)
Cricotopus sylvestris gr. indet 2 (n=47)	Cricgsy2	26	0.790	0.774	5.982: 2.602 to 9.613 (3.58×10^8 : 400 to 4.10×10^9)
Cryptochironomus fulvus/digitatus (n=4)	Cryc?fud	27	0.000	0.000	6.038: 4.628 to 6.508 (2.43×10^6 : 4.25×10^4 to 3.22×10^6)
Dicrotendipes sp. (n=3)	Dicrinde	28	1.000	1.000	6.143 (1.39×10^6)
Stictochironomus sp. (n=2)	Sticinde	28	1.000	1.000	6.143 (1.39×10^6)
Polypedilum nubifer type (n=9)	Poly?nub	29	0.700	0.708	6.190: 3.645 to 6.508 (2.86×10^6 : 4412 to 3.22×10^6)
Psectrocladius sokolovae/pancratovae (n=27)	Psec?sop	29	0.716	0.708	6.204: 3.176 to 7.742 (2.55×10^7 : 1500 to 5.53×10^7)
Diamesinae indet 4 (n=2)	sfDiame4	30	0.951	0.928	6.250 (1.78×10^6)
Micropsectra insignilobus type (n=4)	Micr?ins	30	0.951	0.928	6.250 (1.78×10^6)
Micropsectra junci type (n=4)	Micr?jun	30	0.951	0.928	6.250 (1.78×10^6)
Micropsectra radialis type (n=7)	Micr?rad	30	0.951	0.928	6.250 (1.78×10^6)
Psectrocladius sp. (n=59)	Psecinde	30	0.836	0.928	6.261: 2.602 to 9.613 (3.67×10^8 : 400 to 4.10×10^9)

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Tab. A.4 (continued): taxa cluster regarding weighted average water area; - - - - = 5 suboptimal groups (s_{ave} = 0.503) and —— = 37 optimal groups (s_{ave} = 0.672). Note that order of weighted{$\log_{10}$} ≠ weighted{$10^{\log_{10}}$}.

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	water area $\log_{10}$ x (10^x) in m^2
Paratendipes nudisquama type (n=6)	Patd?nus	31	0.302	0.445	6.313: 3.602 to 7.669 (3.11×10^7 : 4000 to 4.67×10^7)
Cricotopus salinophilus (n=131)	Cricsano	31	0.589	0.445	6.356: 4.321 to 8.484 (3.47×10^7 : 2.10×10^4 to 3.05×10^8)
Pseudosmittia indet 2 (n=21)	Psesind2	32	0.764	0.787	6.451: 2.602 to 7.669 (3.12×10^7 : 400 to 4.67×10^7)
Cricotopus sylvestris gr. indet 1 (n=60)	Cricgsy1	32	0.809	0.787	6.479: 2.602 to 9.613 (1.10×10^9 : 400 to 4.10×10^9)
Cricotopus sylvestris gr. (n=8)	Cricgsyl	33	0.000	0.000	6.661: 3.701 to 9.613 (1.03×10^9 : 5027 to 4.10×10^9)
Acricotopus indet 1 (n=75)	Acriind1	34	0.994	0.994	7.105: 6.839 to 7.669 (1.96×10^7 : 6.91×10^6 to 4.67×10^7)
Chironomini sp. (n=18)	trChiron	34	0.994	0.994	7.107: 2.602 to 9.613 (1.83×10^9 : 400 to 4.10×10^9)
Acricotopus lucens type (n=2)	Acri?luc	35	1.000	1.000	7.669 (4.67×10^7)
Chironomidae indet 1 (n=7)	faChiro1	35	1.000	1.000	7.669 (4.67×10^7)
Cladotanytarsus mancus type (n=4)	Clat?man	36	0.000	0.000	7.742 (5.53×10^7)
Saetheria sp. (n=6)	Saetinde	37	0.000	0.000	9.613 (4.10×10^9)

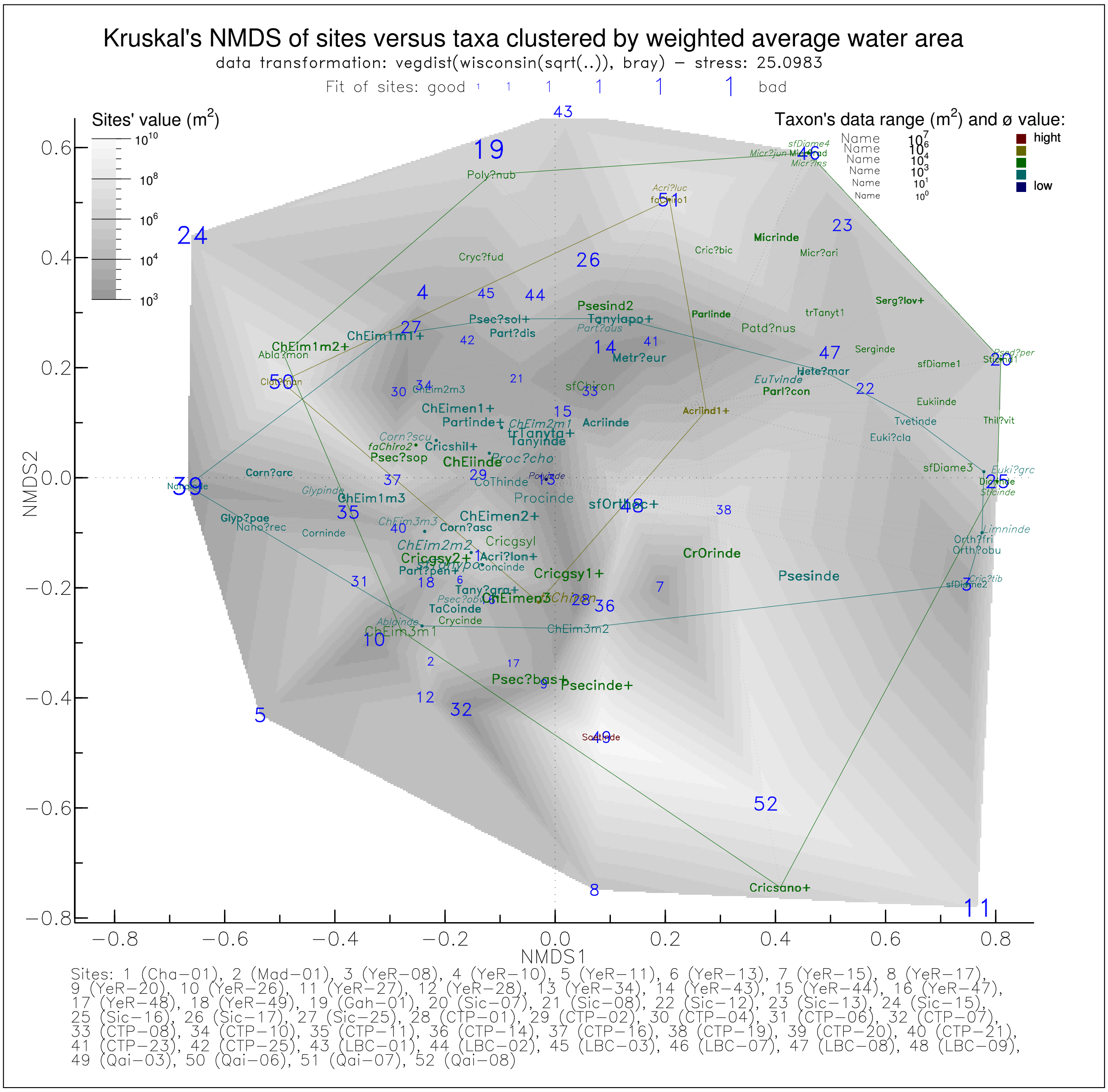

Fig. A.4.: NMDS: taxa vs. sites with cluster groups regarding taxa's weighted average water area$_{\log 10}$ (m^2) and all together 37 optimal groups with cluster's average silhouette width of $s_{\mathrm{ave}} = 0.672$. Plotted groups are merged to 5 suboptimal groups with $s_{\mathrm{ave}} = 0.503$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Environmental variable is given as grey scale image calculated as a linear fit from sites' values. Numeric results see Table A.4 and abbreviations see on pages VI–VIII (*italic* names like *Corn?scu* · are placed by an offset next to their x-y score point; **bold** names indicate a number of head capsules with n ⩾ 10 and **bold+** indicates n ⩾ 40; 1 unit = 0.5 distance after Raup and Crick 1979).

Tab. A.5.: Results of clustered taxa regarding weighted average October air temperature T_{Oct} (°C) with 28 optimal groups (——) and cluster's average silhouette width $s_{ave} = 0.682$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Values of s_i are indicated by horizontal boxes; data sorted by their weighted average values; for multiple measured values, the data range is given; - - - - = 3 suboptimal groups ($s_{ave} = 0.606$).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	cluster's silhouette width average s_{ave}	T_{Oct} in °C
Polypedilum sp. (n=2)	Polyinde	1	0.000	0.000	−2.51
Ablabesmyia sp. (n=5)	Ablainde	2	0.608	0.482	−1.54 : −2.92 to 3.73
Cricotopus salinophilus (n=131)	Cricsano	2	0.356	0.482	−1.42 : −2.93 to 2.88
Chironomus/Einfeldia sp. men3 man1 (n=9)	ChEim3m1	3	0.000	0.000	−1.22 : −2.89 to 4.91
Cricotopus shilovae (n=42)	Cricshil	4	0.831	0.821	−0.73 : −2.98 to 5.94
Psectrocladius barbimanus/-sokolovae (n=108)	Psec?bas	4	0.811	0.821	−0.65 : −2.98 to 5.94
Paratanytarsus penicillatus type (n=52)	Part?pen	5	0.676	0.585	−0.27 : −2.93 to 4.61
Chironomus/Einfeldia sp. men3 man2 (n=5)	ChEim3m2	5	0.719	0.585	−0.21 : −1.60 to 3.26
Acricotopus longipalpus type (n=416)	Acri?lon	5	0.359	0.585	−0.14 : −2.98 to 8.01
Cricotopus tibialis type (n=2)	Cric?tib	6	0.747	0.719	−0.03
Diamesinae indet 2 (n=2)	sfDiame2	6	0.747	0.719	−0.03
Metriocnemus eurynotus type (n=30)	Metr?eur	6	0.664	0.719	0.07 : −1.76 to 9.25
Paratanytarsus sp. (n=206)	Partinde	7	0.692	0.708	0.39 : −2.93 to 8.20
Chironomus/Einfeldia sp. men3 man3 (n=8)	ChEim3m3	7	0.762	0.708	0.48 : −1.43 to 3.26
Tanypodinae sp. (n=24)	sfTanypo	7	0.671	0.708	0.51 : −2.98 to 9.25
Chironomus/Einfeldia sp. men2 man2 (n=24)	ChEim2m2	8	0.685	0.750	0.69 : −2.93 to 9.25
Tanytarsus/Corynocera sp. (n=17)	TaCoinde	8	0.836	0.750	0.74 : −2.92 to 4.61
Orthocladius frigidus type (n=5)	Orth?fri	8	0.730	0.750	0.78 : −0.03 to 4.00
Paratendipes nudisquama type (n=6)	Patd?nus	9	0.681	0.770	0.97 : −0.03 to 1.46
Tanytarsus gracilentus type (n=157)	Tany?gra	9	0.833	0.770	1.01 : −2.98 to 5.94
Cryptochironomus sp. (n=4)	Crycinde	9	0.852	0.770	1.02 : −2.71 to 7.99
Paratanytarsus austriacus type (n=5)	Part?aus	9	0.786	0.770	1.06 : −2.72 to 7.43
Cricotopus sylvestris gr. indet 1 (n=60)	Cricgsy1	9	0.698	0.770	1.08 : −2.98 to 7.99

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Tab. A.5 (continued): taxa cluster regarding weighted average October air temperature T_{Oct}; - - - - = 3 suboptimal groups (s_{ave} = 0.606) and —— = 28 optimal groups (s_{ave} = 0.682).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	T_{Oct} in °C
Pseudosmittia indet 2 (n=21)	Psesind2	10	−0.165	0.481	1.16 : −2.51 to 1.53
Procladius choreus type (n=11)	Proc?cho	10	0.464	0.481	1.22 : −2.92 to 9.25
Glyptotendipes sp. (n=9)	Glypinde	10	0.676	0.481	1.30 : −2.98 to 5.94
Cricotopus sylvestris gr. indet 2 (n=47)	Cricgsy2	10	0.642	0.481	1.34 : −2.98 to 7.99
Pseudosmittia sp. (n=11)	Psesinde	10	0.602	0.481	1.35 : −0.03 to 4.91
Acricotopus sp. (n=12)	Acriinde	10	0.586	0.481	1.35 : −2.93 to 8.20
Psectrocladius obvius type (n=3)	Psec?obv	10	0.564	0.481	1.36 : −2.93 to 3.73
Chironomus/Einfeldia sp. men3 (n=36)	ChEimen3	11	0.575	0.632	1.46 : −2.98 to 7.43
Acricotopus lucens type (n=2)	Acri?luc	11	0.624	0.632	1.46
Chironomidae indet 1 (n=7)	faChiro1	11	0.624	0.632	1.46
Chironomus/Einfeldia sp. men2 (n=40)	ChEimen2	11	0.735	0.632	1.53 : −2.98 to 7.99
Psectrocladius sp. (n=59)	Psecinde	11	0.726	0.632	1.55 : −2.98 to 9.25
Tanytarsus sp. (n=16)	Tanyinde	11	0.507	0.632	1.61 : −2.98 to 7.43
Cricotopus/Orthocladius sp. (n=14)	CrOrinde	12	0.632	0.524	1.81 : −2.89 to 9.25
Cricotopus sylvestris gr. (n=8)	Cricgsyl	12	0.417	0.524	1.89 : −2.98 to 4.91
Eukiefferiella gracei type (n=2)	Euki?grc	13	0.471	0.689	1.99 : −0.03 to 4.00
Chironomus/Einfeldia sp. men1 man3 (n=18)	ChEim1m3	13	0.812	0.689	2.06 : −2.89 to 8.02
Corynoneura arctica/scutellata (n=20)	Corn?asc	13	0.783	0.689	2.07 : −2.89 to 5.94
Cladotanytarsus mancus type (n=4)	Clat?man	14	0.092	0.413	2.17
Chironomus/Einfeldia sp. men2 man3 (n=3)	ChEim2m3	14	0.677	0.413	2.25 : −2.72 to 7.95
Chironomus/Einfeldia sp. men2 man1 (n=11)	ChEim2m1	14	0.622	0.413	2.29 : −2.73 to 9.25
Paratanytarsus dissimilis type (n=33)	Part?dis	14	0.261	0.413	2.33 : −2.72 to 8.02
Tanytarsini sp. (n=483)	trTanyta	15	0.772	0.793	2.45 : −2.98 to 9.25
Corynoneura sp. (n=2)	Corninde	15	0.814	0.793	2.49 : −0.97 to 5.94
Chironomus/Einfeldia sp. men1 (n=103)	ChEimen1	16	0.293	0.591	2.64 : −2.98 to 9.25
Procladius sp. (n=8)	Procinde	16	0.704	0.591	2.71 : −0.70 to 8.20
Orthocladius obumbratus type (n=9)	Orth?obu	16	0.727	0.591	2.72 : −0.03 to 8.20
Chironomus/Einfeldia sp. (n=23)	ChEiinde	16	0.731	0.591	2.77 : −2.71 to 7.97
Cryptochironomus fulvus/digitatus (n=4)	Cryc?fud	16	0.499	0.591	2.84 : −0.97 to 4.11

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Tab. A.5 (continued): taxa cluster regarding weighted average October air temperature T_{Oct}; - - - - = 3 suboptimal groups ($s_{ave} = 0.606$) and —— = 28 optimal groups ($s_{ave} = 0.682$).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	T_{Oct} in °C
Orthocladiinae sp. (n=92)	sfOrthoc	17	0.893	0.888	3.09 : −2.98 to 9.25
Eukiefferiella claripennis type (n=4)	Euki?cla	17	0.882	0.888	3.13 : −0.03 to 4.18
Corynoneura/Thienemanniella sp. (n=9)	CoThinde	18	0.640	0.553	3.41 : −1.60 to 8.20
Ablabesmyia monilis type (n=9)	Abla?mon	18	0.466	0.553	3.51 : −2.98 to 6.74
Psectrocladius sokolovae/pancratovae (n=27)	Psec?sop	19	0.393	0.750	3.63 : −2.93 to 9.20
Conchapelopia sp. (n=2)	Concinde	19	0.870	0.750	3.73 : 3.73 to 3.74
Chironomus/Einfeldia sp. men1 man2 (n=43)	ChEim1m2	19	0.871	0.750	3.74 : −2.73 to 7.97
Chironomus/Einfeldia sp. men1 man1 (n=70)	ChEim1m1	19	0.868	0.750	3.74 : −1.76 to 8.02
Pseudodiamesa pertinax type (n=2)	Psed?per	20	0.697	0.767	4.00
Stictochironomus sp. 1 (n=3)	Sticind1	20	0.697	0.767	4.00
Nanocladius rectinervis type (n=7)	Nano?rec	20	0.809	0.767	4.05 : 1.52 to 5.94
Limnophyes sp. (n=2)	Limninde	20	0.858	0.767	4.09 : −0.03 to 8.20
Corynoneura scutellata type (n=7)	Corn?scu	20	0.856	0.767	4.09 : −1.60 to 9.25
Polypedilum nubifer type (n=9)	Poly?nub	20	0.856	0.767	4.09 : 3.93 to 4.11
Sergentia sp. (n=9)	Sergindе	20	0.691	0.767	4.16 : 4.00 to 4.18
Sergentia longiventris type (n=82)	Serg?lov	20	0.669	0.767	4.17 : 4.00 to 8.20
Tvetenia sp. (n=4)	Tvetinde	21	0.462	0.629	4.35 : −0.03 to 9.25
Tanytarsus lapponicus type (n=87)	Tany?lap	21	0.778	0.629	4.45 : −2.51 to 9.25
Glyptotendipes pallens type (n=12)	Glyp?pae	21	0.789	0.629	4.47 : 1.52 to 5.94
Chironomini sp. (n=18)	trChiron	21	0.488	0.629	4.58 : −2.51 to 7.99
Corynoneura arctica type (n=16)	Corn?arc	22	0.799	0.774	4.85 : −2.51 to 7.97
Saetheria sp. (n=6)	Saetinde	22	0.749	0.774	4.91
Diamesinae indet 1 (n=5)	sfDiame1	23	0.546	0.662	5.09 : 4.00 to 9.25
Eukiefferiella/Tvetenia sp. (n=12)	EuTvinde	23	0.751	0.662	5.14 : −0.67 to 9.25
Psectrocladius sordidellus/limbatellus (n=128)	Psec?sol	23	0.784	0.662	5.17 : −2.89 to 9.25
Chironomidae indet 2 (n=16)	faChiro2	23	0.565	0.662	5.24 : 4.61 to 7.97
Diamesinae indet 3 (n=6)	sfDiame3	24	0.000	0.000	5.49 : −0.03 to 8.20
Acricotopus indet 1 (n=75)	Acriind1	25	0.616	0.777	5.91 : 1.46 to 8.01
Nanocladius sp. (n=2)	Nanoinde	25	0.700	0.777	5.94
Eukiefferiella sp. (n=7)	Eukiinde	25	0.790	0.777	6.00 : 4.00 to 9.25

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Tab. A.5 (continued): taxa cluster regarding weighted average October air temperature T_{Oct}; - - - - = 3 suboptimal groups ($s_{ave} = 0.606$) and —— = 28 optimal groups ($s_{ave} = 0.682$).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	T_{Oct} in °C
Thienemanniella vittata type (n=2)	Thil?vit	25	0.850	0.777	6.10 : 4.00 to 8.20
Cricotopus bicinctus type (n=2)	Cric?bic	25	0.850	0.777	6.10 : 4.18 to 8.02
Chironominae sp. (n=7)	sfChiron	25	0.832	0.777	6.14 : 1.46 to 9.25
Paracladius conversus type (n=10)	Parl?con	25	0.799	0.777	6.17 : −0.03 to 8.20
Paracladius sp. (n=10)	Parlinde	26	0.982	0.982	7.24 : 4.00 to 8.20
Micropsectra sp. (n=26)	Micrinde	26	0.982	0.982	7.26 : −0.03 to 9.25
Dicrotendipes sp. (n=3)	Dicrinde	27	0.981	0.975	8.20
Stictochironomus sp. (n=2)	Sticinde	27	0.981	0.975	8.20
Heterotrissocladius marcidus type (n=16)	Hete?mar	27	0.963	0.975	8.23 : −0.80 to 9.25
Diamesinae indet 4 (n=2)	sfDiame4	28	0.989	0.985	9.20
Micropsectra insignilobus type (n=4)	Micr?ins	28	0.989	0.985	9.20
Micropsectra junci type (n=4)	Micr?jun	28	0.989	0.985	9.20
Micropsectra radialis type (n=7)	Micr?rad	28	0.989	0.985	9.20
Micropsectra aristata type (n=4)	Micr?ari	28	0.981	0.985	9.23 : 9.20 to 9.25
Tanytarsini indet 1 (n=5)	trTanyt1	28	0.972	0.985	9.24 : 9.20 to 9.25

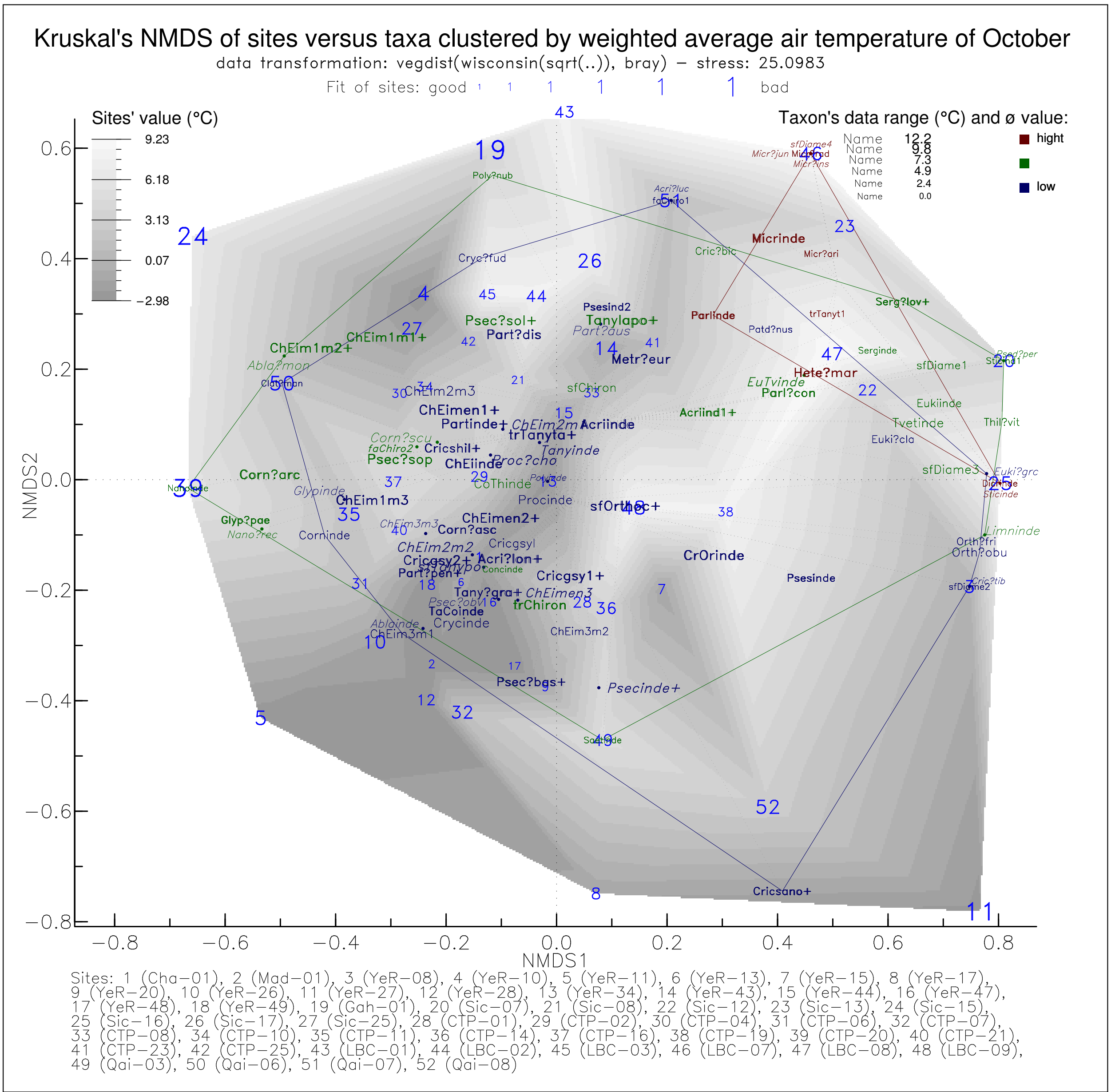

Fig. A.5.: NMDS ordination of taxa versus sites with cluster groups regarding taxa's weighted average air temperature of October (°C) and all together 28 optimal clusters with cluster's average silhouette width of $s_{\text{ave}} = 0.682$. Plotted groups are merged to 3 suboptimal groups with $s_{\text{ave}} = 0.606$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Environmental variable is given as grey scale image calculated as a linear fit from sites' values. Numeric results see Table A.5 and abbreviations see on pages VI–VIII (*italic* names like *Corn?scu* · are placed by an offset next to their x-y score point; **bold** names indicate a number of head capsules with n ⩾ 10 and **bold+** indicates n ⩾ 40; 1 unit = 0.5 distance after Raup and Crick (1979)).

Tab. A.6.: Results of clustered taxa regarding weighted average July air temperature T_{Jul} (°C) with 30 optimal groups (——) and cluster's average silhouette width $s_{ave} = 0.640$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Values of s_i are indicated by horizontal boxes; data sorted by their weighted average values; for multiple measured values, the data range is given; - - - - = 3 suboptimal groups ($s_{ave} = 0.565$).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	cluster's silhouette width average s_{ave}	T_{Jul} in °C
Polypedilum sp. (n=2)	Polyinde	1	0.000	0.000	8.03
Ablabesmyia sp. (n=5)	Ablainde	2	0.000	0.000	8.97 : 7.72 to 13.44
Cricotopus shilovae (n=42)	Cricshil	3	0.734	0.686	9.66 : 7.63 to 16.16
Chironomus/Einfeldia sp. men3 man1 (n=9)	ChEim3m1	3	0.637	0.686	9.74 : 7.72 to 17.43
Cricotopus salinophilus (n=131)	Cricsano	4	0.000	0.000	9.97 : 7.68 to 17.93
Metriocnemus eurynotus type (n=30)	Metr?eur	5	0.533	0.498	10.13 : 8.89 to 15.48
Paratanytarsus penicillatus type (n=52)	Part?pen	5	0.462	0.498	10.21 : 7.68 to 14.36
Acricotopus longipalpus type (n=416)	Acri?lon	6	0.382	0.389	10.32 : 7.63 to 17.72
Chironomus/Einfeldia sp. men3 man2 (n=5)	ChEim3m2	6	0.396	0.389	10.40 : 9.45 to 11.94
Chironomus/Einfeldia sp. men3 man3 (n=8)	ChEim3m3	7	0.757	0.841	10.52 : 9.42 to 11.94
Cryptochironomus sp. (n=4)	Crycinde	7	0.890	0.841	10.56 : 8.18 to 14.38
Paratanytarsus sp. (n=206)	Partinde	7	0.875	0.841	10.57 : 7.68 to 15.55
Tanypodinae sp. (n=24)	sfTanypo	8	0.673	0.730	10.84 : 7.63 to 17.43
Paratanytarsus austriacus type (n=5)	Part?aus	8	0.681	0.730	10.85 : 7.99 to 14.75
Chironomus/Einfeldia sp. men2 man2 (n=24)	ChEim2m2	8	0.830	0.730	10.93 : 7.68 to 17.43
Psectrocladius barbimanus/-sokolovae (n=108)	Psec?bas	8	0.820	0.730	10.95 : 7.63 to 17.93
Tanytarsus/Corynocera sp. (n=17)	TaCoinde	8	0.798	0.730	10.96 : 7.72 to 14.36
Psectrocladius obvius type (n=3)	Psec?obv	8	0.579	0.730	11.02 : 7.68 to 13.44
Procladius choreus type (n=11)	Proc?cho	9	0.840	0.791	11.25 : 7.76 to 17.43
Tanytarsus gracilentus type (n=157)	Tany?gra	9	0.845	0.791	11.25 : 7.63 to 16.16
Cricotopus tibialis type (n=2)	Cric?tib	9	0.877	0.791	11.29
Diamesinae indet 2 (n=2)	sfDiame2	9	0.877	0.791	11.29
Chironomus/Einfeldia sp. men2 man3 (n=3)	ChEim2m3	9	0.514	0.791	11.39 : 7.99 to 14.67

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Tab. A.6 (continued): taxa clusters regarding weighted average July air temperature T_{Jul}; - - - - = 3 suboptimal groups ($s_{ave} = 0.565$) and —— = 30 optimal groups ($s_{ave} = 0.640$).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	cluster's silhouette width average s_{ave}	T_{Jul} in °C
Chironomus/Einfeldia sp. men2 man1 (n=11)	ChEim2m1	10	0.808	0.726	11.60 : 7.98 to 15.47
Corynoneura arctica/scutellata (n=20)	Corn?asc	10	0.825	0.726	11.61 : 7.72 to 16.16
Acricotopus sp. (n=12)	Acriinde	10	0.543	0.726	11.68 : 7.68 to 15.47
Glyptotendipes sp. (n=9)	Glypinde	11	0.446	0.583	11.78 : 7.63 to 16.16
Orthocladius frigidus type (n=5)	Orth?fri	11	0.745	0.583	11.84 : 11.29 to 14.08
Paratanytarsus dissimilis type (n=33)	Part?dis	11	0.740	0.583	11.85 : 7.99 to 14.75
Chironomus/Einfeldia sp. men2 (n=40)	ChEimen2	11	0.400	0.583	11.88 : 7.63 to 17.43
Tanytarsus sp. (n=16)	Tanyinde	12	0.577	0.694	11.95 : 7.63 to 15.48
Chironomus/Einfeldia sp. men1 man3 (n=18)	ChEim1m3	12	0.778	0.694	11.99 : 7.72 to 16.16
Tanytarsini sp. (n=483)	trTanyta	12	0.727	0.694	12.02 : 7.63 to 17.72
Cricotopus/Orthocladius sp. (n=14)	CrOrinde	13	0.080	0.438	12.13 : 7.72 to 17.93
Ablabesmyia monilis type (n=9)	Abla?mon	13	0.723	0.438	12.22 : 7.63 to 14.50
Pseudosmittia sp. (n=11)	Psesinde	13	0.722	0.438	12.22 : 11.29 to 17.43
Chironomus/Einfeldia sp. men3 (n=36)	ChEimen3	13	0.630	0.438	12.25 : 7.63 to 17.43
Cricotopus sylvestris gr. indet 2 (n=47)	Cricgsy2	13	0.035	0.438	12.31 : 7.63 to 17.43
Chironomus/Einfeldia sp. men1 (n=103)	ChEimen1	14	0.654	0.698	12.40 : 7.63 to 16.16
Cricotopus sylvestris gr. indet 1 (n=60)	Cricgsy1	14	0.743	0.698	12.45 : 7.63 to 17.43
Orthocladius obumbratus type (n=9)	Orth?obu	15	0.895	0.881	12.68 : 11.29 to 15.47
Eukiefferiella gracei type (n=2)	Euki?grc	15	0.904	0.881	12.68 : 11.29 to 14.08
Orthocladiinae sp. (n=92)	sfOrthoc	15	0.843	0.881	12.73 : 7.63 to 17.93
Chironomus/Einfeldia sp. men1 man1 (n=70)	ChEim1m1	16	0.646	0.626	12.99 : 8.89 to 16.16
Tanytarsus lapponicus type (n=87)	Tany?lap	16	0.749	0.626	13.05 : 8.03 to 15.48
Corynoneura sp. (n=2)	Corninde	16	0.749	0.626	13.07 : 9.98 to 16.16
Cryptochironomus fulvus/digitatus (n=4)	Cryc?fud	16	0.647	0.626	13.11 : 9.98 to 14.15
Procladius sp. (n=8)	Procinde	16	0.339	0.626	13.14 : 9.42 to 17.43
Psectrocladius sp. (n=59)	Psecinde	17	0.453	0.689	13.22 : 7.63 to 17.93
Chironomus/Einfeldia sp. (n=23)	ChEiinde	17	0.764	0.689	13.27 : 8.18 to 17.43
Eukiefferiella/Tvetenia sp. (n=12)	EuTvinde	17	0.768	0.689	13.30 : 9.44 to 15.28

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Tab. A.6 (continued): taxa clusters regarding weighted average July air temperature T_{Jul}; - - - - = 3 suboptimal groups (s_{ave} = 0.565) and —— = 30 optimal groups (s_{ave} = 0.640).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	T_{Jul} in °C
Cricotopus sylvestris gr. (n=8)	Cricgsyl	17	0.747	0.689	13.30 : 7.63 to 17.43
Psectrocladius sordidellus/limbatellus (n=128)	Psec?sol	17	0.714	0.689	13.31 : 7.72 to 16.16
Limnophyes sp. (n=2)	Limninde	18	0.070	0.526	13.38 : 11.29 to 15.47
Corynoneura scutellata type (n=7)	Corn?scu	18	0.756	0.526	13.46 : 9.45 to 16.16
Eukiefferiella claripennis type (n=4)	Euki?cla	18	0.754	0.526	13.47 : 11.29 to 14.19
Chironomus/Einfeldia sp. men1 man2 (n=43)	ChEim1m2	19	0.430	0.669	13.62 : 7.98 to 15.55
Tvetenia sp. (n=4)	Tvetinde	19	0.771	0.669	13.71 : 11.29 to 15.28
Conchapelopia sp. (n=2)	Concinde	19	0.744	0.669	13.73 : 13.44 to 14.02
Corynoneura/Thienemanniella sp. (n=9)	CoThinde	19	0.730	0.669	13.73 : 9.45 to 16.16
Pseudosmittia indet 2 (n=21)	Psesind2	20	0.000	0.000	13.91 : 8.03 to 15.48
Pseudodiamesa pertinax type (n=2)	Psed?per	21	0.699	0.735	14.08
Stictochironomus sp. 1 (n=3)	Sticind1	21	0.699	0.735	14.08
Paratendipes nudisquama type (n=6)	Patd?nus	21	0.699	0.735	14.08 : 11.29 to 15.48
Polypedilum nubifer type (n=9)	Poly?nub	21	0.814	0.735	14.14 : 14.05 to 14.15
Sergentia longiventris type (n=82)	Serg?lov	21	0.785	0.735	14.15 : 14.08 to 15.47
Nanocladius rectinervis type (n=7)	Nano?rec	21	0.747	0.735	14.17 : 11.50 to 16.16
Sergentia sp. (n=9)	Serginde	21	0.706	0.735	14.17 : 14.08 to 14.19
Paracladius conversus type (n=10)	Parl?con	22	0.176	0.519	14.27 : 11.29 to 15.47
Diamesinae indet 1 (n=5)	sfDiame1	22	0.706	0.519	14.34 : 14.08 to 15.28
Diamesinae indet 3 (n=6)	sfDiame3	22	0.709	0.519	14.34 : 11.29 to 15.47
Chironomidae indet 2 (n=16)	faChiro2	22	0.610	0.519	14.42 : 14.36 to 14.68
Cricotopus bicinctus type (n=2)	Cric?bic	22	0.393	0.519	14.45 : 14.19 to 14.71
Psectrocladius sokolovae/pancratovae (n=27)	Psec?sop	23	0.824	0.724	14.60 : 7.68 to 16.16
Glyptotendipes pallens type (n=12)	Glyp?pae	23	0.841	0.724	14.61 : 11.50 to 16.16
Micropsectra sp. (n=26)	Micrinde	23	0.829	0.724	14.62 : 11.29 to 15.28
Eukiefferiella sp. (n=7)	Eukiinde	23	0.404	0.724	14.68 : 14.08 to 15.47
Thienemanniella vittata type (n=2)	Thil?vit	24	0.767	0.777	14.77 : 14.08 to 15.47
Corynoneura arctica type (n=16)	Corn?arc	24	0.843	0.777	14.79 : 8.03 to 16.16
Paracladius sp. (n=10)	Parlinde	24	0.720	0.777	14.82 : 14.08 to 15.47

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Tab. A.6 (continued): taxa clusters regarding weighted average July air temperature T_{Jul}; - - - - = 3 suboptimal groups ($s_{ave} = 0.565$) and —— = 30 optimal groups ($s_{ave} = 0.640$).

taxon (counts)		shortened	cluster	cluster's silhouette width s_i	average s_{ave}	T_{Jul} in °C
Heterotrissocladius marcidus type	(n=16)	Hete?mar	25	0.136	0.336	14.92 : 10.39 to 15.47
Chironomini sp.	(n=18)	trChiron	25	0.537	0.336	15.03 : 8.03 to 17.43
Diamesinae indet 4	(n=2)	sfDiame4	26	0.951	0.934	15.25
Micropsectra insignilobus type	(n=4)	Micr?ins	26	0.951	0.934	15.25
Micropsectra junci type	(n=4)	Micr?jun	26	0.951	0.934	15.25
Micropsectra radialis type	(n=7)	Micr?rad	26	0.951	0.934	15.25
Micropsectra aristata type	(n=4)	Micr?ari	26	0.936	0.934	15.27 : 15.25 to 15.28
Tanytarsini indet 1	(n=5)	trTanyt1	26	0.912	0.934	15.28 : 15.25 to 15.28
Chironominae sp.	(n=7)	sfChiron	26	0.888	0.934	15.28 : 14.38 to 16.16
Stictochironomus sp.	(n=2)	Sticinde	27	0.865	0.844	15.47
Dicrotendipes sp.	(n=3)	Dicrinde	27	0.865	0.844	15.47
Acricotopus lucens type	(n=2)	Acri?luc	27	0.885	0.844	15.48
Chironomidae indet 1	(n=7)	faChiro1	27	0.885	0.844	15.48
Cladotanytarsus mancus type	(n=4)	Clat?man	27	0.720	0.844	15.55
Nanocladius sp.	(n=2)	Nanoinde	28	0.000	0.000	16.16
Acricotopus indet 1	(n=75)	Acriind1	29	0.000	0.000	17.00 : 15.48 to 17.72
Saetheria sp.	(n=6)	Saetinde	30	0.000	0.000	17.43

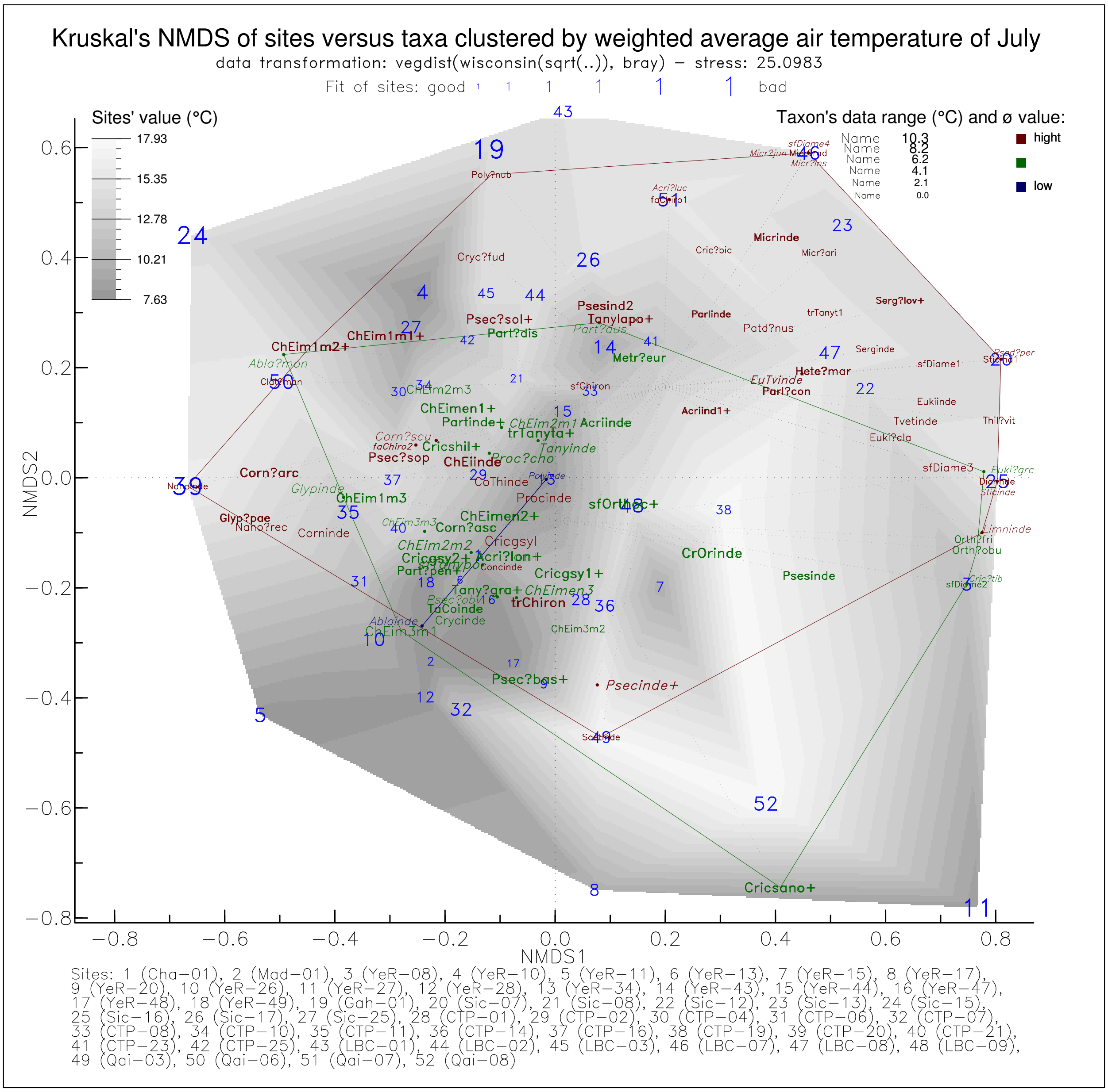

Fig. A.6.: NMDS ordination of taxa versus sites with cluster groups regarding taxa's weighted average air temperature of July (°C) and all together 30 optimal groups with cluster's average silhouette width $s_{\text{ave}} = 0.640$. Plotted groups are are merged to 3 suboptimal groups with $s_{\text{ave}} = 0.565$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Environmental variable is given as grey scale image calculated as a linear fit from sites' values. Numeric results see Table A.6 and abbreviations see on pages VI–VIII (*italic* names like *Corn?scu* · are placed by an offset next to their x-y score point; **bold** names indicate a number of head capsules with n ⩾ 10 and **bold+** indicates n ⩾ 40; 1 unit = 0.5 distance after Raup and Crick (1979)).

Tab. A.7.: Results of clustered taxa regarding weighted average December precipitation P_{Dec} (mm) with 2 optimal groups (——) and cluster's average silhouette width $s_{ave} = 0.665$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Values of s_i are indicated by horizontal boxes; data sorted by their weighted average values; for multiple measured values, the data range is given; - - - - = 8 suboptimal groups ($s_{ave} = 0.641$)

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	P_{Dec} in mm
Acricotopus indet 1 (n=75)	Acriind1	1	0.548	0.651	0.40 : 0.20 to 0.83
Nanocladius sp. (n=2)	Nanoinde	1	0.624	0.651	0.76
Acricotopus lucens type (n=2)	Acri?luc	1	0.641	0.651	0.83
Chironomidae indet 1 (n=7)	faChiro1	1	0.641	0.651	0.83
Corynoneura arctica type (n=16)	Corn?arc	1	0.663	0.651	0.92 : 0.73 to 1.85
Chironomidae indet 2 (n=16)	faChiro2	1	0.674	0.651	0.97 : 0.73 to 1.03
Paratendipes nudisquama type (n=6)	Patd?nus	1	0.721	0.651	1.16 : 0.83 to 1.80
Corynoneura sp. (n=2)	Corninde	1	0.722	0.651	1.16 : 0.76 to 1.56
Glyptotendipes pallens type (n=12)	Glyp?pae	1	0.724	0.651	1.17 : 0.76 to 1.97
Tanytarsini indet 1 (n=5)	trTanyt1	1	0.725	0.651	1.17 : 1.17 to 1.18
Micropsectra aristata type (n=4)	Micr?ari	1	0.726	0.651	1.17 : 1.17 to 1.18
Diamesinae indet 4 (n=2)	sfDiame4	1	0.727	0.651	1.18
Micropsectra insignilobus type (n=4)	Micr?ins	1	0.727	0.651	1.18
Micropsectra junci type (n=4)	Micr?jun	1	0.727	0.651	1.18
Micropsectra radialis type (n=7)	Micr?rad	1	0.727	0.651	1.18
Pseudosmittia indet 2 (n=21)	Psesind2	1	0.733	0.651	1.21 : 0.83 to 2.34
Corynoneura scutellata type (n=7)	Corn?scu	1	0.734	0.651	1.22 : 0.72 to 1.93
Micropsectra sp. (n=26)	Micrinde	1	0.746	0.651	1.28 : 0.72 to 2.00
Nanocladius rectinervis type (n=7)	Nano?rec	1	0.746	0.651	1.28 : 0.76 to 1.97
Psectrocladius sordidellus/limbatellus (n=128)	Psec?sol	1	0.748	0.651	1.29 : 0.72 to 3.75
Psectrocladius sp. (n=59)	Psecinde	1	0.754	0.651	1.33 : 0.27 to 3.75
Conchapelopia sp. (n=2)	Concinde	1	0.756	0.651	1.34 : 1.27 to 1.41
Glyptotendipes sp. (n=9)	Glypinde	1	0.758	0.651	1.35 : 0.76 to 1.95
Cricotopus bicinctus type (n=2)	Cric?bic	1	0.758	0.651	1.36 : 0.72 to 2.00
Heterotrissocladius marcidus type (n=16)	Hete?mar	1	0.760	0.651	1.37 : 1.17 to 3.29
Corynoneura/Thienemanniella sp. (n=9)	CoThinde	1	0.769	0.651	1.45 : 0.76 to 3.29
Psectrocladius obvius type (n=3)	Psec?obv	1	0.772	0.651	1.48 : 1.21 to 1.95
Eukiefferiella/Tvetenia sp. (n=12)	EuTvinde	1	0.774	0.651	1.49 : 1.17 to 2.00
Psectrocladius barbimanus/-sokolovae (n=108)	Psec?bas	1	0.774	0.651	1.49 : 0.27 to 2.22

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Tab. A.7 (continued): taxa cluster regarding weighted average December precipitation P_{Dec}; - - - - = 8 suboptimal groups ($s_{ave} = 0.641$) and —— = 2 optimal groups ($s_{ave} = 0.665$).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	cluster's silhouette width average s_{ave}	P_{Dec} in mm
Chironomus/Einfeldia sp. men2 man3 (n=3)	ChEim2m3	1	0.776	0.651	1.51 : 0.73 to 1.97
Corynoneura arctica/scutellata (n=20)	Corn?asc	1	0.776	0.651	1.52 : 0.76 to 2.37
Cricotopus salinophilus (n=131)	Cricsano	1	0.777	0.651	1.53 : 0.27 to 1.95
Chironomus/Einfeldia sp. men3 man2 (n=5)	ChEim3m2	1	0.778	0.651	1.56 : 1.21 to 1.80
Tanytarsus gracilentus type (n=157)	Tany?gra	1	0.778	0.651	1.56 : 0.76 to 2.37
Chironomus/Einfeldia sp. men2 man2 (n=24)	ChEim2m2	1	0.778	0.651	1.57 : 0.73 to 2.22
Chironomus/Einfeldia sp. (n=23)	ChEiinde	1	0.779	0.651	1.61 : 0.73 to 2.22
Chironomus/Einfeldia sp. men3 man3 (n=8)	ChEim3m3	1	0.779	0.651	1.62 : 1.21 to 2.09
Tanytarsus/Corynocera sp. (n=17)	TaCoinde	1	0.779	0.651	1.64 : 1.03 to 1.97
Cricotopus sylvestris gr. indet 2 (n=47)	Cricgsy2	1	0.778	0.651	1.65 : 0.76 to 3.75
Metriocnemus eurynotus type (n=30)	Metr?eur	1	0.778	0.651	1.66 : 0.83 to 1.80
- - - - -					
Tvetenia sp. (n=4)	Tvetinde	1	0.774	0.651	1.73 : 1.17 to 2.00
Procladius choreus type (n=11)	Proc?cho	1	0.772	0.651	1.75 : 0.73 to 2.37
Cricotopus shilovae (n=42)	Cricshil	1	0.772	0.651	1.75 : 0.76 to 2.09
Chironomus/Einfeldia sp. men1 man3 (n=18)	ChEim1m3	1	0.772	0.651	1.75 : 0.72 to 2.09
Tanypodinae sp. (n=24)	sfTanypo	1	0.772	0.651	1.76 : 1.17 to 2.37
Ablabesmyia sp. (n=5)	Ablainde	1	0.771	0.651	1.76 : 1.27 to 1.94
Chironominae sp. (n=7)	sfChiron	1	0.769	0.651	1.78 : 0.73 to 3.75
Diamesinae indet 1 (n=5)	sfDiame1	1	0.765	0.651	1.80 : 1.17 to 2.00
Cricotopus tibialis type (n=2)	Cric?tib	1	0.764	0.651	1.80
Diamesinae indet 2 (n=2)	sfDiame2	1	0.764	0.651	1.80
Acricotopus longipalpus type (n=416)	Acri?lon	1	0.764	0.651	1.81 : 0.20 to 3.64
Chironomus/Einfeldia sp. men1 (n=103)	ChEimen1	1	0.763	0.651	1.81 : 0.73 to 4.13
Orthocladiinae sp. (n=92)	sfOrthoc	1	0.763	0.651	1.81 : 0.20 to 3.75
Paratanytarsus dissimilis type (n=33)	Part?dis	1	0.761	0.651	1.82 : 0.72 to 3.64
Paratanytarsus penicillatus type (n=52)	Part?pen	1	0.760	0.651	1.82 : 1.03 to 2.09
Psectrocladius sokolovae/pancratovae (n=27)	Psec?sop	1	0.758	0.651	1.83 : 0.76 to 3.75
Orthocladius frigidus type (n=5)	Orth?fri	1	0.756	0.651	1.83 : 1.80 to 1.94
Polypedilum sp. (n=2)	Polyinde	1	0.751	0.651	1.85
Pseudosmittia sp. (n=11)	Psesinde	1	0.747	0.651	1.86 : 1.21 to 2.23

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Tab. A.7 (continued): taxa cluster regarding weighted average December precipitation P_{Dec}; - - - - = 8 suboptimal groups ($s_{ave} = 0.641$) and —— = 2 optimal groups ($s_{ave} = 0.665$).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	P_{Dec} in mm
Eukiefferiella gracei type (n=2)	Euki?grc	1	0.741	0.651	1.87 : 1.80 to 1.94
Chironomus/Einfeldia sp. men2 (n=40)	ChEimen2	1	0.741	0.651	1.88 : 0.73 to 4.13
Chironomus/Einfeldia sp. men3 man1 (n=9)	ChEim3m1	1	0.736	0.651	1.89 : 1.62 to 2.23
Cladotanytarsus mancus type (n=4)	Clat?man	1	0.727	0.651	1.91
Cricotopus/Orthocladius sp. (n=14)	CrOrinde	1	0.725	0.651	1.91 : 0.27 to 3.75
Cricotopus sylvestris gr. indet 1 (n=60)	Cricgsy1	1	0.724	0.651	1.91 : 0.83 to 3.75
Pseudodiamesa pertinax type (n=2)	Psed?per	1	0.709	0.651	1.94
Stictochironomus sp. 1 (n=3)	Sticind1	1	0.709	0.651	1.94
Eukiefferiella claripennis type (n=4)	Euki?cla	1	0.707	0.651	1.95 : 1.80 to 2.00
Tanytarsini sp. (n=483)	trTanyta	1	0.700	0.651	1.96 : 0.20 to 3.75
Paratanytarsus sp. (n=206)	Partinde	1	0.695	0.651	1.97 : 0.73 to 3.75
Chironomus/Einfeldia sp. men3 (n=36)	ChEimen3	1	0.693	0.651	1.97 : 1.21 to 3.64
Tanytarsus sp. (n=16)	Tanyinde	1	0.679	0.651	1.99 : 0.83 to 3.64
Sergentia sp. (n=9)	Sergince	1	0.678	0.651	1.99 : 1.94 to 2.01
Sergentia longiventris type (n=82)	Serg?lov	1	0.672	0.651	2.00 : 1.94 to 3.29
Tanytarsus lapponicus type (n=87)	Tany?lap	1	0.648	0.651	2.04 : 0.72 to 3.64
Cricotopus sylvestris gr. (n=8)	Cricgsyl	1	0.646	0.651	2.04 : 1.48 to 2.47
Procladius sp. (n=8)	Procinde	1	0.594	0.651	2.10 : 1.27 to 3.29
Paratanytarsus austriacus type (n=5)	Part?aus	1	0.502	0.651	2.19 : 1.72 to 3.64
Saetheria sp. (n=6)	Saetinde	1	0.474	0.651	2.22
Acricotopus sp. (n=12)	Acriinde	1	0.467	0.651	2.23 : 1.72 to 3.29
Eukiefferiella sp. (n=7)	Eukiinde	1	0.459	0.651	2.23 : 1.17 to 3.29
Cryptochironomus fulvus/digitatus (n=4)	Cryc?fud	1	0.450	0.651	2.24 : 1.56 to 2.47
Chironomus/Einfeldia sp. men2 man1 (n=11)	ChEim2m1	1	0.426	0.651	2.26 : 1.17 to 4.13
Orthocladius obumbratus type (n=9)	Orth?obu	1	0.370	0.651	2.30 : 1.80 to 3.29
Chironomini sp. (n=18)	trChiron	1	0.336	0.651	2.32 : 0.76 to 3.75
Cryptochironomus sp. (n=4)	Crycinde	1	0.283	0.651	2.36 : 1.85 to 3.75
Chironomus/Einfeldia sp. men1 man1 (n=70)	ChEim1m1	1	0.254	0.651	2.37 : 0.72 to 4.13
Polypedilum nubifer type (n=9)	Poly?nub	1	0.193	0.651	2.41 : 1.91 to 2.47
Limnophyes sp. (n=2)	Limninde	1	−0.113	0.651	2.55 : 1.80 to 3.29
Chironomus/Einfeldia sp. men1 man2 (n=43)	ChEim1m2	1	−0.226	0.651	2.60 : 0.73 to 4.13

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Tab. A.7 (continued): taxa cluster regarding weighted average December precipitation P_{Dec}; - - - - = 8 suboptimal groups ($s_{ave} = 0.641$) and —— = 2 optimal groups ($s_{ave} = 0.665$).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	cluster's silhouette width average s_{ave}	P_{Dec} in mm
Diamesinae indet 3 (n=6)	sfDiame3	1	−0.241	0.651	2.61 : 1.80 to 3.29
Thienemanniella vittata type (n=2)	Thil?vit	1	−0.252	0.651	2.62 : 1.94 to 3.29
Paracladius conversus type (n=10)	Parl?con	2	0.878	0.927	3.17 : 1.80 to 3.64
Dicrotendipes sp. (n=3)	Dicrinde	2	0.946	0.927	3.29
Stictochironomus sp. (n=2)	Sticinde	2	0.946	0.927	3.29
Paracladius sp. (n=10)	Parlinde	2	0.933	0.927	3.40 : 1.94 to 3.64
Ablabesmyia monilis type (n=9)	Abla?mon	2	0.931	0.927	3.40 : 1.94 to 4.13

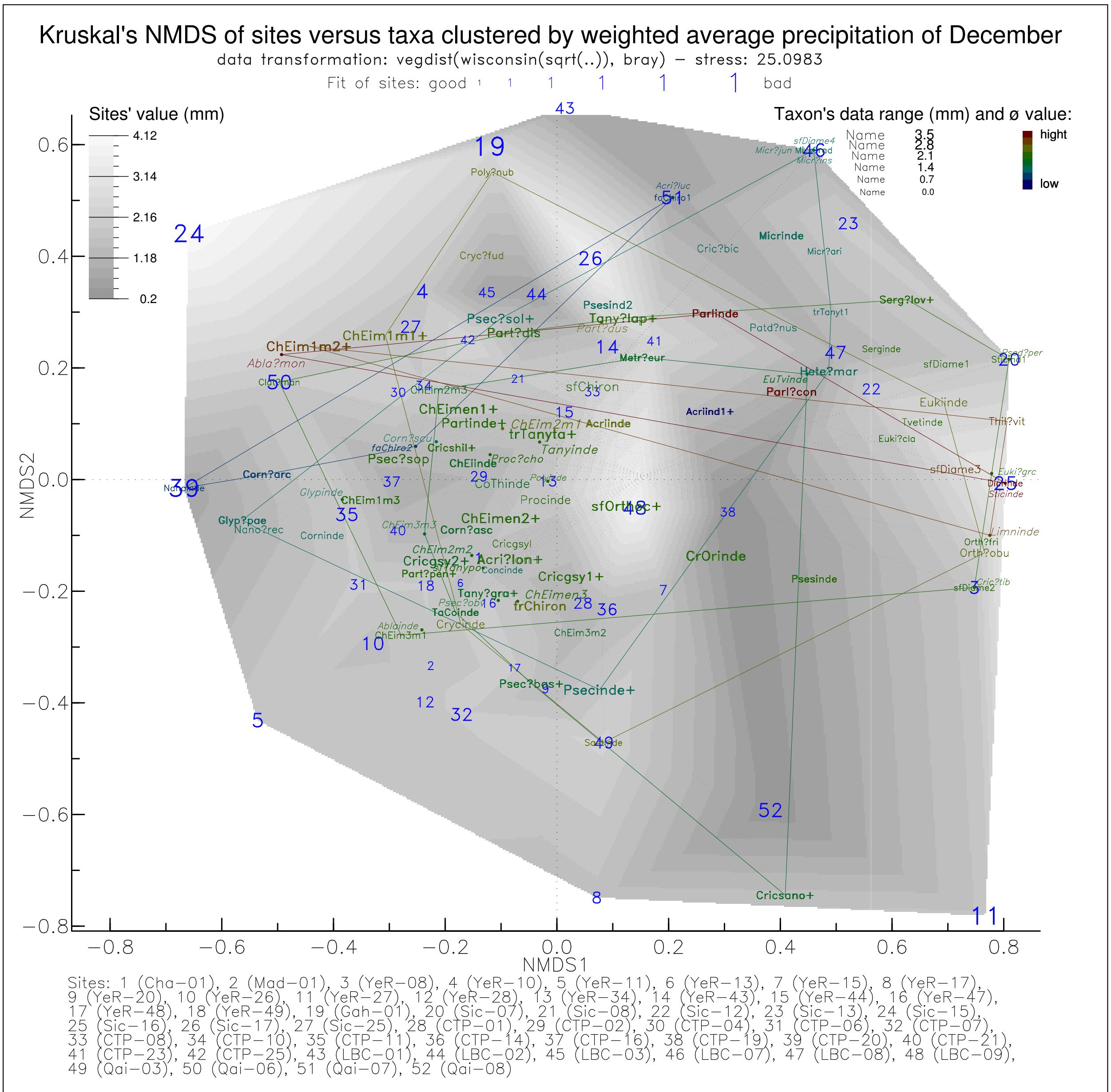

Fig. A.7.: NMDS ordination of taxa versus sites with cluster groups regarding taxa's weighted average precipitation of December (mm) and all together 2 optimal groups with an average silhouette value of $s_{\text{ave}} \geqslant 0.665$. Plotted groups are merged to 8 suboptimal groups with $s_{\text{ave}} = 0.641$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Environmental variable is given as grey scale image calculated as a linear fit from sites' values. Numeric results see Table A.7 and abbreviations see on pages VI–VIII (*italic* names like *Corn?scu* · are placed by an offset next to their x-y score point; **bold** names indicate a number of head capsules with n ⩾ 10 and **bold+** indicates n ⩾ 40; 1 unit = 0.5 distance after Raup and Crick (1979)).

Tab. A.8.: Results of clustered taxa regarding weighted average January precipitation P $_{\text{Jan}}$ (mm) with 22 optimal groups (——) and cluster's average silhouette width $s_{\text{ave}} = 0.621$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Values of s_i are indicated by horizontal boxes; data sorted by their weighted average values; for multiple measured values, the data range is given; - - - - = 8 suboptimal groups ($s_{\text{ave}} = 0.604$).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	cluster's silhouette width average s_{ave}	P $_{\text{Dec}}$ in mm
Nanocladius sp. (n=2)	Nanoinde	1	0.000	0.000	1.13
Chironomidae indet 2 (n=16)	faChiro2	2	0.678	0.649	1.24 : 1.05 to 1.28
Acricotopus indet 1 (n=75)	Acriind1	2	0.620	0.649	1.28 : 0.81 to 2.26
Corynoneura arctica type (n=16)	Corn?arc	3	0.939	0.937	1.37 : 1.05 to 3.01
Glyptotendipes pallens type (n=12)	Glyp?pae	3	0.935	0.937	1.38 : 1.13 to 1.88
Nanocladius rectinervis type (n=7)	Nano?rec	4	0.527	0.603	1.45 : 1.13 to 1.88
Conchapelopia sp. (n=2)	Concinde	4	0.679	0.603	1.48 : 1.44 to 1.53
Corynoneura arctica/scutellata (n=20)	Corn?asc	5	0.624	0.511	1.76 : 1.13 to 3.43
Corynoneura scutellata type (n=7)	Corn?scu	5	0.398	0.511	1.83 : 1.05 to 2.70
Psectrocladius sordidellus/limbatellus (n=128)	Psec?sol	6	0.115	0.447	1.88 : 1.05 to 5.76
Corynoneura sp. (n=2)	Corninde	6	0.565	0.447	1.91 : 1.13 to 2.70
Corynoneura/Thienemanniella sp. (n=9)	CoThinde	6	0.674	0.447	1.94 : 1.13 to 3.03
Chironomus/Einfeldia sp. men2 man3 (n=3)	ChEim2m3	6	0.603	0.447	1.97 : 1.05 to 2.99
Chironomus/Einfeldia sp. men1 man3 (n=18)	ChEim1m3	6	0.277	0.447	2.01 : 1.05 to 3.87
Psectrocladius obvius type (n=3)	Psec?obv	7	0.501	0.610	2.07 : 1.35 to 3.44
Tanytarsus gracilentus type (n=157)	Tany?gra	7	0.743	0.610	2.13 : 1.13 to 3.44
Tanytarsus/Corynocera sp. (n=17)	TaCoinde	7	0.585	0.610	2.15 : 1.28 to 3.43
Chironomus/Einfeldia sp. men3 man3 (n=8)	ChEim3m3	8	0.206	0.649	2.21 : 1.35 to 3.35
Psectrocladius sp. (n=59)	Psecinde	8	0.402	0.649	2.22 : 0.80 to 5.76
Glyptotendipes sp. (n=9)	Glypinde	8	0.459	0.649	2.23 : 1.13 to 3.43
Acricotopus lucens type (n=2)	Acri?luc	8	0.750	0.649	2.26
Chironomidae indet 1 (n=7)	faChiro1	8	0.750	0.649	2.26
Pseudosmittia indet 2 (n=21)	Psesind2	8	0.776	0.649	2.27 : 1.87 to 3.35
Tanytarsini indet 1 (n=5)	trTanyt1	8	0.814	0.649	2.29 : 2.29 to 2.30
Micropsectra aristata type (n=4)	Micr?ari	8	0.816	0.649	2.29 : 2.29 to 2.30
Diamesinae indet 4 (n=2)	sfDiame4	8	0.817	0.649	2.30

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Tab. A.8 (continued): taxa cluster regarding weighted average January precipitation P_{Jan}; - - - - = 8 suboptimal groups ($s_{ave} = 0.604$) and —— = 22 optimal groups ($s_{ave} = 0.621$).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	P_{Dec} in mm
Micropsectra insignilobus type (n=4)	Micr?ins	8	0.817	0.649	2.30
Micropsectra junci type (n=4)	Micr?jun	8	0.817	0.649	2.30
Micropsectra radialis type (n=7)	Micr?rad	8	0.817	0.649	2.30
Acricotopus sp. (n=12)	Acriinde	8	0.591	0.649	2.33 : 1.86 to 3.44
Tanytarsus sp. (n=16)	Tanyinde	8	0.256	0.649	2.36 : 1.35 to 4.27
Paratanytarsus penicillatus type (n=52)	Part?pen	9	0.572	0.755	2.42 : 1.28 to 3.44
Psectrocladius barbimanus/-sokolovae (n=108)	Psec?bas	9	0.751	0.755	2.45 : 0.80 to 3.44
Chironomus/Einfeldia sp. men3 man2 (n=5)	ChEim3m2	9	0.818	0.755	2.46 : 1.35 to 3.03
Micropsectra sp. (n=26)	Micrinde	9	0.841	0.755	2.47 : 1.05 to 4.40
Heterotrissocladius marcidus type (n=16)	Hete?mar	9	0.848	0.755	2.47 : 2.29 to 4.40
Tanytarsus lapponicus type (n=87)	Tany?lap	9	0.840	0.755	2.48 : 1.05 to 4.49
Cricotopus salinophilus (n=131)	Cricsano	9	0.776	0.755	2.50 : 0.80 to 3.44
Paratendipes nudisquama type (n=6)	Patd?nus	9	0.690	0.755	2.52 : 2.26 to 3.03
Chironomus/Einfeldia sp. men2 man2 (n=24)	ChEim2m2	9	0.663	0.755	2.52 : 1.05 to 3.87
Tanypodinae sp. (n=24)	sfTanypo	10	0.334	0.533	2.60 : 1.44 to 3.44
Procladius sp. (n=8)	Procinde	10	0.471	0.533	2.61 : 1.44 to 3.87
Acricotopus longipalpus type (n=416)	Acri?lon	10	0.666	0.533	2.64 : 0.81 to 4.40
Cricotopus sylvestris gr. indet 2 (n=47)	Cricgsy2	10	0.739	0.533	2.67 : 1.13 to 5.76
Cricotopus shilovae (n=42)	Cricshil	10	0.704	0.533	2.69 : 1.13 to 4.40
Ablabesmyia sp. (n=5)	Ablainde	10	0.623	0.533	2.71 : 1.44 to 3.43
Cricotopus bicinctus type (n=2)	Cric?bic	10	0.538	0.533	2.72 : 1.05 to 4.40
Chironominae sp. (n=7)	sfChiron	10	0.188	0.533	2.75 : 1.05 to 5.76
Procladius choreus type (n=11)	Proc?cho	11	0.535	0.607	2.80 : 1.05 to 3.64
Chironomus/Einfeldia sp. (n=23)	ChEiinde	11	0.650	0.607	2.81 : 1.05 to 4.11
Chironomus/Einfeldia sp. men1 man1 (n=70)	ChEim1m1	11	0.683	0.607	2.82 : 1.05 to 4.11
Chironomus/Einfeldia sp. men2 (n=40)	ChEimen2	11	0.708	0.607	2.82 : 1.05 to 5.76
Chironomus/Einfeldia sp. men3 (n=36)	ChEimen3	11	0.749	0.607	2.83 : 1.35 to 3.44
Pseudosmittia sp. (n=11)	Psesinde	11	0.773	0.607	2.84 : 1.35 to 4.40
Tanytarsini sp. (n=483)	trTanyta	11	0.770	0.607	2.85 : 0.81 to 5.76
Chironomus/Einfeldia sp. men1 (n=103)	ChEimen1	11	0.759	0.607	2.85 : 1.05 to 5.76

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Tab. A.8 (continued): taxa cluster regarding weighted average January precipitation P $_{\text{Jan}}$; - - - - = 8 suboptimal groups ($s_{\text{ave}} = 0.604$) and —— = 22 optimal groups ($s_{\text{ave}} = 0.621$).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	P $_{\text{Dec}}$ in mm
Paratanytarsus dissimilis type (n=33)	Part?dis	11	0.608	0.607	2.89 : 1.05 to 4.40
Dicrotendipes sp. (n=3)	Dicrinde	11	0.582	0.607	2.89
Stictochironomus sp. (n=2)	Sticinde	11	0.582	0.607	2.89
Orthocladiinae sp. (n=92)	sfOrthoc	11	0.287	0.607	2.91 : 0.80 to 5.76
Chironomus/Einfeldia sp. men3 man1 (n=9)	ChEim3m1	11	0.201	0.607	2.92 : 2.05 to 3.43
Eukiefferiella/Tvetenia sp. (n=12)	EuTvinde	12	0.466	0.575	2.95 : 2.29 to 4.40
Limnophyes sp. (n=2)	Limninde	12	0.553	0.575	2.96 : 2.89 to 3.03
Orthocladius obumbratus type (n=9)	Orth?obu	12	0.703	0.575	2.98 : 2.89 to 3.03
Paratanytarsus sp. (n=206)	Partinde	12	0.700	0.575	3.00 : 1.05 to 5.76
Polypedilum sp. (n=2)	Polyinde	12	0.665	0.575	3.01
Chironomus/Einfeldia sp. men2 man1 (n=11)	ChEim2m1	12	0.576	0.575	3.02 : 1.86 to 3.95
Cricotopus tibialis type (n=2)	Cric?tib	12	0.469	0.575	3.03
Diamesinae indet 2 (n=2)	sfDiame2	12	0.469	0.575	3.03
Psectrocladius sokolovae/pancratovae (n=27)	Psec?sop	13	0.906	0.930	3.09 : 1.13 to 5.76
Cricotopus/Orthocladius sp. (n=14)	CrOrinde	13	0.949	0.930	3.10 : 0.80 to 5.76
Paracladius conversus type (n=10)	Parl?con	13	0.935	0.930	3.10 : 2.89 to 3.26
Cricotopus sylvestris gr. indet 1 (n=60)	Cricgsy1	14	0.193	0.345	3.19 : 1.87 to 5.76
Metriocnemus eurynotus type (n=30)	Metr?eur	14	0.598	0.345	3.23 : 2.26 to 3.64
Orthocladius frigidus type (n=5)	Orth?fri	14	0.393	0.345	3.27 : 3.03 to 4.23
Paracladius sp. (n=10)	Parlinde	14	0.197	0.345	3.28 : 2.89 to 4.23
Chironomus/Einfeldia sp. men1 man2 (n=43)	ChEim1m2	15	0.548	0.643	3.32 : 1.05 to 3.95
Cryptochironomus sp. (n=4)	Crycinde	15	0.762	0.643	3.34 : 1.88 to 5.76
Paratanytarsus austriacus type (n=5)	Part?aus	15	0.621	0.643	3.36 : 2.99 to 4.23
Diamesinae indet 3 (n=6)	sfDiame3	16	0.336	0.610	3.42 : 2.89 to 4.40
Saetheria sp. (n=6)	Saetinde	16	0.578	0.610	3.43
Chironomini sp. (n=18)	trChiron	16	0.754	0.610	3.46 : 1.13 to 5.76
Cricotopus sylvestris gr. (n=8)	Cricgsyl	16	0.704	0.610	3.48 : 2.52 to 4.27
Tvetenia sp. (n=4)	Tvetinde	16	0.677	0.610	3.49 : 2.29 to 4.40
Thienemanniella vittata type (n=2)	Thil?vit	17	0.386	0.620	3.56 : 2.89 to 4.23
Eukiefferiella sp. (n=7)	Eukiinde	17	0.770	0.620	3.62 : 2.29 to 4.40
Eukiefferiella gracei type (n=2)	Euki?grc	17	0.704	0.620	3.63 : 3.03 to 4.23

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Tab. A.8 (continued): taxa cluster regarding weighted average January precipitation P_{Jan}; - - - - = 8 suboptimal groups ($s_{ave} = 0.604$) and —— = 22 optimal groups ($s_{ave} = 0.621$).

taxon (counts)	shortened	cluster	cluster's silhouette width s_i	average s_{ave}	P_{Dec} in mm
Ablabesmyia monilis type (n=9)	Abla?mon	18	0.000	0.000	3.77 : 3.41 to 3.95
Cladotanytarsus mancus type (n=4)	Clat?man	19	0.910	0.937	3.87
Cryptochironomus fulvus/digitatus (n=4)	Cryc?fud	19	0.954	0.937	3.87 : 2.70 to 4.27
Diamesinae indet 1 (n=5)	sfDiame1	19	0.948	0.937	3.88 : 2.29 to 4.40
Eukiefferiella claripennis type (n=4)	Euki?cla	20	0.000	0.000	4.06 : 3.03 to 4.40
Pseudodiamesa pertinax type (n=2)	Psed?per	21	0.945	0.922	4.23
Stictochironomus sp. 1 (n=3)	Sticind1	21	0.945	0.922	4.23
Polypedilum nubifer type (n=9)	Poly?nub	21	0.876	0.922	4.25 : 4.11 to 4.27
Sergentia longiventris type (n=82)	Serg?lov	22	0.759	0.783	4.37 : 2.89 to 4.49
Sergentia sp. (n=9)	Serginde	22	0.806	0.783	4.40 : 4.23 to 4.49

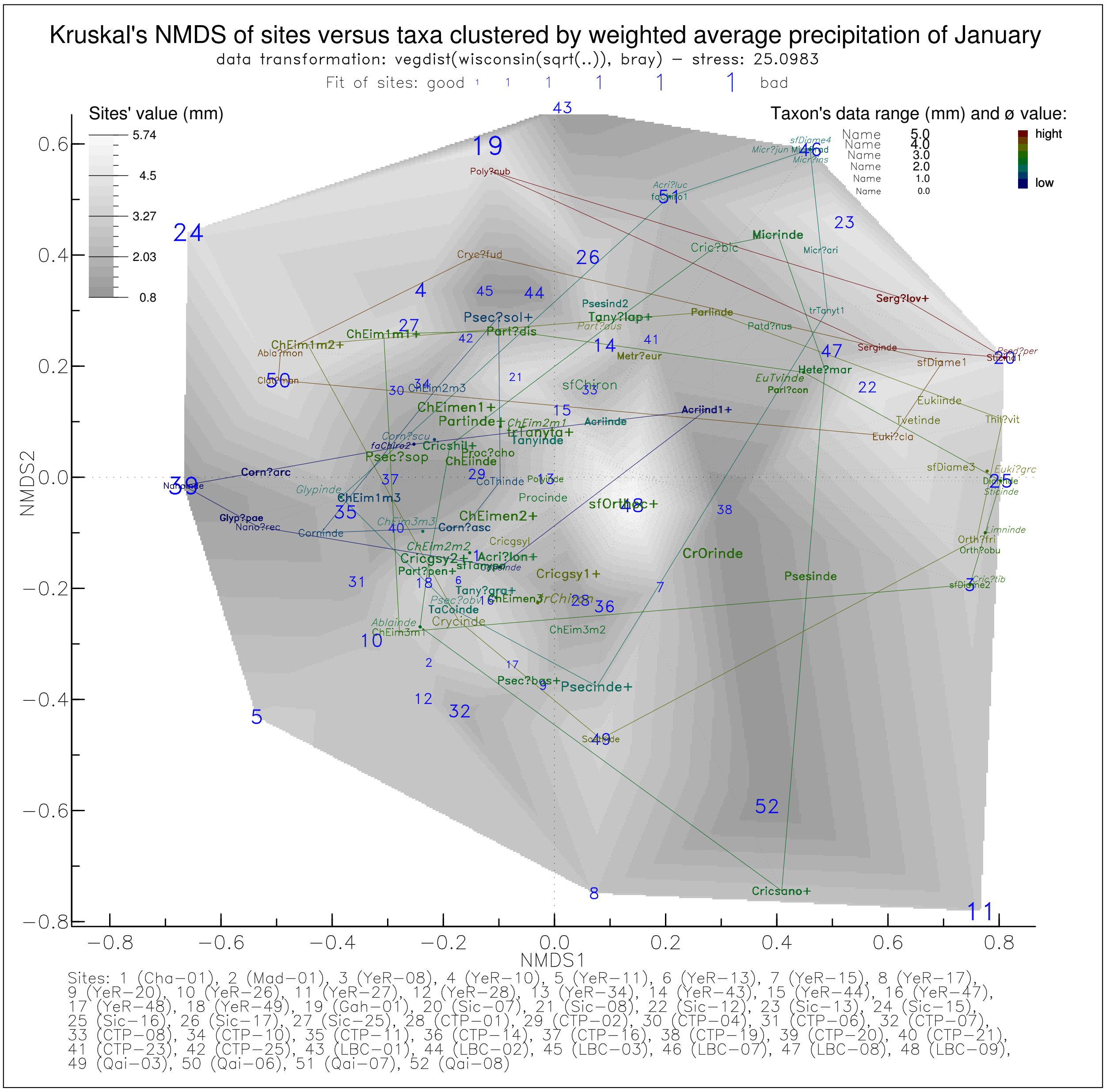


Fig. A.8.: NMDS ordination of taxa and sites with cluster groups regarding taxa's weighted average precipitation of January (mm). All together 22 optimal groups with cluster's average silhouette width of $s_{\text{ave}} = 0.621$. Plotted groups are merged to 8 suboptimal groups with $s_{\text{ave}} = 0.604$. Range of silhouette width s_i is $[-1, 1]$ and means: is $s_i \approx 1$ then element i is clustered optimal, is $s_i \approx 0$ then element i lies between two clusters and is $s_i \approx -1$ then element i is worst clustered and belongs not to its own cluster. Environmental variable is given as grey scale image calculated as a linear fit from sites. Numeric results see Table A.8 and abbreviations see on pages VI–VIII (*italic* names like *Corn?scu* · are placed by an offset next to their x-y score point; **bold** names indicate a number of head capsules with n ⩾ 10 and **bold+** indicates n ⩾ 40; 1 unit = 0.5 distance after Raup and Crick 1979).

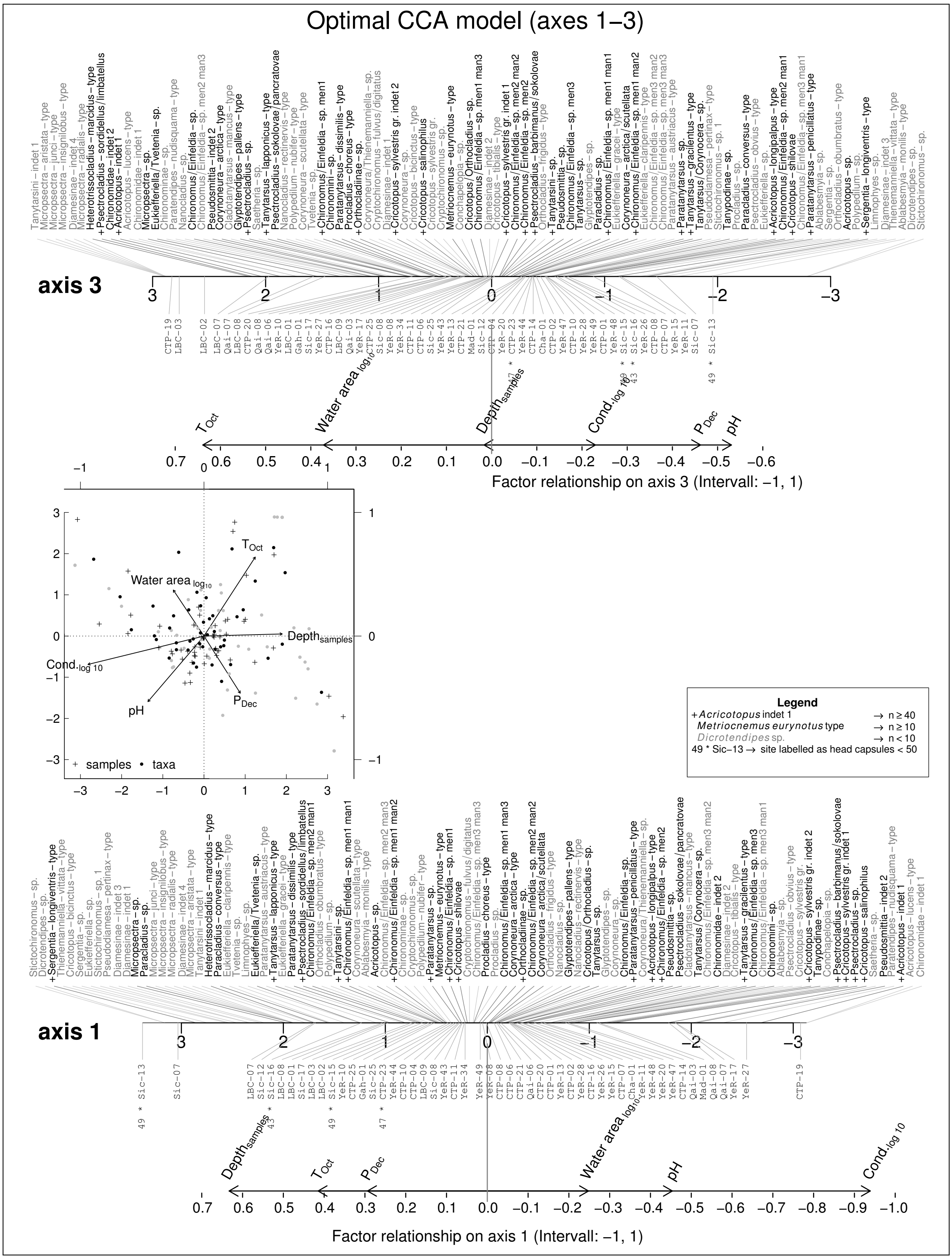


Fig. A.9.: Canonical Correspondence Analysis (CCA) optimal model (axes $1 + 3$): taxa versus sites with significant environmental variables (constraints) tested by ANOVA permutations ($n = 8,999$, $p < 0.05$): electrical conductivity$_{\log 10}$, sampling depth, mean October air temperature, mean December precipitation, pH value and water area$_{\log 10}$ in descending order of eigenvalue amounts ($\Delta\lambda$).

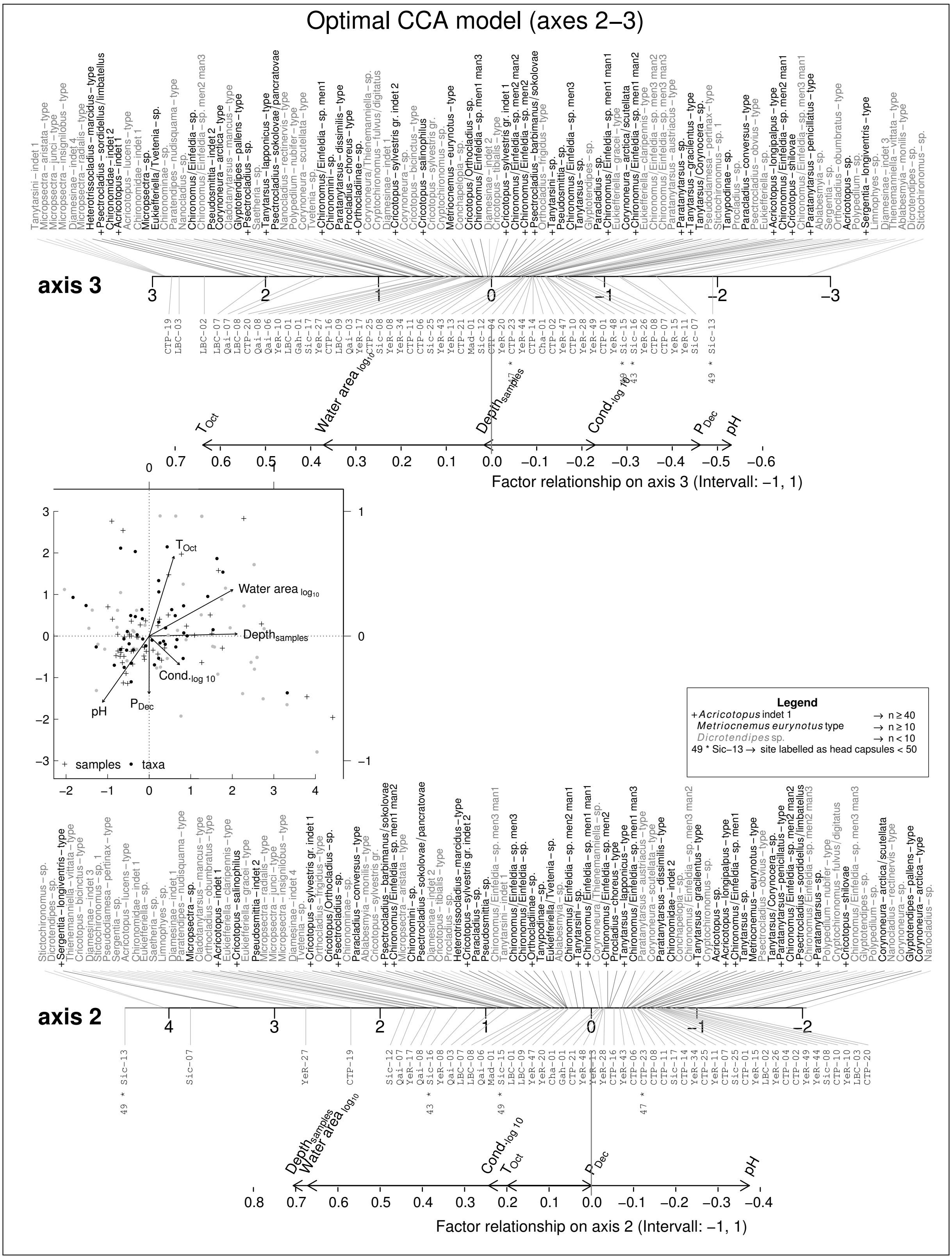


Fig. A.10.: Canonical Correspondence Analysis (CCA) optimal model (axes $2+3$): taxa versus sites with significant environmental variables (constraints) tested by ANOVA permutations (n= $8,999$, $p < 0.05$): electrical conductivity$_{\log 10}$, sampling depth, mean October air temperature, mean December precipitation, pH value and water area$_{\log 10}$ in descending order of eigenvalue amounts ($\Delta\lambda$).

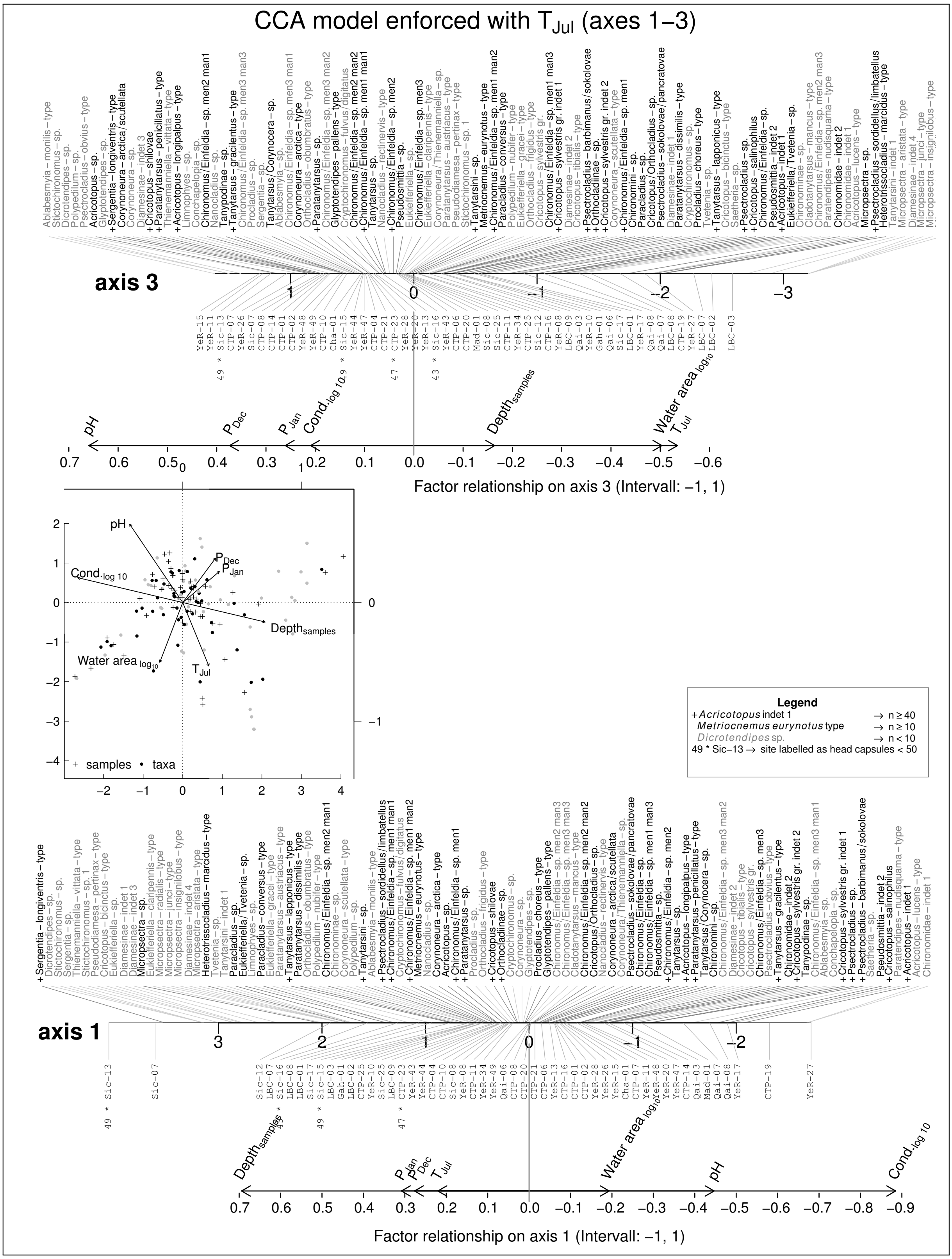


Fig. A.11.: Canonical Correspondence Analysis (CCA) T_{Jul}–model (axes 1 + 3): taxa versus sites with significant environmental variables (constraints) tested by ANOVA permutations (n= 8,999, $p < 0.05$): mean July air temperature (enforced), electrical conductivity$_{\log 10}$, sampling depth, mean December precipitation, pH value, water area$_{\log 10}$ and mean January precipitation in descending order of eigenvalue amounts ($\Delta\lambda$).

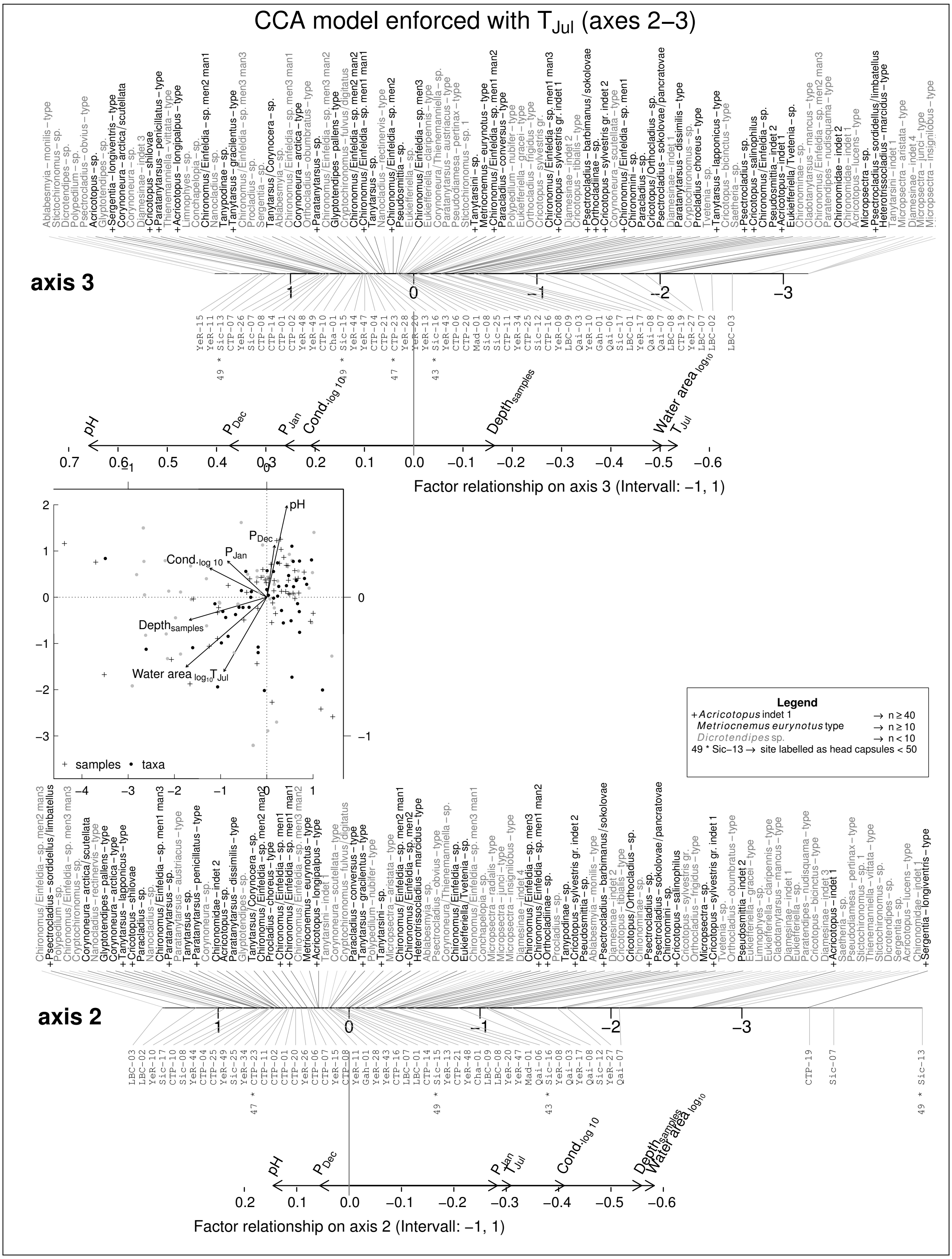


Fig. A.12.: Canonical Correspondence Analysis (CCA) T $_{Jul}$–model (axes 2 + 3): taxa versus sites with significant environmental variables (constraints) tested by ANOVA permutations (n= 8,999, $p < 0.05$): mean July air temperature (enforced), electrical conductivity$_{log\,10}$, sampling depth, mean December precipitation, pH value, water area$_{log\,10}$ and mean January precipitation in descending order of eigenvalue amounts ($\Delta\lambda$).

Tab. A.9.: List of taxa sorted by their scientific names with comments, ecological notes, HOF model analysis and related cluster groups. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110.) For abundant taxa (n $\lesssim$ 10) it was tried to review ecological data from literature when ecological information was found.

Taxon	Groups of measured environmental variables

[1] **Abla?mon**: *Ablabesmyia monilis* type (Linné, 1758)

n=9	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	..3..	..3..	.2.	.2.	.2	...4
HOF:	-	-	-	-	-	-	-	-

[2] **Ablainde**: *Ablabesmyia* sp.

n=5	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3..	1..	.2...	...4.	1..	1..	1.	.2..
HOF:	-	-	-	-	-	-	-	-

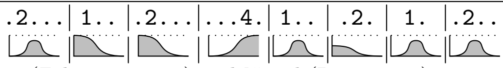
Ecological notes:
Salinity: *Ablabesmyia monilis* & *A.* sp. (=*A. longistyla*, *A. phatta*) in Moller-Pillot and Buskens (1990) are classified for salinity as lacking to rarely occurring under oligohalin conditions (500–3,000 $mg \cdot l^{-1}$). Temperature: Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for *Ablabesmyia* sp. the optimum is considered to be > 15 °C (=warm optima).

[3] **Acriind1**: *Acricotopus* indet 1

n=75	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	...4.	1..	...4.	...4.	.2.	..3	1.	1...
HOF:	-	-	-	-	-	-	-	-

Morphology: premandible with 2 teeth (or 1 with an incision); seta S1: 2 (bifid); mandible: 4–1–0–2 (inner-apical-outer-surface) large incised surface teeth/plate; mentum: middle 2, lateral 7 teeth (2 are hidden and lie behind the 1^{st} lateral), beard present; submental setation below the 3.5^{th} lateral teeth.

[4] **Acri?lon**: *Acricotopus longipalpus* type Reiss (1968)

n=416	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	...4.	1..	.2.	1.	.2..
HOF:								

Not listed for China in Wang (2000) but recorded from Pamir region (Zelentsov 1989) and Nepal (Reiss 1968).
Ecological notes translated from Zelentsov (1989):
General notes: "Larvae inhabit small shallow (0.5–0.8 m) standing and weakly-flowing ponds (lake lagoons, residual basins, pits and puddles), considerably more rarely they are encountered in the calm zones of rivers and the shore of lakes in depths down to 1m. They build barrel-shaped (dolioform), elastic shapes of milky-yellow colour houses, which are attached to different substrates (bottom of reservoir, stones, in accumulation of algae, vegetation). They live on the silt, on the bottom covered with moss or algae, on stones, covered with silt or overgrown layers, on the ground of vegetation and plant detritus." It is possibly a pioneer species also of temporary pools as it was found only in the littoral of relatively small lakes.

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[5] `Acri?luc`: *Acricotopus lucens* type (Zetterstedt, 1850)

n=2	Cond.$_{\log 10}$	Depth$_{\text{samples}}$	Water area$_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	5	1..	...4.	.2...	1..	..3	1.	.2..
HOF:	-	-	-	-	-	-	-	-

[6] `Acriinde`: *Acricotopus* sp.

n=12	Cond.$_{\log 10}$	Depth$_{\text{samples}}$	Water area$_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	...4.	1..	.2.	1.	.2..
HOF:								

[7] `faChiro1`: *Chironomidae* indet 1

n=7	Cond.$_{\log 10}$	Depth$_{\text{samples}}$	Water area$_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	5	1..	...4.	.2...	1..	..3	1.	.2..
HOF:	-	-	-	-	-	-	-	-

Probably a Diamesinae. Morphology: mentum with 1 median tooth, 6 lateral; mandible 3–1–1–3 (inner-apical-outer-surface); postoccipital margin: lateral a broad ligament; antenna: not available (see http://www.chironomidaeproject.com/index.php?id=23)

[8] `faChiro2`: *Chironomidae* indet 2

n=16	Cond.$_{\log 10}$	Depth$_{\text{samples}}$	Water area$_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	..3..	...4.	.2.	..3	1.	1...
HOF:	-	-	-	-	-	-	-	-

Probably another *Acricotopus*. Morphology: mentum with 1 median tooth, 6/7 lateral; mandible 3–1–0–2 (inner-apical-outer-surface) large surface teeth; premandible 2; seta S1 bifid but incised; postoccipital margin: dark brown, antenna 5-segments, RO in the lower 3^{rd} of segment 1 (see http://www.chironomidaeproject.com/index.php?id=36)

[9] `sfChiron`: Chironominae-sp.

n=7	Cond.$_{\log 10}$	Depth$_{\text{samples}}$	Water area$_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	.2.	..3..	.2...	.2.	..3	1.	.2..
HOF:								

[10] `trChiron`: *Chironomini* sp.

n=18	Cond.$_{\log 10}$	Depth$_{\text{samples}}$	Water area$_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3..	1..	...4.	..3..	.2.	..3	1.	..3.
HOF:								

Continuing on next page

Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

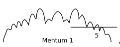
[11] `ChEiinde`: *Chironomus/Einfeldia* sp.

n=23	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	..3..	..3..	1..	..3	1.	..3.
HOF:								

No reliable separation possible especially from *Einfeldia pagna*.
Ecological notes for *Chironomus* see Brooks et al. (2007):
General notes: abundant in warm (Brodersen et al. 2004), eutrophic lakes but also in arctic lakes; mostly bound to the profundal but also present in the littoral; can tolerate low oxygen concentrations and even anoxia for a few weeks and has a high oxy-regulatory capacity (Brodersen et al. 2004); is classified as being an ubiquitous taxon in a lentic-lotic gradient in France by Gandouin et al. (2006); pH: tolerant of low pH (Johnson and Wiederholm 1989; Brodin 1986; Henrikson et al. 1982); salinity: tolerant of high salinity (Vallenduuk et al. 1997; Pinder 1986; Heinrichs and Walker 2006). Zhang et al. (2007) report a salinity (total dissolved solids) for the Tibetan Plateau of $842.22\,\text{mg}\cdot\text{l}^{-1}$ ($\approx 1,250\,\mu\text{S}\cdot\text{cm}^{-1}$). Temperature: Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for *C. anthracinus* group the optimum is considered to be 10–15°C for *C. plumosus* group > 15°C (=warm optima). Walker et al. (1997) calculated a summer temperature of water surfaces in eastern Canada with an optimum for *Chironomus* of 24.7 °C (± 5.3) and 21.6 °C (± 6.5) for square root transformed data.
Ecological notes for *Einfeldia* see Brooks et al. (2007):
General notes: in littoral of lentic environments (W Hofmann 1984) and often soft sediments. Appears under mesotrophic and eutrophic conditions (Sæther 1979) and is ususally indicative of eutrophic waters (e.g. Langdon et al. 2006; Brooks et al. 2001; Sæther 1979). Temperature: has been found in relatively cool conditions in the alpine region of Switzerland (Brooks et al. 2007). However, *Einfeldia pagna* type was found as most abundant in lakes with temperatures > 16 °C in Finland in a T_{Jul} inference model and restricted to the warmest lakes (Luoto 2009). Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for *Einfeldia* sp. the optimum is considered to be < 10 °C (=cold optima).

[12] `ChEimen1`: *Chironomus/Einfeldia* sp. men1

n=103	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	..3..	1..	.2.	1.	..3.
HOF:								

Mentum type follows Vallenduuk et al. (1997): . Possible taxa *C. pallidivittatus* and taxa with mandible types one to three below.
Ecological notes:
General notes: *C. pallidivittatus* is a common taxon in Europe, almost exclusively in stagnant, eutrophic, little polluted water types and also correlated to much plant material and/or organic silt (Vallenduuk et al. 1997). pH: this taxon is also tolerant to low pH values (Berezina 2001: 4.09–4.98 in an experimental mesocosmos).

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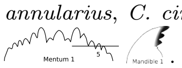
Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[13] `ChEim1m1`: *Chironomus/Einfeldia* sp. men1 man1

n=70	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	..3..	.2.	..3	1.	..3.
HOF:								

Can be for instance: *C. annularius*, *C. cingulatus*, *C. pseudothummi*, *C. tentans*. Mentum and mandible types follow Vallenduuk et al. (1997): 

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Ecological notes:

C. annularius: Vallenduuk et al. (1997): commonly in Europe especially in smaller lakes. Seems to prefere lakes with a low detritus amount on the bottom. Salinity: larvae live especially in fresh and slightly brackish waters with chloride contents to approximately 5,000 $\mathrm{mg \cdot l^{-1}}$. pH: in an experimental mesocosmos investigated by Berezina (2001) it revealed pH tolerances of 6.0–11.0.

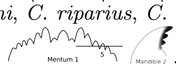
C. cingulatus: Vallenduuk et al. (1997): common in whole Europe in lentic and lotic waters. Only a few data have been checked based on cytological investigations.

C. pseudothummi: Vallenduuk et al. (1997): based on adult males, determined by Strenzke (1959), this species is generally found in small, especially acidic, partly temporary waters.

C. tentans: in Vallenduuk et al. (1997) it is known from whole Europe in stagnant waters. pH: Berezina (2001) revealed pH tolerances of 6.0–11.0 in an experimental mesocosmos.

[14] `ChEim1m2`: *Chironomus/Einfeldia* sp. men1 man2

n=43	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	..3..	..3..	.2.	..3	1.	..3.
HOF:								

C. plumosus type. Can be for instance: *C. cingulatus*, *C. plumosus*, *C. pseudothummi*, *C. riparius*, *C. salinarius*, *C. sinicus*, *Einfeldia pagna* type. Mentum and mandible types follow Vallenduuk et al. (1997): 

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Ecological notes:

C. plumosus: frequently occurring in lakes and rivers (Vallenduuk et al. 1997). pH: it shows a wide pH range (Berezina 2001: 6–11) and indicates eutrophication (Meriläinen et al. 2000; Sæther 1979). Considering eutrophication processes it appears after *C. anthracinus* type (Meriläinen et al. 2000). Temperature: it is considered as thermophilic taxon (Larocque et al. 2001; Luoto 2009: most abundant at 15–16 & > 16 °C). Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for the *C. plumosus* group the optimum is considered > 15 °C (=warm optima). Salinity: on a salinity scale having 10 weights Wolf et al. (2009) classify *C. plumosus* as being a limnic, euryhaline-limnic taxon and they give weights of freshwater–7 (< 0.5 ‰) and oligohaline–3 (0.5 to < 5 ‰) whereat $\sum$ weights = 10.

C. riparius: Epler (2001) states that species are usually found in lotic, organically polluted conditions, such as streams below sewage treatment plants. *C. riparius* is very common, especially in smaller, even temporary water types. The species tolerates a low pH (<4) and a high anthropogenic contamination (Vallenduuk et al. 1997).

C. sinicus: occurs in Inner Mongolia, Hebei and Liaoning Province (Palearctic China) (Wang 2000?) [reference in Kiknadze et al. (2005) is not clear].

C. salinarius: recorded from freshwater (Pinder 1986) and found at high salinity values with up to 20,000 $\mathrm{mg \cdot l^{-1}}$ chloride or higher (Vallenduuk et al. 1997) or up to 41 % chloride (Pinder 1986). It is common in salty and brackish waters and also in salty inland waters (Vallenduuk et al. 1997). It preferes fine detritus or very fine sand, although larvae can be also found on hard substrat (Krebs and Moller-Pillot n.d. in Vallenduuk et al. 1997).

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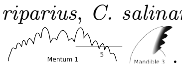
Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[15] `ChEim1m3`: *Chironomus/Einfeldia* sp. men1 man3

n=18	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	...4.	1..	.2.	1.	.2..
HOF:								

C. plumosus type. Can be for instance: is *C. plumosus*, *C. riparius*, *C. salinarius*, *C. sinicus*, *Einfeldia pagna* type. Mentum and mandible types are following Vallenduuk et al. (1997): 

. Ecological notes see above.

[16] `ChEimen2`: *Chironomus/Einfeldia* sp. men2

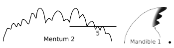
n=40	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	...4.	1..	.2.	1.	..3.
HOF:								

Mentum type follows Vallenduuk et al. (1997): 

. Possible taxa for all three mandible types see below.

[17] `ChEim2m1`: *Chironomus/Einfeldia* sp. men2 man1

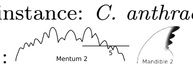
n=11	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	..3..	1..	.2.	1.	..3.
HOF:								

Can be for instance: *C. cingulatus*, *C. annularius*. Mentum and mandible types are following Vallenduuk et al. (1997): 

. Ecological notes see above.

[18] `ChEim2m2`: *Chironomus/Einfeldia* sp. men2 man2

n=24	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	...4.	1..	.2.	1.	.2..
HOF:								

C. anthracinus type. Can be for instance: *C. anthracinus*, *C. annularius*, *C. salinarius*. Mentum and mandible types are following Vallenduuk et al. (1997): 

Ecological notes (see also above):
C. anthracinus type is frequently the dominant type in large lakes (Vallenduuk et al. 1997). It can be found from slightly oligotrophic to eutrophic conditions (Sæther 1979) and considering eutrophication processes it appears before *C. plumosus* type (Meriläinen et al. 2000). Temperature: *C. anthracinus* is considered according to Brooks et al. (2007) as a thermophilic, warm water taxon in a Scandinavian training data set (Brooks and Birks 2000; Larocque et al. 2001: > 14,7 °C) although it dominates in cool lakes in a Swiss calibration set (Lotter et al. 1997). Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for the *C. anthracinus* group the optimum is considered to lie between 10 and 15 °C.

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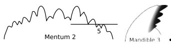
Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: .2.. means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[19] ChEim2m3: *Chironomus/Einfeldia* sp. men2 man3

n=3	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	1..	.2...	..3..	1..	.2.	1.	.2..
HOF:	-	-	-	-	-	-	-	-

C. anthracinus type. Can be for instance: *C. anthracinus*, *C. riparius*, *C. salinarius*. Mentum and mandible types are following Vallenduuk et al. (1997): . Ecological notes see above.

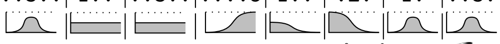
[20] ChEimen3: *Chironomus/Einfeldia* sp. men3

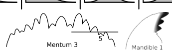
n=36	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3..	1..	..3..	...4.	1..	.2.	1.	..3.
HOF:								

Mentum type follows Vallenduuk et al. (1997): . Possible taxa for all three mandible types see below.

[21] ChEim3m1: *Chironomus/Einfeldia* sp. men3 man1

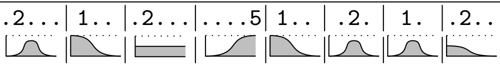
n=9	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3..	1..	..3..	5	1..	.2.	1.	..3.
HOF:								

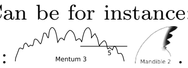


Most likely *C. dorsalis* type. Mentum and mandible types are following Vallenduuk et al. (1997): 
Ecological notes:
C. dorsalis: occurs in small, mostly temporary and even ephemeral waters (Dettinger-Klemm 2000; Vallenduuk et al. 1997) with high abundances during colonisation (Dettinger - Klemm 2003). Salinity: Zhang et al. (2007) report a salinity (total dissolved solids) for the Tibetan Plateau of 6,821 mg · l^{-1} (≈ 10, 100 μS · cm^{-1}).

[22] ChEim3m2: *Chironomus/Einfeldia* sp. men3 man2

n=5	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	5	1..	.2.	1.	.2..
HOF:								



C. anthracinus type. Can be for instance: *C. dorsalis* type, *C. anthracinus*. Mentum and mandible types are following Vallenduuk et al. (1997): . Ecological notes see above.

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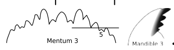
Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[23] `ChEim3m3`: *Chironomus/Einfeldia* sp. men3 man3

n=8	Cond.$_{\log 10}$	Depth$_{\text{samples}}$	Water area$_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	5	1..	.2.	1.	.2..
HOF:								

Most likely *C. anthracinus* type. Mentum and mandible types are following Vallenduuk et al. (1997): 

. Ecological notes see above.

[24] `Clat?man`: *Cladotanytarsus mancus* type (Walker, 1856)

n=4	Cond.$_{\log 10}$	Depth$_{\text{samples}}$	Water area$_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	...4.	.2...	1..	..3	1.	...4
HOF:	-	-	-	-	-	-	-	-

No separation was done if no premandible and mandible was available.

[25] `Concinde`: *Conchapelopia* sp. type (Meigen, 1818)

n=2	Cond.$_{\log 10}$	Depth$_{\text{samples}}$	Water area$_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3..	1..	.2...	5	.2.	..3	1.	1...
HOF:	-	-	-	-	-	-	-	-

[26] `Corn?asc`: *Corynoneura arctica/scutellata*

n=20	Cond.$_{\log 10}$	Depth$_{\text{samples}}$	Water area$_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	5	1..	.2.	1.	.2..
HOF:								

No separation by reticulate head surface possible. Ecological notes see below.

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

27 `Corn?arc`: *Corynoneura arctica* type Kieffer, 1923

n=16	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	5	.2.	..3	1.	1...
HOF:	-	-	-	-	-	-	-	-

Ecological notes:
Temperature: according to Brooks et al. (2007) *C. arctica* is abundant in cool alpine and arctic lakes but occurs in warmer lakes as well.

28 `Corn?scu`: *Corynoneura scutellata* type Winnertz, 1846

n=7	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	...4.	.2.	..3	1.	.2..
HOF:								

Ecological notes:
Occurs in lentic habitats such as floodplain-meadows (Schmid 1993). Moller-Pillot and Buskens (1990) record *C. scutellata* from oligotrophic-eutrophic lakes (pH < 5 and pH > 6) and as occurring occasionally under oligohaline conditions (500–3,000 $mg \cdot l^{-1}$ chloride).

29 `Corninde`: *Corynoneura* sp.

n=2	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	5	1..	..3	1.	.2..
HOF:	-	-	-	-	-	-	-	-

30 `CoThinde`: *Corynoneura/Thienemanniella* sp.

n=9	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	...4.	.2.	..3	1.	.2..
HOF:								

Ecological notes:
31 Temperature: Walker et al. (1997) calculated a summer temperature of water surfaces in eastern Canada with an optimum for *Corynoneura/Thienemanniella* of 14.3 °C (± 6.6) and 14.3 °C (± 6.3) for square root transformed data. Salinity: *Corynoneura* is known to be tolerant of salinity (Heinrichs and Walker 2006).

32 `Cric?bic`: *Cricotopus bicinctus* type (Meigen, 1818)

n=2	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	..3	..3..	.2...	.2.	..3	1.	.2..
HOF:	-	-	-	-	-	-	-	-

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[33] `CrOrinde`: *Cricotopus/Orthocladius* sp.

n=14	Cond.$_{\log 10}$	Depth$_{\text{samples}}$	Water area$_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	..3..	..3..	1..	.2.	1.	..3.
HOF:								

Ecological notes:
Salinity: *Cricotopus* and *Orthocladius* are known to be tolerant of salinity (Heinrichs and Walker 2006) and Zhang et al. (2007) report a salinity (total dissolved solids) for the Tibetan Plateau of 19,229 mg · l^{-1} ($\approx 28,550\,\mu S \cdot cm^{-1}$). Temperature: Bunbury and Gajewski (2008) compared two years from a dataset in Yukon (Northamerica) and calculated bottom water temperatures during the early summer season in 2000 of 13.3 °C ± 4.2 (9 to 17.5 °C) and in 2006 of 13.9 °C ± 4.7 (9.2 to 18.5 °C). Larocque et al. (2001) calculated a similar temperature but as T_{Jul} for the subarctic region and an unimodal HOF response curve with an optimum at 11.4 °C ± 1.9 (n=22). Walker et al. (1997) calculated a summer temperature of water surfaces in eastern Canada with an optimum for *Cricotopus/Orthocladius* of 12.5 °C (± 5.7) and 13.5 °C (± 6.1) for square root transformed data.

[34] `Cricsano`: *Cricotopus salinophilus* Zinchenko et al. (2009)

n=131	Cond.$_{\log 10}$	Depth$_{\text{samples}}$	Water area$_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	...4	1..	...4..	..3..	1...	.2..	.2...	.2..
HOF:	-	-	-	-	-	-	-	-

Morphology: premandible with 2+1 teeth (apical+basal); seta S1: seems 2 long; mentum: 1 median tooth, 6 lateral, submental setation (extremely) laterad; mandible: 3.5/4–1–0–0 (inner-apical-outer-surface), outer margin slightly engraved; postoccipital margin: brown; antenna: blade ratio=1; see http://www.chironomidaeproject.com/index.php?id=27.
Ecological notes by Zinchenko et al. (2009):
"*C. salinophilus* was found at lake El'ton [Russia near Volgograd: 49.13081N, 46.693835E] in salty waters of the rivers Solyanka [Солянка], Jara [Хара], Chernyavka [Чернявка], Lantsug [Ланцуг] with mineralisation levels from 9.0 to 29.5 g · l^{-1} at depths to 50 cm. Locally, at places of mass development, they live together with larvae of the dipteran family Ceratopogonidae and *Chironomus salinarius* Kieffer. The greatest number and biomass of larvae in associated macrozoobenthos was captured in river Solyanka [Солянка] (13. 08. 2008) with a water salinity of 28.5 ‰."

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

35 **Cricshil**: *Cricotopus shilovae* Zelentsov (1989)

n=42	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	5	1..	.2.	1.	.2..
HOF:								

Morphology: separation by distinct submental setation: very near the ventromental plates and not far caudad; different from *Euryhapsis* or *Brillia* and the same taxon as *Euryhapsis* in Zhang et al. (2007). Honqu Tang confirmed that misidentification. It is possibly identical to *C. (I.) perniger* (Zetterstedt, 1850) (Sæther pers. comm.). See http://www.chironomidaeproject.com/index.php?id=26
Ecological notes by Zelentsov (1989):
"larvae inhabit the littoral zone of lakes from the shoreline down to 4m. They live in aggregations of filamentous algae, and in biofouling layers on stones, on higher aquatic vegetation and on silt with plant detritus. Distribution: Lake Yashilkul [Яшилькуль] (eastern Pamirs) and Lake Song-Kel [Сонг-Кёль] (Kyrgyzstan)."

36 **Cricgsyl**: *Cricotopus sylvestris* gr. (Fabricius, 1794)

n=8	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3..	1..	..3..	...4.	1..	..3	1.	..3.
HOF:								

Ecological notes:
Sæther (1979) report a living range from oligotrophic to eutrophic and mesohumic-polyhumic conditions which can reach low pH values. Salinity: Wolf et al. (2009) classify *C. sylvestris* gr. as euryhaline-limnic taxon, i.e. freshwater taxa that tolerate salinity up to 10 ‰ (even higher salinity for a short time). After a classifying system for brackish water bodies following Caspers (1959) with weights 1–10 and $\sum$ weights = 10 it is classified in categories: freshwater–6 (<0.5 ‰), oligohaline–2 (0.5– <5 ‰), mesohaline–2 (5– <18 ‰), polyhaline–0 (18– <30 ‰), euhaline–0 ($30-40$ ‰). Zhang et al. (2007) report for *C. sylvestris* type a salinity from the Tibetan Plateau of total dissolved solids (TDS) of $3,318\,\mathrm{mg\cdot l^{-1}}$ ($\approx 4,900\,\mu\mathrm{S\cdot cm^{-1}}$).

37 **Cricgsy1**: *Cricotopus sylvestris* gr. indet 1

n=60	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3..	1..	..3..	...4.	1..	.2.	1.	..3.
HOF:								

Morphology: premandible 2+1 (apical+large basal); seta S1 1.8 (inner shorter than outer); mentum: 1 middle tooth, 6 lateral teeth, submental setation below 3.5^{th} lateral tooth; mandible 3–1–0–0 strongly engraved at outer margin, antenna: RO-ratio (length RO/ant-1^{st}) 0.15; postoccipital margin pale i.e. yellow. See http://www.chironomidaeproject.com/index.php?id=24. Ecological note see above.

38 **Cricgsy2**: *Cricotopus sylvestris* gr. indet 2

n=47	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3..	1..	..3..	...4.	1..	.2.	1.	.2..
HOF:								

Morphology: premandible: 2+1 (apical+basal); seta S1: seems 1 simple long; mentum: 1 median tooth, 6 lateral, submental setation (extremely) laterad; mandible: 3.5/4–1–0–0 (inner-apical-outer-surface), outer margin slightly engraved; postoccipital margin: brown; antenna: blade ratio=1. See http://www.chironomidaeproject.com/index.php?id=25. Ecological note see above.

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

39 `Cric?tib`: *Cricotopus tibialis* type

n=2	$Cond._{log 10}$	$Depth_{samples}$	Water $area_{log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3..	1..	.2...	.2...	1..	.2.	1.	..3.
HOF:	-	-	-	-	-	-	-	-

40 `Cryc?fud`: *Cryptochironomus fulvus/digitatus*

n=4	$Cond._{log 10}$	$Depth_{samples}$	Water $area_{log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	..3..	5	1..	..3	1.	...4
HOF:	-	-	-	-	-	-	-	-

41 `Crycinde`: *Cryptochironomus* sp.

n=4	$Cond._{log 10}$	$Depth_{samples}$	Water $area_{log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	..3..	..3..	1..	.2.	1.	..3.
HOF:	-	-	-	-	-	-	-	-

42 `sfDiame1`: Diamesinae indet 1

n=5	$Cond._{log 10}$	$Depth_{samples}$	Water $area_{log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	.2.	..3..	.2...	.2.	..3	1.	...4
HOF:	-	-	-	-	-	-	-	-

Similar mentum shape compared to *Diamesa steinboecki* Goetghebuer, 1933 in Makarchenko and Makarchenko (1999). See http://www.chironomidaeproject.com/index.php?id=29

43 `sfDiame2`: Diamesinae indet 2

n=2	$Cond._{log 10}$	$Depth_{samples}$	Water $area_{log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3..	1..	.2...	.2...	1..	.2.	1.	..3.
HOF:	-	-	-	-	-	-	-	-

Morphology: premandible: ?; seta S1: ?; mentum: 1 median, convex tooth (3–4 x 1^{st} lateral) and 8–9? teeth lateral, submental setation below 8th lateral tooth; quite large ventromental plates; mandible: 4–1–0–0 (inner-apical-outer-surface); postoccipital margin: brown with a broad ligament; antenna: 5 segments. See http://www.chironomidaeproject.com/index.php?id=32

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[44] `sfDiame3`: Diamesinae indet 3 (*Pagastia* indet)

n=6	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	..3	..3..	.2...	.2.	..3	1.	..3.
HOF:	-	-	-	-	-	-	-	-

Probably a *Pagastia*. Morphology: mentum with 2 small median teeth, 6/7? lateral, submental setation very far away caudad below $6/(7?)^{th}$ lateral tooth, large ventromental plates; postoccipital margin: dark brown. See http://www.chironomidaeproject.com/index.php?id=34

[45] `sfDiame4`: Diamesinae indet 4

n=2	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	.2.	..3..	1....	..3	..3	1.	.2..
HOF:	-	-	-	-	-	-	-	-

Morphology: mentum with 1 middle prominent very pale, 5–6 lateral, submental setation below the outermost tooth; premandible: 4(5?) teeth; mandible: 6–1–0–0 (inner-apical-dorsal-surface), note: the 6 inner teeth have the pattern: 4 normal + 1 small + 1 normal, a lot of seta interna; antenna: 5 segments; 3^{rd}? instar. See http://www.chironomidaeproject.com/index.php?id=37

[46] `Dicrinde`: *Dicrotendipes* sp.

n=3	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	..3	..3..	.2...	..3	..3	.2	..3.
HOF:	-	-	-	-	-	-	-	-

[47] `Euki?cla`: *Eukiefferiella claripennis* type (Lundbeck, 1898)

n=4	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	.2.	.2...	.2...	1..	..3	1.	...4
HOF:	-	-	-	-	-	-	-	-

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[48] `Euki?grc`: *Eukiefferiella gracei* type (Edwards, 1929)

n=2	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	.2.	.2...	.2...	1..	.2.	1.	..3.
HOF:	-	-	-	-	-	-	-	-

[49] `Eukiinde`: *Eukiefferiella* sp.

n=7	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	..3	..3..	.2...	.2.	..3	1.	..3.
HOF:	-	-	-	-	-	-	-	-

Ecological notes (see also *Eukiefferiella/Tvetenia*):
Gandouin et al. (2006) classify *Eukiefferiella* as lotic taxa in a lentic-lotic gradient in France. Temperature: Bunbury and Gajewski (2008) compared 2 years from a dataset in Yukon (Northamerica) and calculated a bottom water temperature during the early summer season in 2000 of 10.6 °C ± 4.5 (6.1 to 15.2 °C) and in 2006 a temperature of 8.9 °C ± 4.6 (4.3 to 13.4 °C). Larocque et al. (2001) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe revealed for *Eukiefferiella* sp. an optimum that is considered to be < 10 °C (=cold optima). Depth: Korhola et al. (2000) compared samples from Fennoscandia, mainly NW Finnish Lapland, and calculated a mean value of 12.2 m ± 7 (n=6).

[50] `EuTvinde`: *Eukiefferiella/Tvetenia* sp.

n=12	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	.2.	.2...	.2...	.2.	..3	1.	..3.
HOF:								

Ecological notes:
By Brooks et al. (2007): "these genera are eurythermic and occur in flowing waters and the surf zone of lakes (Lindegaard 1992; Cranston et al. 1983). They frequently occur in lake sediment samples although they are seldom abundant." Moller-Pillot and Buskens (1990) report for *Eukiefferiella* as living from oligo-/mesotrophic to hypertrophic conditions. Gandouin et al. (2006) classify *Eukiefferiella* and *Tvetenia* as lotic taxa from a lentic-lotic gradient in France. Temperature: for *Eukiefferiella* Bunbury and Gajewski (2008) report for two years, comparing datasets from Yukon (Northamerica), a bottom water temperature in 2000 of 10.6 ± 4.5 °C (6.1 to 15.2 °C) and in 2006 a bottom water temperature of 8.9 °C ± 4.6 (4.3 to 13.4 °C). Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for *Eukiefferiella* sp. the optimum is considered to be < 10 °C (=cold optima). Depth: values for *Eukiefferiella* are reported by Korhola et al. (2000) from Fennoscandia with 12.2 ± 7 m (n=6). Walker et al. (1997) calculated a summer temperature of water surfaces in eastern Canada with an optimum for *Eukiefferiella/Tvetenia* of 7.8 °C (± 2.5) and 8.3 °C (± 2.6) for square root transformed data. Conductivity data are reported by Rossaro et al. (2004, 2006) for *Tvetenia bavarica* in Alpine running waters of 48.44 μS · cm^{-1} ± 12.03 (min-max: 7–124, n=11).

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[51] `Glyp?pae`: *Glyptotendipes pallens* type (Meigen, 1804)

n=12	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	5	.2.	..3	1.	1...
HOF:	-	-	-	-	-	-	-	-

Ecological notes:
Luoto (2009) reports for *G. pallens* type as being most abundant at > 16 °C for T_{Jul} from a 1,000 km transect in Finland. Salinity: relating salinity Wolf et al. (2009) classify this taxon as "limnic, euryhaline–limnic freshwater taxa that tolerate salinity below 5 ‰". After a classifying system for brackish water bodies following Caspers (1959) with weights 1–10 ($\sum$ weights = 10) it is classified in categories: freshwater–7 (< 0.5 ‰) oligohaline–3 (0.5– < 5 ‰), mesohaline–0 (5– < 18 ‰) 0-polyhaline (18– < 30 ‰), euhaline–0 (30 – 40 ‰).

[52] `Glypinde`: *Glyptotendipes* sp.

n=9	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	5	1..	.2.	1.	.2..
HOF:								

Ecological notes:
Gandouin et al. (2006) classify *Glyptotendipes* sp. as lentic taxa in a lentic-lotic gradient in France. Temperature: Bunbury and Gajewski (2008) published data of lake bottom temperature during early summer season in 2000/2006 from Yukon (Northamerica) and it revealed temperatures of 12 °C ± 5.6 (6.4 to 17.7) and in 2006: 12.2 °C ± 6.5 (5.7 to 18.7). Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for *Glyptotendipes* sp. the optimum is considered to be 10 – 15 °C. Salinity: is known to tolerate salinity (Heinrichs and Walker 2006) and Zhang et al. (2007) report for the Tibetan Plateau values of 1,114 mg · l^{-1} (≈ 1,650 µS · cm^{-1}).

[53] `Hete?mar`: *Heterotrissocladius marcidus* type (Walker, 1856)

n=16	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	.2.	.2...	1....	..3	..3	1.	.2..
HOF:								

Ecological notes:
H. marcidus lives in the sublittoral and littoral zone of oligotrophic (mesotrophic) and mesohumic lakes (Sæther 1979) with depth values of 11.6 m ± 8.1 (n=5) reported by Korhola et al. (2002). Temperature: regarding T_{Jul} values Larocque et al. (2001) report for *H. marcidus* type as being a warm water taxon with an optimum < 14.7 °C (n=36) for a 100–lake training data set in Finland whereas Porinchu et al. (2002) report it as colder preferring taxon with < 15 °C but based on surface water temperatures. Rossaro et al. (2004, 2006) report a water temperature for *H. marcidus* in Alpine running waters of 7.28 °C ± 2.34 (min-max: 0.01–15 °C, n=26) and a pH range of 7.23 ± 1.09 (min-max: 5.76–9, n=14). Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for *Heterotrissocladius marcidus* group the optimum is considered to be 10 – 15 °C. Walker et al. (1997) calculated a summer temperature of water surfaces in eastern Canada with an optimum for *Heterotrissocladius* sp. of 11.1 °C (± 2.9) and 12 °C (± 4) for square root transformed data. Salinity: regarding conductivity it is classified by Wolf et al. (2009) as limnic freshwater taxon (< 0.5 ‰) and the data set of Rossaro et al. (2004, 2006) reports 99.95 µS · cm^{-1} ± 151.41 (min-max: 2–425, n=18).

[54] `Limninde`: *Limnophyes* sp.

n=2	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	.2.	.2...	.2...	.2.	..3	1.	..3.
HOF:	-	-	-	-	-	-	-	-

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[55] `Metr?eur`: *Metriocnemus eurynotus* type (Holmgren, 1833)

n=30	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	..3..	1..	.2.	1.	..3.
HOF:								

Ecological notes:
Rossaro et al. (2004, 2006) report conductivity values of 92.96 $\mu S \cdot cm^{-1}$ ± 107.9 (min-max: 11–395, n=20), pH values of 7.45 ± 1.25 (min–max: 6.26–9.9, n=18) and water temperature values of 5.73 °C ± 1.93 (min–max: 0.3–10, n=32). According to Moller-Pillot and Buskens (1990) *M. eurynotus* occurs only in oxygen-rich (>50 % O_2) small lakes, small fast-flowing streams and springs and lives at chloride concentrations less than 500 $mg \cdot l^{-1}$.

[56] `Micr?ari`: *Micropsectra aristata* type Pinder, 1976

n=4	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	.2.	..3..	1....	..3	..3	1.	.2..
HOF:	-	-	-	-	-	-	-	-

Not mentionend for China in Wang (2000), but comes close to *M. aristata*. See Heiri et al. (2004) and Stur and Ekrem (2006).

[57] `Micr?ins`: *Micropsectra insignilobus* type

n=4	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	.2.	..3..	1....	..3	..3	1.	.2..
HOF:	-	-	-	-	-	-	-	-

See Heiri et al. (2004). Can be *M. logani*, *M. junci*, *M. atrofasciata*.

[58] `Micr?jun`: *Micropsectra junci* type (Meigen, 1818)

n=4	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	.2.	..3..	1....	..3	..3	1.	.2..
HOF:	-	-	-	-	-	-	-	-

See Heiri et al. (2004).

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[59] `Micr?rad`: *Micropsectra radialis* type Goetghebuer, 1928

n=7	$Cond._{log\,10}$	$Depth_{samples}$	$Water\ area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	.2.	..3..	1....	..3	..3	1.	.2..
HOF:	-	-	-	-	-	-	-	-

See Heiri et al. (2004).

[60] `Micrinde`: *Micropsectra* sp.

n=26	$Cond._{log\,10}$	$Depth_{samples}$	$Water\ area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	.2.	..3..	1....	..3	..3	1.	.2..
HOF:								

Ecological notes:
Micropsectra sp. lives in oligotrophic (mesotrophic) lakes from littoral to profundal zone (Sæther 1979) although it is classified by Gandouin et al. (2006) as being a lotic taxon. Brodersen et al. (2004) consider *Micropsectra* sp. as an oxygen conformer. Temperature: regarding temperature data it is considered as a cold adapted taxon (Brodersen et al. 2004; Korhola et al. 2002) and Korhola et al. (2002) calculated temperature optima of < 7 °C (n=30) based on HOF model analysis by Huisman et al. (1993, models II + III). Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for *Micropsectra insignilobus* type the optimum is considered to be > 15 °C (=warm optima) and for *Micropsectra radialis* type the optimum is considered to be < 10 °C (=cold optima). pH: Rossaro et al. (2004, 2006) report for *M. atrofasciata* a pH value of 6.26 ± 0.47 (min-max: 4.94–9.40, n=195); Meriläinen et al. (2000) report for *Micropsectra* sp. during lake developmental stages a reconstructed pH of 5.9–6.8. Salinity: is known to tolerate salinity (Brodersen and Anderson 2002; Heinrichs and Walker 2006).

[61] `Nano?rec`: *Nanocladius rectinervis* type (Kieffer, 1911)

n=7	$Cond._{log\,10}$	$Depth_{samples}$	$Water\ area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	5	.2.	..3	1.	1...
HOF:	-	-	-	-	-	-	-	-

[62] `Nanoinde`: *Nanocladius* sp.

n=2	$Cond._{log\,10}$	$Depth_{samples}$	$Water\ area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	5	.2.	..3	1.	1...
HOF:	-	-	-	-	-	-	-	-

[63] `sfOrthoc`: Orthocladiinae-sp.

n=92	$Cond._{log\,10}$	$Depth_{samples}$	$Water\ area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	..3..	1..	.2.	1.	..3.
HOF:								

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[64] `Orth?fri`: *Orthocladius frigidus* type (Zetterstedt, 1838)

n=5	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	.2...	1..	.2.	1.	..3.
HOF:	-	-	-	-	-	-	-	-

[65] `Orth?obu`: *Orthocladius obumbratus* type Johannsen, 1905

n=9	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	.2.	.2...	.2...	1..	.2.	1.	..3.
HOF:	-	-	-	-	-	-	-	-

[66] `Parl?con`: *Paracladius conversus* type (Walker, 1856)

n=10	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	.2.	..3..	.2...	.2.	..3	.2	..3.
HOF:	-	-	-	-	-	-	-	-

Ecological notes see next taxon *Paracladius* sp.

[67] `Parlinde`: *Paracladius* sp.

n=10	$Cond._{log\,10}$	$Depth_{samples}$	Water $area_{log\,10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	.2.	..3..	.2...	..3	..3	.2	..3.
HOF:	-	-	-	-	-	-	-	-

Ecological notes:
P. alpicola is known from oligotrophic lakes living in the littoral and profundal (Sæther 1979). Temperature: Brooks et al. (2007): "Larvae of *Paracladius* are usually found during cold episodes in lake sediment cores and are present in some of the coldest lakes in Scandinavian training sets. As such the genus is a useful indicator of cold, oligotrophic conditions in lake sediment samples where it may be abundant in these conditions (Walker et al. 1991). However, *P. conversus* does not appear to be cold stenothermic because it presently occurs in lowland rivers and lakes in Britain (Cranston 1982)." Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for *Paracladius* sp. the optimum is considered to be < 10 °C (=cold optima). Walker et al. (1997) calculated a summer temperature of water surfaces in eastern Canada with an optimum for *Paracladius* sp. of 6.3 °C (± 1.2) and 6.8 °C (± 1.6) for square root transformed data. Depth: recorded by Kurek and Cwynar (2009) down to 30 m.

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

68 `Part?aus`: *Paratanytarsus austriacus* type (Kieffer in Albrecht, 1924)

n=5	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	1..	.2...	..3..	1..	.2.	1.	..3.
HOF:	-	-	-	-	-	-	-	-

See Heiri et al. (2004); Moller-Pillot (1990); Klink (1983). Pecten epipharyngis with 4 teeth.

69 `Part?dis`: *Paratanytarsus dissimilis* type Johanssen, 1905

n=33	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	1..	.2...	..3..	1..	.2.	1.	..3.
HOF:								

Moller-Pillot (1990) groups *P. inopertus* and *P. confusus* together to *P. dissimilis* agg.; see also Epler (2001); Klink (1983). Pecten epipharyngis with 5 (rarely 6) teeth.

Ecological notes by Klink (1983) for *P. inopertus*: "Brundin (1949, p. 790) states that the larvae are inhabiting freshwater and brackish lakes, live in algae on reed and stones. According to Thienemann (1951, p. 626) the larvae occur in freshwater, but definitely prefer brackish water. Palmén (1960, p. 281) collected *P. inopertus* as one of the most abundant chironomids in the brackishwater area Tvärminne (South-Finland)." Ecological notes by Klink (1983) for *P. confusus*: "Palmén (1960, p. 281) collected the adults and exuviae from the oligohaline estuaries in the southern part of Finland, together with *P. inopertus* (Walker). In the potamal of the river Fulda [Germany], *P. confusus* is the dominant species in summertime. The larvae are found in mosses, algae and mudlayers on stones and branches. The species is stated as eurythermic and rheophilic (Lehmann 1971, pp. 504–505)."

70 `Part?pen`: *Paratanytarsus penicillatus* type (Goetghebuer, 1928)

n=52	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	5	1..	.2.	1.	.2..
HOF:								

Morphology: see Heiri et al. (2004); pecten epipharyngis with 3 (rarely 4) teeth, mandible 2–1–1–0 (inner-apical-outer-surface teeth)

Ecological notes:

P. penicillatus has a tendency to oligotrophic conditions (Brooks et al. 2001) and is recorded for γ–oligotrophic to η–mesotrophic lakes according to Sæther (1979). It can be found in temporary pools as well (Dettinger - Klemm 2001) and is stated by Ilyashuk and Ilyashuk (2007) as having a broader range of thermal tolerances and is considered by Brooks et al. (2007) as typical of warmer conditions. Ilyashuk and Ilyashuk (2001) suggest by studying the response of alpine chironomid lake communities to atmospheric contaminations that *P. penicillatus* tolerates a wider range of pH and heavy metal concentrations than *Stictochironomus* sp.

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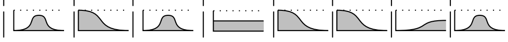
Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: .2.. means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[71] `Partinde`: *Paratanytarsus* sp.

n=206	$\mathtt{Cond.}_{\log 10}$	$\mathtt{Depth}_{\text{samples}}$	$\mathtt{Water\ area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	...4.	1..	.2.	1.	..3.
HOF:								

Ecological notes:
Temperature: *Paratanytarsus* sp. is considered to be a cold adapted taxon (Ilyashuk et al. 2005: $T_{Jul} = 7.6\,°C$ at southern Kola Peninsula in Russia) but can be abundant also in warm lakes (Brooks et al. 2007). Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for *Paratanytarsus* sp. the optimum is considered to be $> 15\,°C$ (=warm optima). Salinity: some species can be found in brackish water but also under freshwater oligotrophic conditions (Klink 1983). Zhang et al. (2007) report a salinity (total dissolved solids) for the Tibetan Plateau of 1,409 $mg \cdot l^{-1}$ ($\approx 2,100\,\mu S \cdot cm^{-1}$).

[72] `Patd?nus`: *Paratendipes nudisquama* type (Edwards, 1929)

n=6	$\mathtt{Cond.}_{\log 10}$	$\mathtt{Depth}_{\text{samples}}$	$\mathtt{Water\ area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	...4.	1..	..3..	.2...	1..	..3	1.	.2..
HOF:	-	-	-	-	-	-	-	-

[73] `Poly?nub`: *Polypedilum nubifer* type (Skuse, 1889)

n=9	$\mathtt{Cond.}_{\log 10}$	$\mathtt{Depth}_{\text{samples}}$	$\mathtt{Water\ area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	1..	..3..	...4.	.2.	..3	1.	...4
HOF:	-	-	-	-	-	-	-	-

See Brooks et al. (2007).

[74] `Polyinde`: *Polypedilum* sp.

n=2	$\mathtt{Cond.}_{\log 10}$	$\mathtt{Depth}_{\text{samples}}$	$\mathtt{Water\ area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	1....	5	1..	1..	1.	..3.
HOF:	-	-	-	-	-	-	-	-

Ecological notes:
Polypedilum is classified as being ubiquitous regarding a lentic-lotic gradient in France by Gandouin et al. (2006) and occurs from mesotrophic to eutrophic conditions (Sæther 1979). pH: in oligotrophic lakes it can live at acidic conditions having pH values of 4.3–4.7 (Henrikson et al. 1982). Temperature: regarding temperature data *Polypedilum* sp. is an eurythermic taxon and indicates temperate climatic conditions (Brooks et al. 2007). Brooks and Birks (2000) calculated a significant unimodal response for *Polypedilum* sp. with air temperatures T_{Jul} of 10–12 °C and $> 12\,°C$ for the Kråkenes Lake in western Norway, Larocque et al. (2001) calculated for T_{Jul} 12.9 °C $\pm$ 0.9 (n=24) for a subarctic region of northern Sweden (Lapland). Porinchu et al. (2002) report for the Sierra Nevada (California) high abundances for surface water temperature beyond 17.5 °C and Bunbury and Gajewski (2008) calculated bottom water temperatures during the early summer season in 2000 of 14.6 °C $\pm$ 3.8 (10.8 to 18.4 °C) and in 2006 of 15 °C $\pm$ 4.2 (10.8 to 19.2 °C). Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for *Polypedilum* sp. the optimum is considered to be $> 15\,°C$ (=warm optima) and for *Polypedilum* type II $10 - 15\,°C$. Walker et al. (1997) calculated a summer temperature of water surfaces in eastern Canada with an optimum for *Polypedilum* of 23.3 °C ($\pm$ 4) and 22.3 °C ($\pm$ 4.8) for square root transformed data. Depth: *Polypedilum* sp. lives in the littoral and sublittoral (Sæther 1979; Korhola et al. 2000: 5.8 m $\pm$ 3, n=22.). Salinity: is known to tolerate salinity (Heinrichs and Walker 2006) and Zhang et al. (2007) report a salinity (total dissolved solids) of 1,428 $mg \cdot l^{-1}$ for the Tibetan Plateau ($\approx 2,120\,\mu S \cdot cm^{-1}$).

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[75] `Proc?cho`: *Procladius choreus* type (Meigen, 1804)

n=11	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	Water $\texttt{area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	..3..	1..	.2.	1.	..3.
HOF:								

Ecological notes:
Vallenduuk and Moller-Pillot (2007) state that larvae of *P. choreus* endure light brackish (oligohaline) waters very well and that they can be found up to 9,300 mg · l^{-1} chloride. See also *Procladius* sp.

[76] `Procinde`: *Procladius* sp.

n=8	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	Water $\texttt{area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	..3..	1..	..3	1.	.2..
HOF:								

Ecological notes:
Procladius sp. is an ubiquitous taxon (Gandouin et al. 2006) and is abundant in samples of most mesotrophic and eutrophic lakes, although may be excluded from the coldest lakes (Brooks et al. 2007). It occurs in fine sediment and may be not survive a long period of anoxia but is often the last chironomid taxon to survive during periods of anoxia (Heiri and Lotter 2003). Temperature: Larocque et al. (2001) calculated a T_{Jul} of 0 °C and no statistical relationship by an HOF model analysis, whereas Bunbury and Gajewski (2008) calculated bottom water temperatures during the early summer season in 2000 of 14.1 °C ± 3.4 (10.7 to 17.6 °C) and in 2006 14.5 °C ± 3.9 (10.7 to 18.4 °C). Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for *Procladius* sp. the optimum is considered to be > 15 °C (=warm optima). Walker et al. (1997) calculated a summer temperature of water surfaces in eastern Canada with an optimum for *Procladius* of 18.1 °C (± 5.6) and 17.6 °C (± 5.8) for square root transformed data. pH: it tolerates acidification (Il'yashuk and Il'yashuk 2000; Brodin 1986, Henrikson et al. 1982: pH of 4.3–4.7). Vallenduuk and Moller-Pillot (2007) state that in many water types, the occurrence of *Procladius* larvae seems to be independent of pH and Leuven et al. (1987) found them to be fairly numerous at pH < 4.0 and still present at pH 9.45. Salinity: is known to tolerate salinity (Heinrichs and Walker 2006) and Zhang et al. (2007) report a salinity (total dissolved solids) on the Tibetan Plateau of 13,809 mg · l^{-1} ($\approx 20,500\,\mu$S · cm^{-1}). Wolf et al. (2009) classify *Procladius* sp. as a (limnic, euryhaline-limnic) freshwater taxon that tolerates a salinity below 5 ‰. On a 10–weight–scale and $\sum$ weights = 10 following Caspers (1959) it falls into categories freshwater–7 (< 0.5 ‰) and oligohaline–3 (0.5– < 5 ‰).

[77] `Psec?bas`: *Psectrocladius barbimanus/sokolovae* type (Edwards, 1929)

n=136	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	Water $\texttt{area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3.	1..	...4..	...4.	.2..	.2..	..3..	.2..
HOF:								

Ecological notes:
P. barbimanus is an holarctic distributed taxon and is living in brackish and limnic waters, probably always in the littoral zone between plants and where algae cover surfaces (Thienemann 1937). *P. barbimanus* belongs according to Brodersen et al. (2004) to oxygen-conformers surviving at high critical oxygen concentrations at about 29 to 37.6 %. Therefore it tends to indicate mesotrophic (oligotrophic) conditions. Salinity: this site in West Greenland investigated by Brodersen et al. (2004) was characterised by a high conductivity value of about 2,500 μS · cm^{-1}. Vallenduuk et al. (1997) state for *P. barbimanus* an occasional presence in oligohaline waters (300–3,000 mg · l^{-1} chloride) and Zhang et al. (2007) report a salinity (total dissolved solids) of 22,589 mg · l^{-1} ($\approx 33,500\,\mu$S · cm^{-1}).
P. sokolovae was described a little ecologically by Zelentsov and Makarchenko (1988) with 11.2 °C water temperature at sampling time and that larvae are congregate in small tundra lakes at the depth of 60–80 cm among silt, detritus and algae and live under permafrost conditions.

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[78] `Psec?obv`: *Psectrocladius obvius* type (Walker, 1856)

n=3	Cond.$_{\log 10}$	Depth$_{\text{samples}}$	Water area$_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3..	1..	.2...	5	1..	.2.	1.	.2..
HOF:	-	-	-	-	-	-	-	-

[79] `Psec?sop`: *Psectrocladius sokolovae/pancratovae*

n=27	Cond.$_{\log 10}$	Depth$_{\text{samples}}$	Water area$_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	..3..	..3..	.2.	..3	1.	..3.
HOF:								

Morphological notes: difficult separation. Middle teeth of mentum distinctly higher than lateral ones with yellow head capsule as described for *P. sokolovae* in Makarchenko and Makarchenko (1999).
Ecological notes:
For *P. sokolovae* see *P. barbimanus/sokolovae*. Akhorov (1977) describes ecology of *P. pancratovae* as: "the depth of biotops of larvae did not exceed 2.5–3 m, temperatures in water bodies ranged from 0 °C in the beginning of June to 18 °C at the end of July, pH ranged from 8.3–9.5; O_2 contents in ?brandished water: in small pools and residual reservoirs it ranged from 6.4 to 8.64 mg · l^{-1}, while in the upper layers of lake Zorkul [Зоркуль] O_2 limits were 6.4–8.0 mg · l^{-1} and finally the elevation at sampling site in the Pamir Mountains was 4,126 m a.s.l." The O_2 contents indicate oligotrophic (mesotrophic) conditions.

[80] `Psec?sol`: *Psectrocladius sordidellus/limbatellus*

n=128	Cond.$_{\log 10}$	Depth$_{\text{samples}}$	Water area$_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	1..	.2...	.2...	.2.	..3	1.	.2..
HOF:								

Difficult separation as mentum looks equally; follows Moller-Pillot (1984b). See also Makarchenko and Makarchenko (1999).
Ecological notes:
Vallenduuk et al. (1997) state for *P. sordidellus/limbatellus* an occurrence in oligotrophic waters as well as in eutrophic ones and therefore it can indicate eutrophic conditions (Luoto 2009). It occurs in large or small stagnant waters or in small slow flowing streams and large rivers (Vallenduuk et al. 1997). Temperature: *P. sordidellus* group has according to Brooks and Birks (2000) a broad range for mean July air temperature of 8 °C up to higher than 12 °C. Bunbury and Gajewski 2008 calculated bottom water temperatures during the early summer season in 2000 of 14.1 °C ± 3.4 (10.7 to 17.4 °C) and in 2006 of 13.9 °C ± 4.4 (9.5 to 18.3 °C). Larocque et al. (2001) calculated for the *P. sordidellus* group a T_{Jul} of 11.6 °C ± 4.6 (n=90) with no specific response curve detected by HOF model type I. Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for *P. sordidellus* group the optimum is considered to be < 10 °C (=cold optima). pH: this group is also considered as being acidophil (Brooks and Birks 2000) which could be shown also by experiments in a mesocosmos by Berezina (2001) with high tolerances from 2.0 up to 11.0. Depth: considering depth values Korhola et al. (2000) found for *P. sordidellus* group a mean value of 7 m ± 5 (n=53) in Fennoscandia. Salinity: Vallenduuk et al. (1997) state for *P. sordidellus/limbatellus* an occasional presence in oligohaline waters (300–3,000 mg · l^{-1} chloride) and Zhang et al. (2007) report for *P. sordidellus* type a definitely higher salinity for total dissolved solids of 10,008 mg · l^{-1} (≈ 14,900 µS · cm^{-1})

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[81] `Psecinde`: *Psectrocladius* sp.

n=59	$\texttt{Cond.}_{log\ 10}$	$\texttt{Depth}_{samples}$	$\texttt{Water area}_{log\ 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3..	1..	..3..	...4.	1..	..3	1.	.2..
HOF:								

Ecological notes: see other taxa above. Indicates temperate climatic conditions and is often found in lake samples (Brooks et al. 2007). Temperature: Walker et al. (1997) calculated a summer temperature of water surfaces in eastern Canada with an optimum for *Psectrocladius* of 17.9 °C (± 6.7) and 17.5 °C (± 6.3) for square root transformed data. Salinity: is known to tolerate salinity (Heinrichs and Walker 2006).

[82] `Psed?per`: *Pseudodiamesa pertinax* type Garrett, 1925

n=2	$\texttt{Cond.}_{log\ 10}$	$\texttt{Depth}_{samples}$	$\texttt{Water area}_{log\ 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	..3	..3..	.2...	.2.	..3	1.	...4
HOF:	-	-	-	-	-	-	-	-

[83] `Psesind2`: *Pseudosmittia* indet 2

n=21	$\texttt{Cond.}_{log\ 10}$	$\texttt{Depth}_{samples}$	$\texttt{Water area}_{log\ 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	...4.	1..	..3..	..3..	1..	..3	1.	.2..
HOF:								

Morphological notes: premandible with 2+1 teeth (apical+basal); seta S1: 2 inner slightly shorter than outer; mandible: 3.5/4–1–1/2–0 (inner-apical-outer-surface); mentum: lateral 5 teeth, submental setation below 1^{st} lateral teeth: early instar 2^{nd} and 3^{rd}. See http://www.chironomidaeproject.com/index.php?id=16.
Ecological notes:
The genus *Pseudosmittia* is commonly in lakes throughout the Holarctic (Brooks et al. 2007). Temperature: Brooks and Birks (2000) calculated a T_{Jul} of lying beyond 14 °C for *Pseudosmittia* sp. Salinity: according to Vallenduuk et al. (1997) some larvae within the genus *Pseudosmittia* tolerate very high salinity values up to about 10,000 mg · l^{-1}.

[84] `Psesinde`: *Pseudosmittia* sp.

n=11	$\texttt{Cond.}_{log\ 10}$	$\texttt{Depth}_{samples}$	$\texttt{Water area}_{log\ 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3..	1..	.2...	.2...	1..	.2.	1.	..3.
HOF:								

Ecological notes see previous taxon *Pseudosmittia* indet 2.

[85] `Saetinde`: *Sætheria* sp.

n=6	$\texttt{Cond.}_{log\ 10}$	$\texttt{Depth}_{samples}$	$\texttt{Water area}_{log\ 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	...4.	1..	5	...4.	.2.	..3	1.	..3.
HOF:	-	-	-	-	-	-	-	-

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[86] `Serg?lov`: *Sergentia longiventris* type Kieffer, 1924

n=82	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	..3	..3..	.2...	.2.	..3	1.	...4
HOF:	-	-	-	-	-	-	-	-

Taxonomy see Brooks et al. (2007), follows Makarchenko and Makarchenko (1999).
Ecological notes:
Brooks et al. (2007) states that *S. longiventris* is thermophilic and occurs in the profundal of dystrophic lakes (Brodin 1986). Temperature: Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for *Sergentia longiventris* the optimum is considered to be > 15 °C (=warm optima).

[87] `Serginde`: *Sergentia* sp.

n=9	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	..3	..3..	.2...	.2.	..3	1.	...4
HOF:	-	-	-	-	-	-	-	-

Ecological notes:
According to Brooks et al. (2007) *Sergentia* sp. occur in the sublittoral to profundal of mesotrophic to oligotrophic lakes. Temperature: Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for *Sergentia* sp. the optimum is considered to be < 10 °C (=cold optima). Walker et al. (1997) calculated a summer temperature of water surfaces in eastern Canada with an optimum for *Sergentia* sp. of 9.8 °C (±4.3) and 10.7 °C (±4.3) for square root transformed data.

[88] `Sticinde`: *Stictochironomus* sp.

n=2	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	..3	..3..	.2...	..3	..3	.2	..3.
HOF:	-	-	-	-	-	-	-	-

[89] `Sticind1`: *Stictochironomus* sp. 1 Pinder and Reiss (1983)

n=3	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	..3	..3..	.2...	.2.	..3	1.	...4
HOF:	-	-	-	-	-	-	-	-

[90] `sfTanypo`: *Tanypodinae* sp.

n=24	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3..	1..	.2...	...4.	1..	.2.	1.	.2..
HOF:								

Tanypodinae show a wide variety of response to environmental factors (Vallenduuk and Moller-Pillot 2007).

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[91] `trTanyt1`: Tanytarsini indet 1

n=5	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	.2.	..3..	1....	..3	..3	1.	.2..
HOF:	-	-	-	-	-	-	-	-

Morphology: premandible with 2(+?) teeth (apical+basal); mandible: 3–1–2–1 plate (inner-apical-outer-surface); mentum: 1 middle (?crenate), lateral 5 teeth; postoccipital plate well developed (triangular); postoccipital margin brown; head yellow; antennal pedestal: 2x width, with well developed spur at pedestal (about as long as wide). See Torbjørn Ekrem's comment on http://www.chironomidaeproject.com/index.php?id=38: this is most probably a *Micropsectra*. The antennal pedestal spur and bifid premandible is typical of this genus.

[92] `trTanyta`: Tanytarsini sp.

n=483	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	..3..	1..	.2.	1.	..3.
HOF:								

Walker et al. (1997) calculated a summer temperature of water surfaces in eastern Canada with an optimum for subtribe Tanytarsina of 14.3 °C (± 6) and 14.6 °C (± 6.2) for square root transformed data.

[93] `TaCoinde`: *Tanytarsus/Corynocera* sp.

n=17	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	5	1..	.2.	1.	.2..
HOF:								

Tanytarsus gracilentus type and *Corynocera oliveri* are grouped together as *Tanytarsus/Corynocera* sp. when there was no dark plate visible behind the mentum as described by Brooks et al. (2007), but at least a mandible and antennal pedestals. See also Chironomidae discussion list (http://lists.vm.ntnu.no/pipermail/chironomidae/2009-March/thread.html#93).
Ecological notes:
Corynocera oliveri occurs in cold, oligotrophic lakes (Brooks et al. 2007; Brooks 2000; Larocque 2008). Temperature: Bunbury and Gajewski (2008) calculated for two different years from a dataset in Yukon (Northamerica) during the early summer season in 2000 a temperature of 9.3 °C ± 4.6 (4.7 to 14 °C) and in 2006 a temperature of 10.6 °C ± 5 (5.6 to 15.6 °C). Larocque (2008) reviewed temperature optima based on eight transfer models for summer air temperature published for America and Europe and for *Corynocera oliveri* the optimum is considered to be < 10 °C (=cold optima). Depth: living in the sublittoral and profundal zone Korhola et al. (2000) calculated a mean depth of 9.4 m ± 6.3 (n=9). Salinity: Zhang et al. (2007) report for *Corynocera oliveri* a mean salinity (total dissolved solids) on the Tibetan Plateau of 3,514 $\text{mg} \cdot \text{l}^{-1}$ ($\approx 5,200\,\mu\text{S} \cdot \text{cm}^{-1}$). Ecological notes for *Tanytarsus gracilentus* see below.

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

94 `Tany?gra`: *Tanytarsus gracilentus* type (Holgrem, 1883)

n=157	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	..3..	1..	.2...	5	1..	.2.	1.	.2..
HOF:								

Morphology: separation by distinct dark plate behind the mentum and the type of mandible (Brooks et al. 2007, see). Brooks et al. (2007) state that it has a mandible like 3–1–2–2 (inner-apical-outer-surface), but in the original description of Paasivirta (1972) seems a printing error just where the outer teeth appear. In contrast to Brooks et al. (2007), Moller-Pillot (1990) illustrates 3–1–3–2 as mandible with 3 outer teeth which matches also to examined specimens in this study. Note that the 3^{rd} outer tooth is worn frequently. See also Chironomidae discussion list (http://lists.vm.ntnu.no/pipermail/chironomidae/2009-March/thread.html#93).

Ecological notes:

Tanytarsus gracilentus is known to live in freshwater rockpools in shallow brackish water habitats and can be extremely numerous in oligotrophic lakes of arctic and subarctic environments (Ekrem and Halvorsen 2007). Depth: in the first description of larvae Paasivirta (1972) found *T. gracilentus* in several depths but concentrated at 0.2 to 0.6 m. Lindegaard (1992) reported *T. gracilentus* from 2–6 down to 20–114 m. Salinity: it can live at low and high salinity values: Paasivirta (1972) reported a specific conductivity of 235 to 6,600 μS, Walker et al. (1995) observed an enduring at high salinities (4,000 to 12,000 $\mu\text{S}\cdot\text{cm}^{-1}$) with somewhat lower productivity, Brodersen et al. (2004) found *T. gracilentus* in arctic lakes of Greenland with 2,798 $\mu\text{S}\cdot\text{cm}^{-1}$ and Rossaro et al. (2004, 2006) report very low conductivity values of 90.54 $\mu\text{S}\cdot\text{cm}^{-1} \pm 9.59$ (min-max: 72–109, n=11). Temperature: in the same Alpine datasets the water temperature was calculated with 4.11 °C ± 1.31 (min-max: 2–8, n=13) that may indicate cold conditions. Temperature data by Brodersen et al. (2004) revealed 14 °C (T_{Jul}). It is suggested to be a pioneer species (Paasivirta 1972) and has strong oxy-regulator capacities (Brodersen et al. 2004).

95 `Tany?lap`: *Tanytarsus lapponicus* type Lindeberg 1970

n=87	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	1..	.2...	.2...	.2.	..3	1.	.2..
HOF:								

See Heiri et al. (2004), Ekrem and Halvorsen (2007), http://www.chironomidaeproject.com/index.php?id=39.

Ecological notes:

Ekrem and Halvorsen (2007) have been found "the larvae of *T. lapponicus* in the sublittoral/profundal zone in a study of recovering acidified lakes in the Killarney Provincial Park, Ontario, Canada. Twenty-two lakes were studied, with pH ranging from 4.6 to 7.7. The depth at which the larvae were found ranged from 6–22 m [..] only the sublittoral/profundal zone was sampled in each lake. The species appears to be an indicator of non-acidic conditions. It was found in lakes with pH ranging from 5.8–7.7, but was absent from lakes with lower pH. *Tanytarsus lapponicus* was found in both clearwater and brownwater lakes, the dissolved organic carbon content (DOC) ranged from 0.8 to 4.2 $\text{mg}\cdot\text{l}^{-1}$"

96 `Tanyinde`: *Tanytarsus* sp.

n=16	$\texttt{Cond.}_{\log 10}$	$\texttt{Depth}_{\text{samples}}$	$\texttt{Water area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	.2...	1..	.2...	..3..	1..	.2.	1.	.2..
HOF:								

Ecological notes:

Many Palearctic morphotypes described in Brooks et al. (2007) occur in the littoral of relatively warm, productive lakes, will tolerate acidic conditions and include also eurytopic taxa (e.g. *T. mendax* type described in Heiri et al. 2004). Salinity: is known to tolerate salinity (Heinrichs and Walker 2006) and Zhang et al. (2007) report a salinity (total dissolved solids) for the Tibetan Plateau of 780.54 $\text{mg}\cdot\text{l}^{-1}$ ($\approx 1,160\,\mu\text{S}\cdot\text{cm}^{-1}$).

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Tab. A.9 (continued): List of taxa. Cluster groups for tested environmental variables are given as follows: `.2..` means a membership in 2^{nd} group of 4 groups alltogether (left: has lowest values, right: has highest values, details see on pages 71–110).

Taxon	Groups of measured environmental variables

[97] `Thil?vit`: *Thienemanniella vittata* type (Edwards, 1924)

n=2	$\mathtt{Cond.}_{\log 10}$	$\mathtt{Depth}_{\text{samples}}$	$\mathtt{Water\ area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	..3	..3..	.2...	.2.	..3	1.	..3.
HOF:	-	-	-	-	-	-	-	-

[98] `Tvetinde`: *Tvetenia* sp.

n=4	$\mathtt{Cond.}_{\log 10}$	$\mathtt{Depth}_{\text{samples}}$	$\mathtt{Water\ area}_{\log 10}$	pH	T_{Oct}	T_{Jul}	P_{Dec}	P_{Jan}
groups:	1....	.2.	.2...	.2...	.2.	..3	1.	..3.
HOF:	-	-	-	-	-	-	-	-

Tab. A.10.: Summary of transfer models' parameters: apparent calculations compared with procedure of leave one out cross-validation (LOOCV); abbreviations see on pages VI–VIII. Note that for MAT-models no LOOCV can be calculated.

	r^2				$Bias_{avg}$		$Bias_{max}$		LLSESP	
Method	app.	LOOCV	RMSE	RMSEP	app.	LOOCV	app.	LOOCV	app.	LOOCV
Inverse										
WA_{inv}	0.8182	0.6201	0.4154	−0.6043	0.0000	0.0063	0.7665	1.3469	0.1818	0.3246
$WA_{inv\ tol}$	0.8409	0.5093	0.3886	−0.7087	0.0000	0.0783	0.8112	2.0084	0.1591	0.3626
Classical										
WA_{cla}	0.8182	0.6273	0.4592	−0.6461	0.0000	0.0088	−0.7309	1.0816	0.0000	0.1673
$WA_{cla\ tol}$	0.8409	0.5178	0.4237	−0.7597	0.0000	0.0956	0.6895	1.9198	0.0000	0.2365
WAPLS-1	0.8182	0.6036	0.4155	−0.6163	0.0086	0.0051	0.7733	1.4972	0.1798	0.3474
WAPLS-2	0.9081	0.6568	0.2954	−0.5769	0.0096	0.0041	0.3113	1.7676	0.0905	0.2732
WAPLS-3	0.9329	0.6794	0.2526	−0.5547	0.0101	0.0427	0.2391	1.4910	0.0715	0.2856
WAPLS-4	0.9449	0.6518	0.2289	−0.5928	0.0123	0.0344	0.2828	1.6068	0.0556	0.2313
WAPLS-5	0.9519	0.6126	0.2137	−0.6367	0.0088	0.0446	0.2215	1.5157	0.0509	0.2352
PLS-1	0.5827	0.3955	0.6292	−0.7582	0.0000	0.0301	1.6198	2.1119	0.4173	0.6166
PLS-2	0.7635	0.5812	0.4737	−0.6308	0.0000	−0.0202	0.7800	1.4818	0.2365	0.4090
PLS-3	0.8271	0.5684	0.4050	−0.6535	0.0000	0.0173	0.9445	1.6416	0.1729	0.3301
PLS-4	0.8628	0.6075	0.3608	−0.6390	0.0000	−0.0080	0.6705	1.6282	0.1372	0.2409
PLS-5	0.8749	0.5890	0.3446	−0.6561	0.0000	−0.0083	0.3952	1.4807	0.1252	0.2523
ML	0.6170	0.3880	0.6942	−0.8423	−0.1504	−0.0937	−0.7061	2.5274	0.1333	0.3903
$MAT_{k=3}$	0.6251	0.6251	0.6156	−0.6156	0.0686	0.0686	1.6278	1.6278	0.4855	0.4855
$WMAT_{k=3}$	0.6353	0.6353	0.5994	−0.5994	0.0543	0.0543	1.5128	1.5128	0.4477	0.4477
$MAT_{k=6}$	0.6463	0.6463	0.6349	−0.6349	0.0148	0.0148	2.0418	2.0418	0.5677	0.5677
$WMAT_{k=6}$	0.6637	0.6637	0.6097	−0.6097	0.0082	0.0082	1.9473	1.9473	0.5281	0.5281
Bayes	0.8613	0.6657	0.3924	−0.6433	−0.0376	0.0278	0.4554	1.0067	0.0007	0.0750
$ANN_{neu=2}$ 1	0.6198	0.4546	0.6696	−0.7294	−0.2307	−0.0698	−0.9118	1.9018	0.2305	0.4772
$ANN_{neu=3}$ 1	0.8017	0.6360	0.4339	−0.5939	−0.0099	0.0765	0.7858	0.9717	0.1998	0.3311
$ANN_{neu=4}$ 1	0.7695	0.6413	0.4716	−0.5847	0.0608	−0.0212	0.6180	1.3472	0.2305	0.3310
$ANN_{neu=2}$ 0.1	0.9081	0.7279	0.3031	−0.5281	−0.0152	−0.0699	0.5618	0.8176	0.0271	0.1621
$ANN_{neu=3}$ 0.1	0.9067	0.7170	0.2995	−0.5315	0.0042	0.0134	0.4424	0.7946	0.0607	0.1810
$ANN_{neu=4}$ 0.1	0.9542	0.7476	0.2084	−0.4906	−0.0028	0.0290	0.5702	0.7880	0.0446	0.2345
$ANN_{neu=2}$ 0.01	0.9521	0.7590	0.2179	−0.4785	0.0118	0.0118	0.7884	1.0159	0.0908	0.2530
$ANN_{neu=3}$ 0.01	0.9504	0.7647	0.2181	−0.4727	0.0092	−0.0135	0.6995	0.9730	0.0702	0.2299
$ANN_{neu=4}$ 0.01	0.9580	0.7624	0.1999	−0.4750	−0.0029	−0.0130	0.5942	0.8768	0.0525	0.2347
$ANN_{neu=2}$ 0.001	0.6146	0.0003	0.9712	−0.9786	−0.0972	−0.0894	2.2858	2.3096	0.9921	1.0003
$ANN_{neu=3}$ 0.001	0.6585	0.0286	0.9383	−0.9739	−0.0815	−0.0868	2.2427	2.2997	0.9592	0.9955
$ANN_{neu=4}$ 0.001	0.6294	0.1996	0.9470	−0.9608	−0.0851	−0.0810	2.2565	2.3076	0.9680	0.9823

Tab. A.11.: Apparent estimates of transfer models calculated for electrical conductivity$_{\log 10}$. Abbreviations see on pages VI–VIII.

	Artificial Neuronal Network models (ANN)															
	2 neurons with learning rates:				3 neurons with learning rates:				4 neurons with learning rates:					MAT		
sample code	0.001	0.01	0.1	1	0.001	0.01	0.1	1	0.001	0.01	0.1	1	Bayes	k=3	k=6	ML
Cha-01	-0.18157	0.30859	0.17399	1.13345	-0.18288	0.30588	0.22743	-0.15510	-0.18440	0.25561	0.30440	0.24625	0.42061	0.17597	0.20556	0.35903
Mad-01	-0.17376	1.12220	1.53489	1.34974	-0.14001	1.08137	1.30552	1.32922	-0.15243	1.08966	1.13256	1.04019	0.70710	0.00805	0.44628	1.01709
YeR-08	-0.18183	0.31811	0.21692	-0.63395	-0.18784	0.30035	0.32429	-0.15541	-0.18640	0.31378	0.31791	0.01993	0.33215	-0.90069	-0.24050	1.39190
YeR-10	-0.19653	-0.84727	-0.88753	-0.72825	-0.26052	-0.79687	-0.77830	-0.97085	-0.24506	-0.78298	-0.93016	-0.75782	-1.52174	-0.53037	-0.49515	-1.03270
YeR-11	-0.17372	0.56233	0.79961	1.31073	-0.13897	0.55287	0.30519	-0.15510	-0.15170	0.51852	0.54850	0.27673	0.66639	0.06718	0.17557	0.41534
YeR-13	-0.18950	-0.09371	-0.24440	-0.72825	-0.22637	-0.05912	-0.16842	-0.15510	-0.21707	-0.08670	-0.15962	-0.75742	0.28044	-0.14375	-0.01297	-0.00286
YeR-15	-0.17487	0.38029	0.02498	1.31073	-0.14279	0.41023	0.29931	-0.15510	-0.15561	0.44300	0.42241	0.27673	0.15771	0.01873	-0.05383	0.34029
YeR-17	-0.15572	1.33346	1.55362	1.49268	-0.07389	1.42592	1.67309	1.32922	-0.08639	1.53430	1.54518	1.49936	1.37957	0.99094	0.75787	1.34679
YeR-20	-0.18123	-0.06504	-0.02556	-0.53628	-0.18004	-0.04555	-0.06795	-0.15510	-0.18276	-0.09478	-0.01983	0.27354	0.48664	0.80503	0.54728	0.83031
YeR-26	-0.17918	-0.59200	-0.27295	1.30986	-0.16955	-0.58980	-0.39985	-0.15510	-0.17451	-0.59724	-0.58276	0.27673	-0.08053	-0.24655	0.05834	-0.39396
YeR-27	-0.15811	1.33343	1.55361	1.49268	-0.08204	1.42574	1.67311	1.32922	-0.09519	1.53409	1.54549	1.49936	2.19235	0.29225	0.11940	1.78096
YeR-28	-0.18983	-0.63790	-0.24721	-0.72825	-0.22742	-0.52689	-0.37364	-0.15510	-0.21811	-0.60292	-0.33408	-0.75742	0.11448	-0.09488	-0.00548	0.06064
YeR-34	-0.19211	-0.66322	-0.43812	-0.72825	-0.23951	-0.68584	-0.66676	-0.63813	-0.22727	-0.68347	-0.64336	-0.75742	-0.50156	-0.59062	-0.35692	-0.68249
YeR-43	-0.18576	-0.59545	-0.77334	-0.72821	-0.20947	-0.59390	-0.69817	-0.15511	-0.20248	-0.59332	-0.59799	-0.75742	-0.54932	-0.29056	-0.43813	-0.69388
YeR-44	-0.18767	-0.62800	-0.65667	-0.72825	-0.22081	-0.68899	-0.70512	-0.15510	-0.21080	-0.68240	-0.60169	-0.75742	-0.58461	-0.89745	-0.59704	-0.65855
YeR-47	-0.17773	1.10972	1.38509	1.29886	-0.15977	1.07260	0.34605	-0.15510	-0.16813	1.11399	0.75626	0.27846	0.66255	0.42088	0.28831	0.91544
YeR-48	-0.17921	0.67851	0.54340	1.30436	-0.16910	0.64092	0.22514	-0.15510	-0.17446	0.70988	0.59114	0.27673	0.46860	-0.02608	-0.02248	0.61903
YeR-49	-0.19138	-0.08248	-0.26104	-0.72825	-0.23719	-0.10145	-0.17283	-0.15510	-0.22489	-0.13775	-0.06363	-0.75742	-0.12870	-0.51234	-0.55935	-0.32547
Gah-01	-0.19781	-0.82060	-0.69449	-0.72825	-0.26390	-0.83609	-0.93915	-0.98296	-0.24928	-0.84795	-0.82745	-0.75742	-0.87587	-1.03267	-0.79943	-1.33637
Sic-07	-0.19075	-1.60425	-1.73962	-0.72806	-0.23702	-1.65316	-1.77641	-1.59000	-0.22341	-1.44474	-1.46943	-0.77505	-1.75946	-1.45975	-1.25078	1.63316
Sic-08	-0.18927	-0.94934	-0.42728	-0.72825	-0.22633	-0.92017	-0.72940	-0.15510	-0.21626	-0.92177	-0.95571	-0.75742	-0.91756	-0.76303	-0.49941	-0.73383
Sic-12	-0.19265	-1.60050	-1.73557	-0.72825	-0.24426	-1.65346	-1.75377	-1.59000	-0.23028	-1.60280	-1.64732	-1.53416	-1.59715	-1.43111	-1.42140	-1.69444
Sic-13	-0.19497	-1.62301	-1.74081	-0.72824	-0.25557	-1.71203	-1.78478	-1.59000	-0.23968	-1.48374	-1.53024	-0.77412	-1.94867	-1.41686	-1.16857	1.63575
Sic-15	-0.18265	-0.65723	-0.44747	-0.43798	-0.19544	-0.65594	-0.75303	-0.15510	-0.19087	-0.65624	-0.65480	-0.72076	-0.75724	-0.66691	-0.56967	-0.72206
Sic-16	-0.18735	-1.29135	-1.45877	-0.72824	-0.21819	-1.24699	-1.38277	-1.27325	-0.20913	-1.27821	-1.41556	-0.75735	-1.50133	-0.61701	-0.61325	-1.60805
Sic-17	-0.18979	-1.52817	-1.72389	-0.72825	-0.23245	-1.55425	-1.52523	-1.58641	-0.21933	-1.59155	-1.66127	-1.53451	-1.45731	-0.68659	-0.86211	-1.59959
Sic-25	-0.18906	-0.72479	-0.62180	-0.72825	-0.22748	-0.72055	-0.66702	-0.15510	-0.21631	-0.71308	-0.72775	-0.75742	-0.75192	-0.60325	-0.54506	-0.84529
CTP-01	-0.18034	-0.38983	-0.35138	-0.03913	-0.17718	-0.37832	-0.41788	-0.15510	-0.17951	-0.36405	-0.48176	0.27502	-0.03002	0.22631	-0.13140	-0.14820
CTP-02	-0.18099	-0.42591	-0.30208	-0.40321	-0.18035	-0.42572	-0.52986	-0.15510	-0.18218	-0.40752	-0.44528	-0.56739	-0.21638	-0.29502	-0.02248	-0.37190
CTP-04	-0.18809	-0.41981	-0.38451	-0.72825	-0.22129	-0.44060	-0.38690	-0.15510	-0.21195	-0.46644	-0.42789	-0.75742	-0.45784	-0.69089	-0.40273	-0.62160
CTP-06	-0.18419	-0.39568	-0.35518	-0.72813	-0.20082	-0.39909	-0.45188	-0.15518	-0.19621	-0.39407	-0.41743	-0.75727	-0.14878	0.16934	-0.05556	-0.44090
CTP-07	-0.17926	0.23454	-0.07152	1.31040	-0.16904	0.23808	0.23764	-0.15510	-0.17446	0.20137	0.11101	0.27673	0.01011	0.09429	0.05556	0.03550
CTP-08	-0.18690	-0.33130	-0.26321	-0.72824	-0.21110	-0.31583	-0.10645	-0.15510	-0.20575	-0.32501	-0.38284	-0.75742	0.09333	-0.06842	0.17796	-0.08663
CTP-10	-0.18915	-0.35054	-0.29219	-0.72825	-0.22828	-0.35837	-0.36018	-0.15510	-0.21665	-0.37350	-0.28032	-0.75742	-0.38398	-0.52147	-0.59028	-0.64762
CTP-11	-0.19364	-0.48350	-0.34413	-0.72825	-0.24591	-0.47855	-0.65158	-0.15511	-0.23311	-0.43616	-0.43375	-0.75742	-0.23589	-0.77443	-0.42617	-0.71212
CTP-14	-0.17506	0.75636	0.64095	1.31220	-0.14614	0.75503	0.45444	1.32922	-0.15739	0.75291	0.77009	0.29449	0.40247	-0.40979	0.10278	0.66807
CTP-16	-0.18423	0.05260	-0.16259	-0.69751	-0.20053	0.05264	-0.01223	-0.15510	-0.19622	0.06184	0.05153	-0.75700	-0.04972	0.04499	-0.11460	-0.07321
CTP-19	-0.16223	1.33319	1.55362	1.49268	-0.09167	1.42545	1.67313	1.32922	-0.10902	1.53360	1.54549	1.49936	1.78702	1.08012	0.75721	1.71866
CTP-20	-0.18060	-0.63920	-0.46212	-0.61736	-0.18235	-0.64018	-0.46582	-0.59792	-0.18187	-0.64081	-0.62359	-0.90138	-0.56702	-0.43917	-0.23625	-0.68490
CTP-21	-0.18992	0.24476	-0.23964	-0.72825	-0.22926	0.21483	0.03371	-0.15510	-0.21886	0.21517	0.25325	-0.75742	0.19886	-0.39441	-0.56483	-0.04635
CTP-23	-0.18751	-0.72058	-0.65197	-0.72825	-0.21710	-0.72099	-0.67221	-0.15517	-0.20905	-0.70402	-0.65821	-0.75742	-0.41706	-0.57217	-0.44668	-0.77147
CTP-25	-0.19548	-1.06102	-0.96776	-0.72825	-0.25525	-1.06128	-0.86297	-0.67067	-0.24064	-0.99135	-0.83552	-0.75742	-1.09364	-0.43534	-0.72795	-0.87438
LBC-01	-0.20040	-1.41851	-1.48738	-0.72825	-0.27300	-1.45772	-1.55944	-1.58452	-0.25874	-1.51152	-1.56321	-0.75742	-2.19789	-0.90625	-0.86165	-1.66589
LBC-02	-0.19647	-1.44178	-1.73032	-0.72825	-0.26039	-1.45727	-1.14523	-1.59000	-0.24473	-1.44876	-1.43486	-1.53421	-0.89102	-1.04232	-0.84625	-1.29540
LBC-03	-0.19463	-1.48056	-1.73301	-0.72825	-0.25324	-1.47658	-1.11613	-1.59000	-0.23787	-1.48599	-1.43870	-1.53172	-1.60771	-1.15421	-0.86397	-1.31009
LBC-07	-0.18877	-1.59115	-1.73689	-0.72824	-0.22732	-1.65534	-1.77511	-1.59000	-0.21520	-1.76598	-1.76135	-1.53410	-2.24820	-1.72682	-1.34811	-1.88255
LBC-08	-0.18683	-1.57891	-1.72711	-0.72822	-0.21654	-1.64208	-1.73978	-1.59000	-0.20739	-1.73557	-1.74800	-1.53259	-2.18661	-1.14447	-1.00936	-1.89057
LBC-09	-0.20177	-1.13911	-0.79247	-0.72825	-0.27684	-1.10861	-0.89693	-0.98286	-0.26347	-1.11498	-1.14018	-0.75742	-0.05675	-0.79100	-0.59124	-0.89926
Qai-03	-0.17676	1.23704	1.54977	1.46591	-0.15732	1.25613	1.65357	1.32922	-0.16525	1.25541	1.41939	1.04420	1.03124	0.40597	0.52461	1.36910
Qai-06	-0.18280	0.01204	-0.03846	1.26948	-0.19430	0.01631	-0.08545	-0.15511	-0.19097	0.01938	0.00575	-0.55356	-0.05574	-0.13955	-0.51729	-0.23051
Qai-07	-0.17088	1.32659	1.55316	1.49166	-0.12776	1.41542	1.67254	1.32912	-0.14157	1.52076	1.54479	1.49691	1.89633	0.48719	0.07319	2.12052
Qai-08	-0.16739	1.27039	1.55176	1.49263	-0.11256	1.34440	1.61406	1.32922	-0.12815	1.39887	1.53299	1.49936	1.80060	0.92083	0.56678	1.90213

Tab. A.11 (continued): apparent estimates of transfer models calculated for electrical conductivity$_{\log 10}$. Abbreviations see on pages VI–VIII.

	Partial Least Squares (PLS) with components:					Weighted Averaging (WA)				Weighted Averaging Partial Least Squares (WAPLS) with components:					WMAT	
sample code	1	2	3	4	5	cla	cla tol	inv	inv tol	1	2	3	4	5	k=3	k=6
Cha-01	-0.04231	0.14822	0.26701	0.41618	0.39552	0.08038	0.13578	0.01456	0.06936	0.00675	0.25835	0.23516	0.26280	0.25312	0.27307	0.26636
Mad-01	0.36190	0.97744	1.26384	1.33476	1.26318	0.73794	0.51816	0.55255	0.39089	0.54610	1.05426	1.15702	1.20172	1.19855	0.05012	0.45526
YeR-08	-0.27414	-0.16467	-0.22762	-0.14608	-0.04448	-0.08976	-0.04394	-0.12464	-0.08176	-0.13281	0.29251	0.49056	0.35424	0.33050	-0.91033	-0.30428
YeR-10	-1.13806	-1.22265	-0.92173	-0.85307	-0.87118	-1.03015	-0.93273	-0.89403	-0.82912	-0.90415	-1.08854	-0.96123	-0.76386	-0.75722	-0.50409	-0.48642
YeR-11	0.59896	0.30730	0.16433	0.47181	0.27074	0.21673	0.25893	0.12611	0.17291	0.11858	0.38927	0.36637	0.49725	0.54999	0.14195	0.20940
YeR-13	-0.57657	-0.23438	0.06200	0.02535	0.03728	-0.12398	-0.15486	-0.15264	-0.17503	-0.16088	-0.00312	-0.06576	-0.05966	-0.07631	-0.14916	-0.02103
YeR-15	0.69847	0.24931	0.13049	0.44502	0.12832	0.09226	0.15859	0.02427	0.08854	0.01649	0.19392	0.11345	0.22132	0.27107	0.07005	-0.00058
YeR-17	2.28237	1.16531	1.55529	1.32664	1.45128	1.83235	1.73569	1.44795	1.41467	1.44378	1.01326	1.09893	1.01664	1.06023	1.26852	1.02531
YeR-20	-0.01484	0.27793	0.38431	0.34140	0.25376	0.21231	0.20802	0.12250	0.13011	0.11496	0.36463	0.28092	0.25429	0.23235	0.86937	0.62868
YeR-26	0.11412	0.14400	-0.03801	-0.07988	-0.20327	-0.05585	-0.27966	-0.09690	-0.27997	-0.10500	-0.03988	-0.38248	-0.53794	-0.64020	-0.27120	0.02720
YeR-27	1.84811	0.74193	1.02433	0.73393	0.97645	2.31834	2.07401	1.84557	1.69915	1.84240	1.08506	1.25021	1.18260	1.29781	0.53709	0.36147
YeR-28	-0.57757	-0.13853	0.22397	0.04569	-0.02369	-0.07960	-0.14253	-0.11633	-0.16466	-0.12448	-0.01900	-0.19943	-0.32265	-0.44584	-0.09793	-0.00950
YeR-34	-0.66751	-0.85917	-0.88245	-0.96032	-1.00336	-0.54406	-0.49393	-0.49633	-0.46014	-0.50544	-0.58621	-0.63795	-0.62877	-0.65938	-0.59801	-0.37998
YeR-43	-0.37838	-0.49903	-0.69422	-0.70619	-0.70570	-0.57719	-0.42534	-0.52344	-0.40247	-0.53262	-0.61897	-0.68567	-0.64092	-0.60332	-0.28909	-0.43412
YeR-44	-0.49654	-0.53861	-0.47468	-0.45316	-0.55404	-0.68444	-0.59904	-0.61119	-0.54852	-0.62058	-0.68235	-0.65738	-0.55555	-0.59358	-0.90904	-0.62476
YeR-47	0.20085	0.67430	0.90960	0.98156	0.92730	0.45188	0.36658	0.31851	0.26343	0.31147	0.72801	0.81500	0.91900	0.98414	0.35843	0.29565
YeR-48	0.15399	0.29119	0.38975	0.49168	0.40285	0.24472	0.24735	0.14902	0.16318	0.14155	0.41876	0.41694	0.49754	0.54901	-0.02822	-0.00707
YeR-49	-0.71351	-0.50988	-0.27509	-0.34168	-0.37615	-0.40745	-0.30261	-0.38456	-0.29927	-0.39339	-0.32384	-0.29156	-0.14881	-0.11016	-0.51195	-0.55747
Gah-01	-1.23610	-1.15399	-0.87994	-1.02656	-0.96098	-0.90860	-1.01931	-0.79459	-0.90191	-0.80445	-1.02280	-1.09284	-0.96101	-0.86463	-1.04068	-0.84085
Sic-07	-0.86692	-1.32736	-1.57085	-1.26252	-1.11375	-2.15973	-2.02315	-1.81822	-1.74601	-1.83067	-1.47230	-1.30453	-1.52468	-1.27474	-1.48209	-1.31009
Sic-08	-0.40815	-0.71623	-0.60284	-0.42103	-0.60796	-0.64476	-0.68002	-0.57872	-0.61662	-0.58804	-0.67642	-0.66993	-0.56323	-0.59901	-0.75575	-0.51344
Sic-12	-0.90863	-1.21728	-1.42487	-1.42810	-1.37388	-1.65433	-2.03343	-1.40472	-1.75465	-1.41613	-1.44639	-1.48218	-1.67432	-1.54711	-1.43142	-1.42794
Sic-13	-1.15728	-1.84201	-2.10710	-1.64146	-1.42877	-2.28615	-2.03953	-1.92164	-1.75978	-1.93436	-1.53477	-1.42045	-1.71239	-1.44165	-1.42149	-1.22927
Sic-15	-0.34322	-0.41708	-0.67918	-0.63525	-0.56838	-0.68275	-0.54394	-0.60980	-0.50219	-0.61920	-0.64130	-0.56031	-0.55792	-0.68250	-0.62737	-0.55256
Sic-16	-0.60005	-0.59120	-0.70008	-0.81947	-0.79112	-1.29090	-1.87626	-1.10737	-1.62250	-1.11803	-1.36096	-1.47172	-1.46255	-1.30356	-0.64377	-0.62631
Sic-17	-0.71958	-1.08182	-1.53624	-1.77127	-1.78305	-1.40603	-1.72126	-1.20156	-1.49217	-1.21246	-1.59633	-1.64088	-1.68274	-1.71952	-0.68787	-0.85055
Sic-25	-0.63972	-0.62584	-0.56097	-0.55441	-0.55401	-0.74333	-0.61190	-0.65937	-0.55934	-0.66889	-0.76817	-0.76669	-0.69799	-0.74981	-0.62172	-0.56400
CTP-01	0.01499	-0.06878	-0.30485	-0.33327	-0.41746	-0.10841	-0.10935	-0.13990	-0.13676	-0.14810	-0.04944	-0.23192	-0.27796	-0.29229	0.15869	-0.12855
CTP-02	-0.05223	0.10379	-0.08427	-0.22022	-0.27896	-0.15041	-0.29741	-0.17427	-0.29490	-0.18256	-0.12967	-0.38478	-0.48644	-0.55595	-0.32449	-0.05716
CTP-04	-0.52291	-0.57403	-0.57104	-0.56431	-0.57611	-0.60817	-0.48812	-0.54879	-0.45525	-0.55803	-0.61785	-0.65259	-0.57301	-0.57167	-0.69158	-0.42234
CTP-06	-0.37353	-0.27261	-0.34507	-0.37494	-0.33328	-0.27953	-0.48911	-0.27991	-0.45609	-0.28846	-0.33189	-0.46565	-0.47546	-0.48813	0.15056	-0.05845
CTP-07	0.19051	0.17900	0.15790	0.26546	0.13003	0.08615	0.02025	0.01928	-0.02779	0.01148	0.21482	0.14006	0.19995	0.21695	0.22539	0.12484
CTP-08	-0.21147	-0.44361	-0.41603	-0.34298	-0.48961	-0.23651	-0.12234	-0.24471	-0.14768	-0.25318	-0.18972	-0.29634	-0.25179	-0.22761	-0.09003	0.15255
CTP-10	-0.65332	-0.60149	-0.51599	-0.52966	-0.54320	-0.63660	-0.47393	-0.57205	-0.44333	-0.58134	-0.63180	-0.61844	-0.50753	-0.51136	-0.45419	-0.54537
CTP-11	-0.82184	-0.79283	-0.63077	-0.73107	-0.75356	-0.54651	-0.48645	-0.49834	-0.45385	-0.50745	-0.57635	-0.71138	-0.68570	-0.66951	-0.77261	-0.44501
CTP-14	0.27539	0.87066	0.66270	0.44935	0.44931	0.38392	0.45910	0.26290	0.34123	0.25572	0.66115	0.61086	0.70209	0.78996	-0.40685	0.07935
CTP-16	-0.35578	-0.08627	-0.03082	-0.02328	0.03011	-0.17237	-0.10689	-0.19223	-0.13469	-0.20057	0.02003	0.07182	0.09922	0.03039	0.04851	-0.10815
CTP-19	1.19580	2.48948	1.79400	1.72152	1.82268	3.01061	2.83749	2.41196	2.34114	2.41023	1.55025	1.44140	1.34805	1.49107	1.24005	0.87153
CTP-20	-0.22196	-0.17622	-0.38343	-0.42453	-0.41347	-0.55680	-0.57691	-0.50676	-0.52992	-0.51589	-0.64834	-0.70118	-0.57882	-0.58140	-0.43994	-0.24493
CTP-21	-0.64012	-0.47478	-0.31591	-0.33783	-0.28101	-0.15774	-0.05733	-0.18026	-0.09302	-0.18857	0.02892	0.09578	0.24373	0.33272	-0.38966	-0.55629
CTP-23	-0.43715	-0.64164	-0.77686	-0.81357	-0.85090	-0.54345	-0.42344	-0.49584	-0.40087	-0.50494	-0.58751	-0.65616	-0.60468	-0.57011	-0.56361	-0.45465
CTP-25	-0.99271	-1.09972	-1.04560	-1.20828	-1.23277	-0.84826	-0.65588	-0.74522	-0.59632	-0.75495	-0.93330	-1.01721	-1.00253	-1.02910	-0.42578	-0.70216
LBC-01	-1.43958	-1.45219	-1.32543	-1.68765	-1.66045	-1.24261	-1.37749	-1.06786	-1.20310	-1.07842	-1.42548	-1.63771	-1.80869	-1.88001	-0.90795	-0.85256
LBC-02	-1.23259	-1.68598	-1.61971	-1.38651	-1.33123	-1.32446	-1.26401	-1.13483	-1.10767	-1.14556	-1.51476	-1.40116	-1.30700	-1.41754	-1.21054	-1.00988
LBC-03	-1.11264	-1.55055	-1.50447	-1.25737	-1.22048	-1.43685	-1.30433	-1.22678	-1.14158	-1.23774	-1.65082	-1.51253	-1.36465	-1.45323	-1.26903	-1.02502
LBC-07	-0.71285	-1.05238	-1.62881	-1.97341	-1.95566	-2.28262	-1.95488	-1.91875	-1.68861	-1.93147	-2.25884	-1.57149	-1.75686	-1.90346	-1.72523	-1.35523
LBC-08	-0.58036	-0.71261	-1.06986	-1.36290	-1.42869	-1.69586	-1.73650	-1.43869	-1.50498	-1.45019	-1.88999	-1.86746	-1.89364	-1.82033	-1.15274	-1.01652
LBC-09	-1.49925	-1.25863	-0.80334	-1.05534	-0.99799	-0.52540	-0.51085	-0.48107	-0.47437	-0.49014	-0.57476	-0.80499	-0.97589	-1.09333	-0.83937	-0.63833
Qai-03	0.07029	0.63052	1.02479	1.40584	1.55853	0.80239	0.80113	0.60528	0.62883	0.59896	1.24491	1.34572	1.25291	1.16275	0.39312	0.52025
Qai-06	-0.32894	-0.21674	-0.23252	-0.08919	0.02722	-0.21600	-0.17864	-0.22793	-0.19502	-0.23636	-0.02641	0.04719	0.02493	-0.07637	-0.13903	-0.50759
Qai-07	0.49519	1.33496	1.17044	1.44448	1.71972	2.31048	2.49143	1.83914	2.05015	1.83595	1.88525	2.25234	2.21527	2.16429	0.60212	0.16769
Qai-08	0.80404	1.07212	1.35256	1.27277	1.24094	1.51383	1.58146	1.18735	1.28499	1.18251	1.37163	1.42606	1.27097	1.19676	0.93180	0.61534

Tab. A.12.: LOOCV estimates of transfer models calculated for electrical conductivity$_{\log 10}$. Abbreviations see on pages VI–VIII. Note that for MAT-models no LOOCV can be calculated.

	Artificial Neuronal Network models (ANN)															
	2 neurons with learning rates:				3 neurons with learning rates:				4 neurons with learning rates:					MAT		
sample code	0.001	0.01	0.1	1	0.001	0.01	0.1	1	0.001	0.01	0.1	1	Bayes	k=3	k=6	ML
Cha-01	-0.18999	0.77233	0.98894	0.65598	-0.18974	0.70703	0.95326	-0.09074	-0.19069	0.70646	0.63625	-0.01714	0.43747	0.17597	0.20556	0.35068
Mad-01	-0.17770	1.02542	1.03895	0.82952	-0.13794	1.01582	1.08057	0.00421	-0.16216	0.98967	0.70929	0.34869	0.54560	0.00805	0.44628	0.87337
YeR-08	-0.19185	-0.66551	-0.65840	-0.30835	-0.19958	-0.64357	-0.38668	-0.63564	-0.20548	-0.70251	-0.77937	-0.67353	-1.69908	-0.90069	-0.24050	1.66127
YeR-10	-0.25197	-0.89746	-0.46071	-0.66769	-0.17833	-0.48528	-0.67960	-0.34752	-0.24271	-0.38302	-1.00580	-0.79725	-1.57349	-0.53037	-0.49515	-1.01232
YeR-11	-0.18502	0.71615	1.21126	0.04327	-0.14474	0.70829	1.08626	-0.07415	-0.12704	0.69267	0.71104	0.58461	0.84221	0.06718	0.17557	0.26735
YeR-13	-0.18556	0.01436	-0.43755	0.04158	-0.21671	0.02888	-0.04581	0.14857	-0.27688	0.17666	-0.01146	-0.25877	0.30059	-0.14375	-0.01297	0.02819
YeR-15	-0.17692	0.06385	-0.19919	0.35370	-0.19077	0.01601	0.16904	0.54624	-0.18861	0.14610	-0.09220	-0.54150	0.03378	0.01873	-0.05383	0.15266
YeR-17	-0.17379	1.35563	1.58176	0.60752	-0.16309	1.49632	1.78149	1.74685	-0.07097	1.67428	1.80839	1.79305	1.59516	0.99094	0.75787	1.46727
YeR-20	-0.18258	0.26644	0.61010	0.09393	-0.17614	0.30489	-0.04915	0.20785	-0.17856	0.17666	0.15556	0.31803	0.51498	0.80503	0.54728	0.84005
YeR-26	-0.15551	-0.16375	-0.19479	0.50506	-0.17057	-0.11423	-0.36025	-0.34987	-0.14515	-0.19910	-0.24091	0.77500	0.10530	-0.24655	0.05834	0.16211
YeR-27	-0.19554	1.18500	1.39726	1.21446	-0.17620	1.34904	1.52081	1.44131	-0.11758	1.01994	1.12651	1.90980	2.25774	0.29225	0.11940	1.72917
YeR-28	-0.18714	0.07381	0.31475	0.02627	-0.21125	0.21101	0.32756	-0.00302	-0.22774	0.16838	-0.04505	-0.71432	0.28056	-0.09488	-0.00548	0.32649
YeR-34	-0.18883	-0.63766	-0.41785	-0.56123	-0.20752	-0.79449	-0.74564	-0.64819	-0.24375	-0.77991	-0.55278	-0.89134	-0.39765	-0.59062	-0.35692	-0.67628
YeR-43	-0.17951	-1.12409	-0.72701	0.16246	-0.19939	-1.04320	-0.94822	-0.75902	-0.20771	-1.06458	-1.27829	-0.46578	-0.49851	-0.29056	-0.43813	-0.69843
YeR-44	-0.19607	-0.09799	0.19681	-0.87064	-0.20385	-0.27541	-0.26602	-0.50047	-0.20159	-0.41255	-0.46122	-0.44315	-0.57347	-0.89745	-0.59704	-0.79267
YeR-47	-0.19401	1.07508	1.31522	0.75681	-0.18715	1.07923	1.30576	0.67298	-0.18412	1.05860	0.90068	0.09460	0.55097	0.42088	0.28831	0.79225
YeR-48	-0.19664	0.38968	0.16327	0.02939	-0.19867	0.39548	0.19292	0.33849	-0.20021	0.39597	0.13319	0.16777	0.36339	-0.02608	-0.02248	0.36124
YeR-49	-0.23149	-0.45423	-0.37872	0.60451	-0.22251	-0.52436	-0.42386	-0.65260	-0.24996	-0.54290	-0.62868	-0.58452	-0.21337	-0.51234	-0.55935	-0.40648
Gah-01	-0.17650	-0.86515	-0.69157	-0.36915	-0.27512	-0.91030	-1.35637	-1.52810	-0.24737	-0.96268	-1.01849	-1.41264	-0.59326	-1.03267	-0.79943	-1.13249
Sic-07	-0.19066	-1.57735	-1.75800	-1.78006	-0.17355	-1.64544	-1.75196	-1.46102	-0.26030	-1.42037	-1.45086	-1.16511	-2.56014	-1.45975	-1.25078	1.62037
Sic-08	-0.20299	-0.23957	-0.00501	-0.03102	-0.21133	-0.19284	-0.40901	-0.51802	-0.21579	-0.29411	-0.32357	-0.65647	-0.82787	-0.76303	-0.49941	-0.67020
Sic-12	-0.18745	-1.53676	-1.74610	-1.35781	-0.17820	-1.63638	-1.76336	-0.85808	-0.20692	-1.62432	-1.62763	-1.18057	-1.58215	-1.43111	-1.42140	-1.03161
Sic-13	-0.18555	-1.59660	-1.67450	-1.55637	-0.17002	-1.69238	-1.85395	-1.35992	-0.23646	-1.52731	-1.44361	-1.33273	-2.25083	-1.41686	-1.16857	1.63355
Sic-15	-0.17964	-0.49918	-0.48947	0.70171	-0.17711	-0.52094	-1.00426	-0.47584	-0.18521	-0.44276	-0.55344	-0.53981	-0.19398	-0.66691	-0.56967	-0.71720
Sic-16	-0.18185	-0.95575	-1.20359	-0.03244	-0.18664	-0.89584	-0.93505	-0.57131	-0.18736	-0.86183	-1.22717	-1.10868	-1.51450	-0.61701	-0.61325	-1.61040
Sic-17	-0.19351	-1.35951	-1.62319	-0.72328	-0.18547	-1.35495	-1.67271	-0.55943	-0.19235	-1.31042	-1.31733	-1.14948	-1.04560	-0.68659	-0.86211	-1.39641
Sic-25	-0.17831	-0.74737	-0.45259	-0.06921	-0.26289	-0.72061	-0.75659	-0.56394	-0.21709	-0.78922	-0.80242	-0.68274	-0.74935	-0.60325	-0.54506	-0.86529
CTP-01	-0.17469	-0.38044	-0.32001	0.33918	-0.17822	-0.31737	-0.32943	-0.53307	-0.17772	-0.26965	-0.54285	0.20837	-0.00099	0.22631	-0.13140	-0.10318
CTP-02	-0.17819	-0.32508	-0.57454	0.03648	-0.17407	-0.34701	-0.16484	0.17894	-0.17735	-0.26598	-0.67185	-0.19570	-0.14616	-0.29502	-0.02248	-0.11237
CTP-04	-0.21195	-0.54540	-0.60550	0.09043	-0.24662	-0.54829	-0.46307	-0.10654	-0.21425	-0.56171	-0.53600	-0.44993	-0.48554	-0.69089	-0.40273	-0.69039
CTP-06	-0.18725	-0.57274	-0.51280	-0.88280	-0.19474	-0.50331	-0.42955	-0.04456	-0.18926	-0.50499	-0.59974	-0.21092	-0.08355	0.16934	-0.05556	-0.55034
CTP-07	-0.18140	0.32251	-0.04818	-0.20167	-0.16733	0.42772	0.33232	-0.19246	-0.16821	0.43241	0.51259	0.40481	-0.03505	0.09429	0.05556	-0.02889
CTP-08	-0.20983	-0.51744	-0.75592	-0.18049	-0.21368	-0.36204	-0.08681	-0.15209	-0.25249	-0.34321	-0.25559	-0.65374	0.09737	-0.06842	0.17796	-0.10768
CTP-10	-0.23249	-0.23947	-0.44112	-0.73801	-0.22703	-0.44576	-0.49849	-0.61989	-0.24071	-0.48347	-0.16250	-0.50248	-0.38435	-0.52147	-0.59028	-0.65962
CTP-11	-0.24556	-0.77794	-0.63004	-1.34965	-0.22021	-0.75371	-0.93287	-0.93614	-0.24425	-0.82597	-0.66357	-0.59928	-0.27622	-0.77443	-0.42617	-0.75719
CTP-14	-0.18545	-0.15086	0.82828	0.00301	-0.19088	0.20621	-0.04058	-0.51119	-0.17380	0.19175	0.07127	0.49570	0.32548	-0.40979	0.10278	0.41411
CTP-16	-0.20070	-0.32390	-0.23798	-0.57054	-0.21370	-0.31750	-0.10625	-0.63413	-0.20815	-0.28996	-0.30892	0.02775	-0.46439	0.04499	-0.11460	-0.26262
CTP-19	-0.15491	1.23554	1.47670	0.72153	-0.19317	1.37318	1.46147	1.43075	-0.14051	1.51561	1.42424	1.75050	2.14287	1.08012	0.75721	1.69539
CTP-20	-0.17582	0.08380	0.12339	-0.33562	-0.17528	0.03055	0.18479	-0.19840	-0.17487	-0.02044	0.21007	0.00211	-0.36149	-0.43917	-0.23625	-0.68384
CTP-21	-0.25133	-0.47620	-0.38975	-0.51394	-0.20040	-0.06224	-0.37389	-0.65951	-0.21308	-0.28727	-0.27454	-0.46769	0.18196	-0.39441	-0.56483	-0.17299
CTP-23	-0.20096	-0.82038	-0.42345	0.32750	-0.21995	-0.85769	-1.05518	-0.17848	-0.22937	-0.76588	-0.67689	-0.25785	-0.34023	-0.57217	-0.44668	-0.76057
CTP-25	-0.17789	-1.23458	-0.78835	-0.81514	-0.18935	-1.26413	-1.08234	-1.31093	-0.19790	-1.28940	-1.12242	-0.66115	-1.10154	-0.43534	-0.72795	-0.87755
LBC-01	-0.20150	-1.07625	-1.24781	0.04312	-0.20307	-1.04513	-0.84066	-1.55230	-0.18654	-1.06343	-1.03361	-0.92206	-2.11944	-0.90625	-0.86165	-1.23620
LBC-02	-0.17820	-1.46332	-1.62344	-0.63072	-0.23640	-1.50094	-1.79751	-1.63540	-0.26908	-1.51502	-1.42909	-1.34743	-0.67261	-1.04232	-0.84625	-1.20959
LBC-03	-0.19689	-1.51866	-1.71905	-1.74652	-0.17848	-1.51344	-1.43364	-1.58420	-0.22495	-1.49584	-1.39490	-1.22694	-1.44471	-1.15421	-0.86397	-1.25646
LBC-07	-0.18119	-1.46768	-1.70110	-1.72212	-0.19900	-1.50649	-1.78548	-1.55573	-0.20478	-1.52333	-1.73174	-1.20278	-3.17916	-1.72682	-1.34811	-2.06270
LBC-08	-0.18363	-1.20194	-1.47156	-1.35149	-0.16177	-1.16834	-1.32494	-1.55310	-0.18452	-1.18622	-1.38651	-0.77429	-2.32270	-1.14447	-1.00936	-1.57293
LBC-09	-0.18023	-0.65152	-0.31225	-1.64945	-0.20205	-0.57606	-0.67094	-1.50750	-0.23285	-0.73534	-0.42737	-0.66338	0.18652	-0.79100	-0.59124	-0.69212
Qai-03	-0.18997	0.97283	1.13654	0.94609	-0.19499	0.96686	0.87406	-0.21121	-0.19144	0.92133	1.19800	0.35706	0.35940	0.40597	0.52461	0.04837
Qai-06	-0.20316	0.15297	0.91686	0.38400	-0.19079	0.09304	0.61656	-0.18796	-0.19781	0.14285	0.02298	-0.50838	-0.21190	-0.13955	-0.51729	-0.64734
Qai-07	-0.19468	1.09904	1.29737	0.21313	-0.18478	1.14194	1.32030	1.15933	-0.19264	1.23812	1.32693	0.76772	1.10824	0.48719	0.07319	-0.41247
Qai-08	-0.20165	1.10179	1.31368	0.27015	-0.17698	1.04579	0.27998	1.32707	-0.17575	1.12988	0.98180	1.71052	1.58317	0.92083	0.56678	1.67306

Tab. A.12 (continued): LOOCV estimates of transfer models calculated for electrical conductivity$_{\log 10}$. Abbreviations see on pages VI–VIII. Note that for MAT-models no LOOCV can be calculated.

	Partial Least Squares (PLS) with components:					Weighted Averaging (WA)				Weighted Averaging Partial Least Squares (WAPLS) with components:					WMAT	
sample code	1	2	3	4	5	cla	cla tol	inv	inv tol	1	2	3	4	5	k=3	k=6
Cha-01	-0.06057	0.13395	0.25736	0.42920	0.41927	0.08166	0.10430	0.01486	0.04142	0.00655	0.26787	0.26377	0.31081	0.32098	0.27307	0.26636
Mad-01	0.19660	0.74576	1.16021	1.32800	1.29199	0.59420	0.32041	0.42376	0.21926	0.41694	0.89798	1.06249	1.15463	1.18221	0.05012	0.45526
YeR-08	-0.32099	-0.25954	-0.39156	-0.40695	-0.35634	-0.79956	-1.69462	-0.71100	-1.48883	-0.68769	-0.58691	-0.40080	-0.41892	-0.42063	-0.91033	-0.30428
YeR-10	-1.06190	-1.22193	-1.03569	-0.91317	-0.84580	-0.99585	-0.88778	-0.86336	-0.78937	-0.87393	-1.07333	-0.99141	-0.76572	-0.71500	-0.50409	-0.48642
YeR-11	0.45379	0.44303	-0.06803	0.38939	0.36377	0.14462	0.15378	0.06430	0.08140	0.05726	0.32418	0.35449	0.52240	0.60802	0.14195	0.20940
YeR-13	-0.58637	-0.25448	0.06770	0.05238	0.06884	-0.11936	-0.12592	-0.14838	-0.15023	-0.15675	0.01562	-0.00685	0.04130	0.06133	-0.14916	-0.02103
YeR-15	0.32530	0.39150	-0.33463	0.27439	0.03542	-0.04770	0.03199	-0.09250	-0.02032	-0.10099	-0.00274	-0.13836	-0.08643	-0.06522	0.07005	-0.00058
YeR-17	2.32814	2.44259	2.08808	2.20605	2.36064	2.32011	2.39902	1.83565	2.03167	1.87463	1.23685	1.54766	1.29559	1.43577	1.26852	1.02531
YeR-20	-0.01432	0.29984	0.43326	0.40743	0.32186	0.24047	-0.11036	0.14861	-0.13650	0.14014	0.41584	0.37042	0.37195	0.37901	0.86937	0.62868
YeR-26	0.15095	0.23344	0.08152	0.11680	0.01053	0.02113	-0.19311	-0.03052	-0.20572	-0.03914	0.11791	-0.07635	-0.16250	-0.24830	-0.27120	0.02720
YeR-27	0.87853	0.65950	-0.11025	0.05636	-0.04643	1.83270	1.65294	1.43181	1.32730	1.44119	0.83232	0.24603	0.68296	0.61998	0.53709	0.36147
YeR-28	-0.53253	-0.05593	0.43931	0.40849	0.40062	0.04733	0.10485	-0.00559	0.05186	-0.01187	0.21824	0.23058	0.25493	0.23404	-0.09793	-0.00950
YeR-34	-0.63592	-0.83976	-0.89127	-1.03160	-1.07724	-0.51168	-0.44182	-0.46937	-0.41586	-0.47172	-0.51692	-0.51919	-0.46822	-0.46826	-0.59801	-0.37998
YeR-43	-0.33162	-0.39796	-0.54815	-0.58147	-0.61584	-0.42716	-0.36726	-0.39972	-0.35291	-0.40843	-0.40096	-0.38715	-0.46560	-0.50326	-0.28909	-0.43412
YeR-44	-0.43556	-0.45116	-0.39966	-0.35101	-0.43516	-0.67912	-0.58284	-0.60571	-0.53445	-0.61545	-0.67398	-0.64299	-0.53006	-0.55289	-0.90904	-0.62476
YeR-47	0.11106	0.56107	0.82536	0.91992	0.86631	0.35898	0.20058	0.23746	0.11958	0.22781	0.61596	0.69331	0.79691	0.87131	0.35843	0.29565
YeR-48	0.06972	0.22977	0.29879	0.43323	0.33694	0.14890	0.10819	0.07203	0.04676	0.06484	0.31313	0.26977	0.28924	0.29199	-0.02822	-0.00707
YeR-49	-0.77022	-0.65538	-0.45346	-0.49341	-0.53213	-0.46987	-0.38961	-0.43874	-0.37456	-0.44922	-0.42914	-0.45762	-0.36707	-0.36409	-0.51195	-0.55747
Gah-01	-1.21052	-1.19816	-0.94031	-1.04118	-1.04515	-0.87973	-0.79509	-0.76886	-0.71163	-0.77918	-1.14896	-1.73545	-2.30120	-2.92068	-1.04068	-0.84085
Sic-07	-0.67175	-1.09072	-1.50965	-1.37417	-1.12396	-2.18853	-2.12559	-1.83606	-1.82326	-1.68767	-1.49547	-1.29887	-1.54964	-1.26186	-1.48209	-1.31009
Sic-08	-0.27562	-0.53007	-0.48473	-0.20672	-0.28952	-0.57970	-0.52678	-0.52425	-0.48614	-0.52974	-0.57914	-0.53226	-0.37488	-0.36664	-0.75575	-0.51344
Sic-12	-0.82135	-1.11341	-1.35476	-1.37996	-1.30826	-1.52536	-2.09158	-1.28847	-1.77828	-1.29986	-1.19117	-1.31813	-1.29185	-1.43235	-1.43142	-1.42794
Sic-13	-0.74798	-1.33151	-2.11990	-2.26632	-2.10976	-2.27498	-2.00976	-1.90268	-1.72505	-1.90924	-1.66899	-1.27596	-1.72184	-1.43043	-1.42149	-1.22927
Sic-15	-0.27285	-0.26112	-0.41969	-0.36576	-0.29013	-0.39271	-0.20198	-0.37128	-0.21326	-0.38067	-0.24053	0.01675	0.31707	0.44179	-0.62737	-0.55256
Sic-16	-0.55163	-0.51699	-0.57219	-0.65190	-0.60028	-0.97313	-1.89653	-0.84244	-1.63572	-0.78353	-0.85188	-1.00722	-1.12384	-1.05122	-0.64377	-0.62631
Sic-17	-0.54160	-0.73433	-1.07742	-1.35246	-1.39715	-1.15541	-1.85296	-0.98830	-1.58652	-0.99913	-1.20393	-1.19773	-1.21741	-1.22155	-0.68787	-0.85055
Sic-25	-0.62278	-0.61148	-0.54888	-0.53664	-0.52492	-0.73304	-0.60475	-0.64967	-0.55272	-0.65953	-0.76438	-0.78316	-0.73624	-0.80697	-0.62172	-0.56460
CTP-01	0.03112	-0.03079	-0.28006	-0.27551	-0.36707	-0.07127	-0.05771	-0.10798	-0.09174	-0.11691	0.02460	-0.08760	-0.07930	-0.04381	0.15869	-0.12855
CTP-02	-0.03523	0.15224	0.01511	-0.11942	-0.18629	-0.10907	-0.25332	-0.13905	-0.25721	-0.14764	-0.06499	-0.28957	-0.40051	-0.49605	-0.32449	-0.05716
CTP-04	-0.52571	-0.58207	-0.58712	-0.59106	-0.60761	-0.61974	-0.51001	-0.55874	-0.47428	-0.56742	-0.64250	-0.70700	-0.66371	-0.69549	-0.69158	-0.42234
CTP-06	-0.36917	-0.26552	-0.32597	-0.35448	-0.31072	-0.29501	-0.48748	-0.29223	-0.45527	-0.30128	-0.30636	-0.35900	-0.35958	-0.38649	0.15056	-0.05845
CTP-07	0.17801	0.22413	0.12130	0.33012	0.20331	0.08550	-0.02600	0.01834	-0.06705	0.01025	0.22894	0.17866	0.25326	0.28413	0.22539	0.12484
CTP-08	-0.20631	-0.42825	-0.51211	-0.30203	-0.47256	-0.21852	-0.10456	-0.22976	-0.13196	-0.23839	-0.16978	-0.27662	-0.23175	-0.20423	-0.09003	0.15255
CTP-10	-0.65353	-0.63846	-0.58028	-0.60933	-0.61839	-0.63731	-0.49361	-0.57302	-0.46022	-0.58239	-0.67069	-0.75416	-0.73091	-0.78628	-0.45419	-0.54537
CTP-11	-0.84095	-0.85149	-0.69765	-0.82763	-0.80157	-0.56502	-0.56028	-0.51474	-0.51780	-0.52362	-0.61607	-0.79653	-0.82719	-0.86462	-0.77261	-0.44501
CTP-14	-0.02423	0.37772	0.36172	0.21172	0.09499	0.12129	0.20165	0.04403	0.11926	0.03752	0.30136	0.17929	0.19958	0.25858	-0.40685	0.07935
CTP-16	-0.38942	-0.16139	-0.13103	-0.16609	-0.12787	-0.63225	-1.86878	-0.57096	-1.62651	-0.58010	-0.59326	-0.51975	-0.48527	-0.58227	0.04851	-0.10815
CTP-19	0.25004	1.61062	2.87277	3.13892	3.35986	3.93390	3.57553	3.20418	2.98533	3.16608	3.35829	2.61385	3.16465	3.03465	1.24005	0.87153
CTP-20	-0.18293	-0.08270	-0.19115	-0.15210	-0.09053	-0.47688	-0.53742	-0.44044	-0.49603	-0.44287	-0.57869	-0.78186	-0.78889	-0.76635	-0.43994	-0.24493
CTP-21	-0.67516	-0.54862	-0.42773	-0.49231	-0.46858	-0.15494	-0.14271	-0.17904	-0.16604	-0.18739	0.03012	0.09461	0.26512	0.40906	-0.38966	-0.55629
CTP-23	-0.41658	-0.62367	-0.76923	-0.80894	-0.85011	-0.48914	-0.37433	-0.45029	-0.35856	-0.46053	-0.49903	-0.51090	-0.38369	-0.27198	-0.56361	-0.45465
CTP-25	-0.99274	-1.12126	-1.08893	-1.27099	-1.29223	-0.85088	-0.64618	-0.74633	-0.58759	-0.75638	-0.94777	-1.05290	-1.06252	-1.10991	-0.42578	-0.70216
LBC-01	-1.25103	-1.30371	-1.25834	-1.51213	-1.59915	-1.12149	-0.85901	-0.96155	-0.75973	-0.97452	-1.23671	-1.39370	-1.59333	-1.68544	-0.90795	-0.85256
LBC-02	-0.94777	-1.41762	-1.69726	-1.73445	-1.58589	-1.18958	-1.07420	-1.01586	-0.93864	-1.02549	-1.40689	-1.37159	-1.25612	-1.34827	-1.21054	-1.00988
LBC-03	-0.83088	-1.24438	-1.48494	-1.44491	-1.28991	-1.32082	-0.99571	-1.12094	-0.87424	-1.13320	-1.60868	-1.61128	-1.45164	-1.48119	-1.26903	-1.02502
LBC-07	-0.53583	-0.70103	-1.11250	-1.49037	-1.52435	-1.76107	-1.41590	-1.46633	-1.21912	-1.09948	-1.59410	-1.77986	-1.79065	-1.70240	-1.72523	-1.35523
LBC-08	-0.45438	-0.46572	-0.61400	-0.72612	-0.70683	-1.35758	-1.81154	-1.14950	-1.55539	-1.16210	-1.36739	-1.33671	-1.59637	-1.67576	-1.15274	-1.01652
LBC-09	-1.35533	-1.27781	-0.82416	-0.84046	-0.84946	-0.39960	-0.39304	-0.37647	-0.37427	-0.38198	-0.36177	-0.45869	-0.53758	-0.60858	-0.83937	-0.63833
Qai-03	-0.14620	0.18233	0.38020	0.66919	0.89049	0.18202	-0.00039	0.09042	-0.05098	0.04993	0.33563	0.37852	0.37499	0.33035	0.39312	0.52025
Qai-06	-0.36664	-0.30752	-0.38176	-0.33210	-0.23561	-0.36444	-0.40774	-0.35064	-0.38894	-0.35330	-0.23770	-0.17192	-0.19281	-0.30938	-0.13903	-0.50759
Qai-07	0.00308	0.63313	0.47334	0.48677	0.63430	1.03333	0.19519	0.76808	0.10656	0.61775	0.34730	0.62394	0.50813	0.59929	0.60212	0.16769
Qai-08	0.48282	0.65956	0.80720	0.91831	0.70931	1.14071	1.25407	0.85608	0.98555	0.85816	0.99019	1.03937	0.77918	0.52410	0.93180	0.61534

Tab. A.13.: Transfer models for conductivity/salinity compared with literature data sorted after r^2_{LOO}. Note that Heinrichs et al. (2001) implements data from Walker et al. (1995). Boxes indicate values.

Model	Author	Variable	Taxa	r^2_{LOO}	RMSEP
WAPLS–2	Yang et al. (2003)	conductivity	diatoms	0.920	0.220
WAPLS–3	Yang et al. (2003)	conductivity	diatoms	0.910	0.240
WA_{inv}	Yang et al. (2003)	conductivity	diatoms	0.900	0.260
WA_{cla}	Yang et al. (2003)	conductivity	diatoms	0.900	0.250
WAPLS–1	Yang et al. (2003)	conductivity	diatoms	0.900	0.260
WAPLS–4	Yang et al. (2003)	conductivity	diatoms	0.880	0.270
$WA_{cla/tol}$	Yang et al. (2003)	conductivity	diatoms	0.870	0.290
$WA_{inv/tol}$	Yang et al. (2003)	conductivity	diatoms	0.870	0.290
WAPLS–3	Eggermont et al. (2006)	conductivity	chironomids	0.822	0.339
WAPLS–2	Eggermont et al. (2006)	conductivity	chironomids	0.820	0.340
WAPLS–3	Zhang et al. (2007)	salinity	chironomids	0.816	0.277
$WMAT_{k=4}$	Eggermont et al. (2006)	conductivity	chironomids	0.814	0.363
$WA_{inv/tol}$	Verschuren et al. (2004)	conductivity, 0/1 data	chironomids	0.810	0.390
WAPLS–4	Eggermont et al. (2006)	conductivity	chironomids	0.810	0.351
$MAT_{k=4}$	Eggermont et al. (2006)	conductivity	chironomids	0.809	0.369
ML	Zhang et al. (2007)	salinity	chironomids	0.803	0.288
ML	Eggermont et al. (2006)	conductivity	chironomids	0.802	0.367
WAPLS–2	Zhang et al. (2007)	salinity	chironomids	0.801	0.287
WAPLS–4	Zhang et al. (2007)	salinity	chironomids	0.799	0.290
WAPLS–5	Eggermont et al. (2006)	conductivity	chironomids	0.795	0.368
$WMAT_{k=4}$	Zhang et al. (2007)	salinity	chironomids	0.782	0.306
WA_{inv}	Verschuren et al. (2004)	conductivity, 0/1 data	chironomids	0.780	0.420
WA_{cla}	Zhang et al. (2007)	salinity	chironomids	0.778	0.315
WA_{inv}	Zhang et al. (2007)	salinity	chironomids	0.772	0.308
WAPLS–1	Zhang et al. (2007)	salinity	chironomids	0.772	0.308
$ANN_{neu=3} - 0.01$	this study	conductivity	chironomids	0.765	0.473
PLS–4	Eggermont et al. (2006)	conductivity	chironomids	0.764	0.392
$ANN_{neu=4} - 0.01$	this study	conductivity	chironomids	0.762	0.475
$ANN_{neu=2} - 0.01$	this study	conductivity	chironomids	0.759	0.479
WA_{cla}	Eggermont et al. (2006)	conductivity	chironomids	0.758	0.444
WAPLS–5	Zhang et al. (2007)	salinity	chironomids	0.757	0.328
WAPLS–1	Eggermont et al. (2006)	conductivity	chironomids	0.757	0.399
WA_{inv}	Eggermont et al. (2006)	conductivity	chironomids	0.756	0.396
PLS–2	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.755	0.439
PLS–5	Eggermont et al. (2006)	conductivity	chironomids	0.752	0.401
PLS–4	Zhang et al. (2007)	salinity	chironomids	0.750	0.323

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Tab. A.13 (continued): Transfer models for conductivity/salinity compared with literature data sorted after r^2_{LOO}. Note that Heinrichs et al. (2001) implements data from Walker et al. (1995). Boxes indicate values.

Model	Author	Variable	Taxa	r^2_{LOO}	RMSEP
PLS–2	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.750 □	0.440 □
PLS–5	Zhang et al. (2007)	salinity	chironomids	0.748 □	0.324 □
$\mathrm{ANN}_{\mathrm{neu}=4} - 0.1$	this study	conductivity	chironomids	0.748 □	0.491 □
PLS–3	Eggermont et al. (2006)	conductivity	chironomids	0.746 □	0.405 □
$\mathrm{WA}_{\mathrm{cla/tol}}$	Eggermont et al. (2006)	conductivity	chironomids	0.746 □	0.454 □
$\mathrm{WA}_{\mathrm{inv/tol}}$	Eggermont et al. (2006)	conductivity	chironomids	0.745 □	0.407 □
$\mathrm{MAT}_{k=4}$	Zhang et al. (2007)	salinity	chironomids	0.741 □	0.335 □
PLS–3	Zhang et al. (2007)	salinity	chironomids	0.738 □	0.330 □
WAPLS–2	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.734 □	0.458 □
$\mathrm{ANN}_{\mathrm{neu}=2} - 0.1$	this study	conductivity	chironomids	0.728 □	0.528 □
$\mathrm{WA}_{\mathrm{cla}}$	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.723 □	0.534 □
WAPLS–1	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.721 □	0.472 □
$\mathrm{WA}_{\mathrm{inv}}$	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.720 □	0.469 □
$\mathrm{WA}_{\mathrm{inv/tol}}$	Walker et al. (1995)	salinity	chironomids	0.720 □	0.520 □
PLS–2	Eggermont et al. (2006)	conductivity	chironomids	0.718 □	0.426 □
$\mathrm{ANN}_{\mathrm{neu}=3} - 0.1$	this study	conductivity	chironomids	0.717 □	0.532 □
WAPLS–1	Mischke et al. (2007)	conductivity	ostracods	0.710 □	0.350 □
WAPLS–3	this study	conductivity	chironomids	0.679 □	0.555 □
PLS–2	Zhang et al. (2007)	salinity	chironomids	0.673 □	0.371 □
$\mathrm{WA}_{\mathrm{cla/tol}}$	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.670 □	0.624 □
PLS–1	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.667 □	0.517 □
$\mathrm{WA}_{\mathrm{inv/tol}}$	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.667 □	0.513 □
Bayes	this study	conductivity	chironomids	0.666 □	0.643 □
$\mathrm{WMAT}_{k=6}$	this study	conductivity	chironomids	0.664 □	0.610 □
WAPLS–2	this study	conductivity	chironomids	0.657 □	0.577 □
WAPLS–4	this study	conductivity	chironomids	0.652 □	0.593 □
$\mathrm{MAT}_{k=6}$	this study	conductivity	chironomids	0.646 □	0.635 □
$\mathrm{WA}_{\mathrm{cla/tol}}$	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.644 □	0.644 □
$\mathrm{ANN}_{\mathrm{neu}=4} - 1$	this study	conductivity	chironomids	0.641 □	0.585 □
$\mathrm{WA}_{\mathrm{cla/tol}}$	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.641 □	0.537 □
WAPLS–2	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.637 □	0.540 □
$\mathrm{ANN}_{\mathrm{neu}=3} - 1$	this study	conductivity	chironomids	0.636 □	0.594 □
$\mathrm{WMAT}_{k=3}$	this study	conductivity	chironomids	0.635 □	0.599 □
$\mathrm{WA}_{\mathrm{cla}}$	this study	conductivity	chironomids	0.627 □	0.646 □

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Tab. A.13 (continued): Transfer models for conductivity/salinity compared with literature data sorted after r^2_{LOO}. Note that Heinrichs et al. (2001) implements data from Walker et al. (1995). Boxes indicate values.

Model	Author	Variable	Taxa	r^2_{LOO}	RMSEP
PLS–1	Eggermont et al. (2006)	conductivity	chironomids	0.627	0.490
$\mathrm{MAT}_{k=3}$	this study	conductivity	chironomids	0.625	0.616
PLS–2	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.624	0.606
$\mathrm{WA}_{\mathrm{inv}}$	this study	conductivity	chironomids	0.620	0.604
WAPLS–5	this study	conductivity	chironomids	0.613	0.637
$\mathrm{WA}_{\mathrm{cla}}$	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.610	0.692
PLS–4	this study	conductivity	chironomids	0.608	0.639
WAPLS–1	this study	conductivity	chironomids	0.604	0.616
$\mathrm{WA}_{\mathrm{inv}}$	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.603	0.558
WAPLS–1	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.603	0.558
PLS–1	Zhang et al. (2007)	salinity	chironomids	0.602	0.408
$\mathrm{WA}_{\mathrm{cla/tol}}$	Zhang et al. (2007)	salinity	chironomids	0.597	0.435
$\mathrm{WA}_{\mathrm{inv/tol}}$	Zhang et al. (2007)	salinity	chironomids	0.594	0.415
PLS–5	this study	conductivity	chironomids	0.589	0.656
PLS–2	this study	conductivity	chironomids	0.581	0.631
PLS–3	this study	conductivity	chironomids	0.568	0.654
$\mathrm{WA}_{\mathrm{cla/tol}}$	this study	conductivity	chironomids	0.518	0.760
$\mathrm{WA}_{\mathrm{inv/tol}}$	this study	conductivity	chironomids	0.509	0.709
PLS–1	Heinrichs et al. (2001)	salinity (late summer)	chironomids	0.472	0.849
$\mathrm{ANN}_{\mathrm{neu}=2} - 1$	this study	conductivity	chironomids	0.455	0.729
PLS–1	this study	conductivity	chironomids	0.396	0.758
ML	this study	conductivity	chironomids	0.388	0.842
$\mathrm{ANN}_{\mathrm{neu}=4} - 0.001$	this study	conductivity	chironomids	0.200	0.961
$\mathrm{ANN}_{\mathrm{neu}=3} - 0.001$	this study	conductivity	chironomids	0.029	0.974
$\mathrm{ANN}_{\mathrm{neu}=2} - 0.001$	this study	conductivity	chironomids	0.000	0.979

Tab. A.14.: Comparison of TDS values in Zhang et al. (2007) with own measured data values based on weighted average values. Counted head capsules (n) and frequency (f) are given for both datasets. Suggested TDS values were estimated with TDS = 0.6735395 · *conductivity* ($r^2_{adj} = 0.996$) by regressing conductivity values on own measured salinity values. Values around 0 indicate a very good conformity; data sorted by increasing difference to Zhang et al. (2007) with boxes indicating %-values. Taxa not found in this study but by Zhang et al. (2007) are: *Zalutschia* sp., *Psectrocladius calcaratus* type, *Corynoneura lacustris* type; *Psectrocladius* sp3 is possibly covered partly by *Psectrocladius sordidellus/limbatellus* type.

Taxon	counted n, f : f_{Zhang}	Conductivity mS · cm^{-1}	Conductivity TDS	Zhang et al. (2007) TDS	Δ% compared to Zhang et al. (2007) $\left(\frac{TDS_{cond}}{TDS_{Zhang}} \cdot 100 - 100\right)$
Cladotanytarsus mancus type	4_n, $1_f : 2_f$	1.05400	709.91	695.03	2.14
Cricotopus sylvestris gr. indet 2	47_n, $14_f : 23_f$	5.04994	3,401.33	3,318.17	2.51
Cricotopus shilovae	42_n, $15_f : 14_f$	0.94890	639.12	860.83	−25.75
	(Values of *Euryhapsis* were used. Honqu Tang confirmed that misidentification in Zhang et al. (2007).)				
Ablabesmyia sp./ *Ablabesmyia monilis* type	14_n, $6_f : 8_f$	3.76207	2,533.90	3,819.85	−33.66
Cricotopus sylvestris gr.	8_n, $6_f : 23_f$	6.61600	4,456.14	3,318.17	34.30
Paratanytarsus sp.	296_n, $31_f : 24_f$	1.04920	706.67	1,409.85	−49.88
	(Values of all four *Paratanytarsus* taxa were used.)				
Glyptotendipes sp.	21_n, $7_f : 10_f$	0.77019	518.75	1,114.66	−53.46
	(Values of all two *Glyptotendipes* taxa were used.)				
Psectrocladius barbimanus/sokolovae	108_n, $18_f : 6_f$	13.22135	8,905.10	22,588.68	−60.58
Chironomus/Einfeldia sp. men3 man1/man2	14_n, $9_f : 11_f$	3.0026	2,022.40	6,821.44	−70.35
	(Values of *C. dorsalis* type were used as it is most likely *Chironomus/Einfeldia* sp. men3 man1/2)				
Tanytarsus gracilentus type/ *Tanytarsus/Corynocera* sp.	174_n, $21_f : 17_f$	3.54972	2,390.88	6,821.44	−64.95
	(Values of *Corynocera oliveri* were used as it is very similar to *T. gracilentus*. See notes for *T. gracilentus* type on page 143.)				
Paracladius sp.	20_n, $4_f : 7_f$	0.25340	170.67	626.13	−72.74
	(Values of all two *Paracladius* taxa were used.)				
Cricotopus/Orthocladius sp.	14_n, $12_f : 5_f$	7.40886	4,990.16	19,229.92	−74.05
Nanocladius sp.	9_n, $2_f : 4_f$	0.29200	196.67	1,168.93	−83.17
	(Values of all two *Nanocladius* taxa were used.)				
Procladius sp.	19_n, $15_f : 21_f$	3.02279	2,035.97	13,809.84	−85.26
	(Values of all two *Procladius* taxa were used.)				
Cryptochironomus sp.	8_n, $5_f : 5_f$	0.22975	154.75	1,283.64	−87.94
	(Values of all two *Cryptochironomus* taxa were used.)				
Polypedilum sp.	11_n, $3_f : 4_f$	0.14536	97.91	1,428.22	−93.14
	(Values of all two *Polypedilum* taxa were used.)				
Chironomus/Einfeldia sp.	379_n, $39_f : 25_f$	2.44081	1,643.98	842.22	95.20
	(Values of all 11 *Chironomus/Einfeldia* taxa were used except *C/E.* men3 man1 or man2.)				
Psectrocladius sordidellus/limbatellus	128_n, $19_f : 20_f$	0.12804	86.24	10,008.21	−99.14
Cricotopus sylvestris gr. indet 1	60_n, $16_f : 23_f$	20.70242	13,943.90	3,318.17	320.23
Tanytarsus sp.	103_n, $25_f : 17_f$	5.37794	3,622.26	780.54	364.07
	(Values of all two *Tanytarsus* taxa were used except *T. gracilentus* type and *Tanytarsus/Corynocera* sp.)				

Tab. A.15.: Comparison of estimated salinity/conductivity optima obtained from other published transfer models.

Taxon	Code	Suggested TDS $\left(\frac{mg}{l}\right)$	TDS Zhang et al. (2007) $\left(\frac{mg}{l}\right)$	Walker et al. (1995) $\left(\frac{mg}{l}\right)$	Notes Walker et al. (1995)	Rossaro et al. (2004) $\left(\frac{mg}{l}\right)$	Notes Rossaro et al. (2004)
Cricotopus/Orthocladius sp.	CrOrinde	4,990.16	19,229.92	21,135			
Chironomus/Einfeldia sp.	ChEiinde	1,588.13	842.22	1,738	*Chironomus* sp.		
Procladius sp.	Procinde	2,035.97	13,809.84	1,211			
Cryptochironomus sp.	Crycinde	154.75	1,283.64	1,079			
Glyptotendipes sp.	Glypinde	518.75	1,114.66	1,072	*Einfeldia/Glyptotendipes*		
Tanytarsini sp.	trTanyta	982.18		1,064			
Corynoneura/Thienemanniella sp.	CoThinde	10,137.37		634			
Polypedilum sp.	Polyinde	97.91	1428.22	573			
Dicrotendipes sp.	Dicrinde	30.31		422			
Nanocladius sp.	Nanoinde	196.67	1168.93	338			
Paratendipes nudisquama type	Patd?nus	5,9017.78		175	*Paratendipes* sp.	151.68	± 110.29 (11–425, n=19)
Heterotrissocladius marcidus type	Hete?mar	38.98		85	*Heterotrissocladius* sp.	99.95	± 151.41 (2–425, n=18)
Sergentia sp.	Serginde	21.63		83			
Tanytarsus gracilentus + *Tanytarsus/Corynocera* type	Tany?gra TaCoinde	2,390.88	6821.44			90.54	*T. gracilentus*: 90.54 ± 9.59 (72–109, n=11)
Paratanytarsus austriacus type	Part?aus	66.82				63.92	± 46.52 (7.4–230, n=16)
Tvetenia sp.	Tvetinde	396.71				36.5	*T. bavarica*: 48.44 ± 12.03 (7–124, n=11); *T. calvescens*: 24.56 ± 39.25 (4–339, n=230)
Eukiefferiella claripennis type	Euki?cla	398.4				35.6	± 36.81 (5–91, n=15)
Orthocladius frigidus type	Orth?fri	1,228.4				27.61	± 45.98 (4–425, n=238)

Continuing on next page

Tab. A.15 (continued): Comparison of estimated salinity/conductivity optima obtained from other published transfer models.

Taxon	Code	Suggested TDS $\left(\frac{mg}{l}\right)$	TDS Zhang et al. (2007) $\left(\frac{mg}{l}\right)$	Walker et al. (1995) $\left(\frac{mg}{l}\right)$	Notes Walker et al. (1995)	Rossaro et al. (2004) $\left(\frac{mg}{l}\right)$	Notes Rossaro et al. (2004)
Eukiefferiella sp.	`Eukiinde`	23.77				26.26	*E. brevicalcar*: 24.14 ± 51.69 (2–474, n=186); *E. claripennis*: 35.6 ± 36.81 (5–91, n=15); *E. fuldensis*: 11.42 ± 9.57 (4–124, n=103); *E. minor*: 33.88 ± 61.11 (6–474, n=137)
Corynoneura sp.	`Corninde`	277.16				11.29	*C. edwardsi*: 11.29 ± 7.55 (4–117, n=61)

Tab. A.16.: Abiotic data for sampling sites relevant in statistical analysis. For details see chapter Methods.

sample code	Lake's name	Latitude (°)	Longitude (°)	Elevation (m)	Depth sample (m)	Water area log 10 (m^2)	Conductivity ($\frac{mS}{cm}$)	salinity ($\frac{g}{l}$)	pH	Water temp. (°C)	T_{Jan} (°C)	T_{Feb} (°C)	T_{Mar} (°C)	T_{Apr} (°C)	T_{May} (°C)	T_{Jun} (°C)	T_{Jul} (°C)	T_{Aug} (°C)	T_{Sep} (°C)	T_{Oct} (°C)	T_{Nov} (°C)
Cha-01	Cha Hu	35.00272	97.63183	4282	0.20	6.63660	1.379	0.970	10.66	18.3	-15.15160	-12.06320	-6.41928	-0.89802	3.53406	6.87618	9.44850	8.85438	4.99445	-1.59489	-9.74219
Mad-01	NA	34.87469	98.15528	4244	0.20	5.49742	14.000	9.930	9.10	23.1	-16.43930	-13.53100	-7.96053	-2.57961	1.80186	5.09268	7.76174	7.24447	3.55833	-2.91486	-11.14740
YeR-08	NA	35.40528	99.43067	3937	0.20	3.60206	2.270	0.235	8.00	29.7	-13.68920	-10.08910	-4.21869	1.45174	5.79440	8.27967	11.28520	10.61660	6.49042	-0.02542	-8.09649
YeR-10	NA	34.92058	98.52081	4269	0.20	4.42379	0.115	0.110	10.43	16.0	-16.32010	-13.30280	-7.67306	-2.24017	2.12320	5.23885	7.99284	7.46242	3.73574	-2.72264	-10.97480
YeR-11	NA	34.91567	98.51338	4262	0.20	4.63241	2.483	1.754	9.83	17.4	-16.32520	-13.31440	-7.68761	-2.25745	2.10546	5.22724	7.97757	7.44725	3.72385	-2.73221	-10.98150
YeR-13	NA	34.86961	97.51083	4290	0.20	4.62815	0.590	0.603	10.83	15.6	-14.31770	-11.22490	-5.66673	-0.20997	4.16783	7.48051	9.97994	9.34738	5.54135	-0.96527	-8.94135
YeR-15	NA	34.90339	97.56250	4286	0.10	3.45102	3.470	2.000	9.75	17.4	-14.59780	-11.51220	-5.93190	-0.46134	3.93029	7.24968	9.77307	9.15400	5.33828	-1.18812	-9.21585
YeR-17	NA	34.92631	97.57631	4282	0.20	5.30030	4.450	2.600	10.27	17.5	-14.71840	-11.63150	-6.03659	-0.55407	3.84689	7.17160	9.70571	9.09201	5.26567	-1.27538	-9.32983
YeR-20	NA	35.02517	97.35350	4310	0.20	3.70131	0.654	0.662	9.31	9.0	-14.31650	-11.14280	-5.48861	0.08009	4.52058	7.87839	10.38510	9.74432	5.81836	-0.80201	-8.86149
YeR-26	NA	35.01278	97.57147	4310	0.10	2.84942	0.254	0.261	10.06	14.8	-14.98760	-11.87950	-6.23008	-0.69544	3.74056	7.08741	9.64710	9.04352	5.16628	-1.43329	-9.56637
YeR-27	NA	35.04697	97.90186	4260	0.05	6.98777	38.200	26.900	7.55	24.3	-16.17940	-13.15860	-7.48299	-1.96840	2.48229	5.82595	8.48242	7.94196	4.10791	-2.49579	-10.78980
YeR-28	NA	35.02747	98.05094	4257	0.20	4.90309	0.174	0.177	9.50	13.4	-16.35920	-13.38470	-7.73260	-2.26047	2.17427	5.49930	8.17927	7.65221	3.85365	-2.71347	-10.99970
YeR-34	NA	34.73811	98.11436	4242	0.10	2.60206	0.199	0.203	10.00	11.0	-15.85060	-12.96140	-7.47736	-2.17221	2.15374	5.41120	8.02686	7.48453	3.86908	-2.51433	-10.60300
YeR-43	NA	34.24664	97.84258	4754	0.20	2.98318	0.256	0.264	8.87	10.8	-13.29950	-10.44110	-5.26810	-0.21722	3.90849	7.04954	9.43887	8.78199	5.39472	-0.67204	-8.19072
YeR-44	NA	34.25394	97.84631	4740	0.20	3.78937	0.205	0.207	9.34	13.1	-13.33710	-10.47820	-5.30063	-0.24601	3.88268	7.02550	9.41815	8.76297	5.37233	-0.69918	-8.22631
YeR-47	NA	34.83186	98.33308	4225	0.10	4.30561	9.290	5.800	9.38	5.6	-16.49760	-13.61820	-8.04777	-2.66979	1.69189	4.95095	7.62930	7.10616	3.44336	-2.98056	-11.18930
YeR-48	NA	34.82794	98.36642	4228	0.10	4.32131	20.300	13.400	10.10	5.1	-16.43900	-13.54940	-7.97755	-2.59747	1.75904	4.99895	7.68140	7.15435	3.49072	-2.92586	-11.12600
YeR-49	NA	34.83106	98.38758	4230	0.20	3.84029	1.544	1.562	10.76	7.7	-16.40940	-13.50940	-7.93401	-2.55042	1.80437	5.03031	7.71802	7.18924	3.52209	-2.89366	-11.09300
Gah-01	Gahai	34.23539	102.32617	3485	0.01	6.50773	0.140	NA	9.66	11.4	-8.58177	-5.09732	0.35599	5.39524	9.21520	11.41150	14.14890	13.48170	9.66011	4.11182	-2.77619
Sic-07	NA	33.34086	101.11092	4030	25.30	5.71692	0.039	NA	8.00	11.1	-7.52953	-4.22807	0.74460	5.40648	8.79977	10.69350	14.07940	12.53330	9.25876	4.00311	-2.49955
Sic-08	NA	33.39869	101.10919	4028	0.40	3.64464	0.081	NA	7.80	16.7	-7.66892	-4.33579	0.66759	5.36185	8.77635	10.65590	14.04780	12.52210	9.22050	3.93056	-2.62087
Sic-12	NA	33.23109	101.13031	4222	22.00	5.30434	0.032	NA	8.08	9.6	-7.21619	-3.96454	0.94973	5.54783	8.89691	10.80640	14.19230	12.60100	9.37462	4.18408	-2.22319
Sic-13	NA	33.21550	101.11819	4307	39.90	5.18889	0.029	NA	8.03	10.0	-7.21667	-3.98159	0.92448	5.51567	8.86213	10.78420	14.15960	12.56800	9.35118	4.16987	-2.22644
Sic-15	Kasha lake	31.65603	100.25722	3534	10.10	5.93316	0.219	NA	8.77	16.7	-3.99837	-1.06420	3.04925	7.01645	10.76610	12.70970	14.50030	13.68030	11.23270	6.74251	0.84468
Sic-16	NA	31.11317	99.75531	4220	36.70	6.14322	0.045	NA	8.11	12.0	-2.17159	0.78129	4.66859	8.43722	12.37800	14.23730	15.46520	14.77760	13.04680	8.19678	2.55330
Sic-17	NA	31.24586	99.86261	4533	0.50	5.42795	0.022	NA	7.80	7.9	-3.11351	-0.22252	3.72786	7.57924	11.52040	13.43500	14.74530	14.08800	12.12280	7.43101	1.67201
Sic-25	NA	34.83406	99.10047	4679	0.50	3.17609	0.218	NA	8.80	11.5	-15.27440	-12.09520	-6.44850	-0.98635	3.28207	6.07061	8.88703	8.28637	4.55515	-1.76309	-9.85040
CTP-01	NA	30.22573	90.63222	4607	0.25	2.84880	0.372	NA	9.94	11.5	-8.39490	-4.95016	-1.03287	3.85139	8.27012	11.58740	11.93500	10.97010	9.03955	3.26049	-3.52741
CTP-02	NA	30.22578	90.63352	4607	0.45	4.39044	0.355	NA	10.70	12.8	-8.39194	-4.94758	-1.03037	3.85319	8.27192	11.58910	11.93630	10.97170	9.04132	3.26292	-3.52483
CTP-04	NA	31.09133	91.69239	4745	0.55	2.75205	0.447	NA	8.70	12.6	-11.80360	-8.37591	-3.97377	1.11490	5.71149	9.42781	10.45690	9.62301	7.07577	0.81940	-6.53097
CTP-06	NA	31.53750	91.44167	4570	0.70	5.68124	0.410	NA	10.02	12.7	-11.48510	-7.89366	-3.21792	2.05241	6.70070	10.43580	11.50200	10.62920	7.90947	1.51539	-5.94499
CTP-07	NA	31.53333	91.43333	4575	0.40	2.60206	0.926	0.200	10.50	13.3	-11.46300	-7.87079	-3.19724	2.07266	6.71997	10.45260	11.51460	10.64060	7.92435	1.53262	-5.92452
CTP-08	NA	32.18482	91.71229	4898	0.30	2.77815	0.495	NA	8.31	6.3	-12.51000	-8.82090	-3.76915	1.68870	6.44224	10.34300	11.68970	10.84730	7.77267	1.11480	-6.63651
CTP-10	NA	32.10877	91.28453	4672	0.70	3.55630	0.428	NA	10.40	11.4	-11.46140	-7.69649	-2.67584	2.80743	7.52975	11.32470	12.49680	11.59670	8.62911	2.04217	-5.59298
CTP-11	NA	32.10965	91.28379	4671	0.20	3.68124	0.570	NA	9.70	13.3	-11.46020	-7.69491	-2.67371	2.80994	7.53235	11.32730	12.49940	11.59910	8.63128	2.04409	-5.59123
CTP-14	NA	32.02741	90.51158	4681	0.95	5.84263	5.880	3.100	10.30	13.3	-9.60048	-5.68491	-0.68712	4.86112	9.53504	13.14810	14.02050	13.01540	10.21460	3.73533	-3.71030
CTP-16	NA	31.46768	90.03850	4673	0.80	6.10467	1.151	0.400	9.78	14.1	-8.15379	-4.27002	0.41054	5.82528	10.39680	13.81450	14.35880	13.29470	10.84030	4.61323	-2.53135
CTP-19	Datsa Co	31.82911	87.55698	4478	5.60	6.83922	31.100	19.100	10.04	14.6	-4.96413	-0.74292	4.35934	10.05150	14.42080	17.54110	17.71660	16.45940	14.11920	8.00719	1.04219
CTP-20	NA	32.09821	89.52790	4724	0.40	3.17609	0.233	NA	10.40	17.2	-7.33738	-3.18773	1.88466	7.57482	12.21200	15.62220	16.16290	15.02240	12.35010	5.94424	-1.32345
CTP-21	NA	31.36823	90.42113	4626	0.65	3.93425	1.513	0.600	10.35	14.1	-8.99070	-5.21546	-0.60668	4.72841	9.30398	12.78870	13.44170	12.43090	9.96098	3.73168	-3.45602
CTP-23	NA	32.54237	91.82277	5002	0.40	2.87506	0.194	NA	9.10	6.2	-12.98470	-9.23305	-3.97231	1.59379	6.40359	10.38730	11.87510	11.04420	7.77987	0.98023	-6.92369
CTP-25	NA	32.57214	91.85719	5133	0.40	3.69897	0.195	NA	8.45	8.0	-13.08340	-9.33205	-4.05474	1.51735	6.33304	10.32910	11.83770	11.01120	7.72694	0.91296	-7.00889
LBC-01	NA	29.78111	92.39229	4930	37.10	6.19280	0.020	NA	7.93	12.2	-2.29426	0.50967	3.91515	7.68275	11.63190	14.54080	14.70980	14.05470	12.50360	8.02099	2.16296
LBC-02	NA	29.79355	92.38990	5001	4.90	5.26659	0.037	NA	7.30	10.8	-2.38508	0.42368	3.83847	7.61693	11.57300	14.49000	14.66610	14.01020	12.45000	7.95138	2.07826
LBC-03	NA	29.79013	92.39249	5001	3.70	4.42943	0.036	NA	7.47	10.6	-2.35921	0.44773	3.85972	7.63474	11.58830	14.50300	14.67830	14.02280	12.46480	7.97108	2.10278
LBC-07	NA	29.76839	94.60960	4150	18.00	6.25036	0.015	NA	7.10	3.1	-0.54531	1.70033	4.76985	7.99934	11.27550	14.01260	15.25400	14.81710	13.08340	9.20381	4.17327
LBC-08	NA	29.75839	94.60837	4077	12.00	4.97187	0.015	NA	7.40	NA	-0.49591	1.74829	4.81594	8.03915	11.31180	14.04530	15.28410	14.84760	13.11510	9.24537	4.22082
LBC-09	NA	29.48565	96.66539	3920	0.50	6.82069	0.070	NA	7.47	11.9	-1.51076	0.11165	3.32051	6.76124	10.29240	13.13560	14.37740	13.75720	12.08460	7.98603	2.98338
Qai-03	Quinghai	37.16168	99.76312	3199	3.60	9.61296	18.600	12.200	9.33	13.1	-9.89738	-6.30799	0.48080	6.79206	11.64310	15.12330	17.43060	16.62760	11.65290	4.90895	-2.77713
Qai-06	Keluke Hu	37.28811	96.88681	2812	6.80	7.74249	1.054	0.400	8.52	15.0	-12.21300	-8.69011	-2.14267	4.03060	9.21623	12.88710	15.55150	14.77270	9.49019	2.16953	-5.73878
Qai-07	Xiaochai Damuhu	37.46298	95.57683	3174	0.30	7.66903	130.300	NA	8.40	13.3	-13.37830	-9.64011	-2.83297	3.54251	8.94407	12.76630	15.47660	14.73450	9.14323	1.46223	-6.69736
Qai-08	Da Sugan Hu	38.88772	93.89921	2796	3.40	8.48408	37.600	26.200	9.17	12.1	-12.68020	-8.60362	-1.55290	5.29203	11.14510	15.46690	17.93390	17.22230	11.17360	2.88349	-5.63793

Tab. A.16 (continued): Abiotic data for sampling sites relevant in statistical analysis. For details see chapter Methods.

sample code	Lake's name	T_{Dec} (°C)	T_{Annual} (°C)	P_{Jan} (mm)	P_{Feb} (mm)	P_{Mar} (mm)	P_{Apr} (mm)	P_{May} (mm)	P_{Jun} (mm)	P_{Jul} (mm)	P_{Aug} (mm)	P_{Sep} (mm)	P_{Oct} (mm)	P_{Nov} (mm)	P_{Dec} (mm)	P_{Annual} (mm)	Salinity ($\frac{g}{l}$)	Oxygen (%)	T_{H_2O} (°C)
Cha–01	Cha Hu	-14.64400	-2.25614	2.63575	3.21465	5.03120	7.74930	24.00480	51.26590	64.96220	58.16700	41.44900	16.31310	2.48721	1.61584	278.8960	0.970	127.0	18.3
Mad–01	NA	-16.02710	-3.78608	2.91350	3.60631	5.61585	8.70776	25.24890	55.96880	72.17210	64.97110	45.52070	18.32150	2.77266	1.86852	307.6880	9.930	130.0	23.1
YeR–08	NA	-12.93620	-0.44831	3.02964	3.93974	5.89568	12.60500	41.32800	60.31520	76.49800	66.88180	44.08210	19.45980	3.71314	1.80414	339.5520	0.235	82.0	29.7
YeR–10	NA	-15.88540	-3.56989	2.99207	3.58329	5.79072	9.90816	29.16750	58.30570	75.48650	66.47230	47.27460	19.34610	3.00984	1.83734	323.1740	0.110	118.0	16.0
YeR–11	NA	-15.89160	-3.58180	3.01597	3.59030	5.80647	9.90615	29.09740	58.34960	75.48130	66.36250	47.34110	19.35280	3.00885	1.84306	323.1550	1.754	177.0	17.4
YeR–13	NA	-13.78690	-1.57048	2.69888	3.26978	5.13061	7.86379	26.65200	54.57080	67.19070	59.82090	43.76560	16.83310	2.44239	1.55680	291.7950	0.603	176.0	15.6
YeR–15	NA	-14.07670	-1.81620	2.68997	3.26689	5.12141	7.86253	25.93760	53.78210	66.79120	59.57200	43.23810	16.75050	2.46453	1.58192	289.0590	2.000	113.0	17.4
YeR–17	NA	-14.20000	-1.91020	2.67672	3.25368	5.09892	7.83351	25.49620	53.19640	66.35190	59.23000	42.81900	16.64450	2.46864	1.58869	286.6580	2.600	163.0	17.5
YeR–20	NA	-13.75790	-1.34951	2.52378	3.04725	4.78610	7.33391	24.16640	49.99690	62.22080	55.45390	40.19760	15.52120	2.34136	1.48130	269.0710	0.662	84.0	9.0
YeR–26	NA	-14.46900	-2.07011	2.60741	3.17371	4.97056	7.64850	23.94630	50.85060	64.24340	57.47570	41.07370	16.11000	2.45491	1.58668	276.1410	0.261	168.0	14.8
YeR–27	NA	-15.72180	-3.27044	2.69272	3.31795	5.17379	8.01594	22.65720	50.71460	66.04110	59.48960	41.34100	16.68200	2.62011	1.74662	280.4930	26.900	56.0	24.3
YeR–28	NA	-15.90800	-3.52493	2.85753	3.51278	5.39045	8.31742	23.15690	52.05440	67.66000	60.94450	42.15110	17.12160	2.72597	1.85272	287.7450	0.177	170.0	13.4
YeR–34	NA	-15.42950	-3.36181	3.01206	3.70661	5.78464	8.94407	27.81350	59.57070	75.11880	67.30330	48.15300	19.05480	2.77058	1.84822	323.0800	0.203	102.0	11.0
YeR–43	NA	-12.82160	-1.37981	3.35357	3.99994	6.31342	9.67372	37.38810	72.29950	84.74070	74.45450	57.34710	21.41810	2.70528	1.71498	375.4090	0.264	110.0	10.8
YeR–44	NA	-12.86000	-1.40897	3.34759	3.99546	6.30487	9.66125	37.24390	72.10780	84.59500	74.35170	57.20740	21.38170	2.70592	1.71681	374.6190	0.207	169.0	13.1
YeR–47	NA	-16.08950	-3.87962	3.40642	3.71272	6.04037	9.65570	27.03100	58.48650	74.69780	64.15860	48.03090	19.26010	2.95441	1.95163	319.3860	5.800	76.0	5.6
YeR–48	NA	-16.02720	-3.81993	3.43789	3.71623	6.07812	9.81218	27.61100	58.96780	75.20220	64.31450	48.40880	19.41540	2.98107	1.94807	321.8930	13.400	70.0	5.1
YeR–49	NA	-15.99500	-3.78336	3.42797	3.71091	6.07872	9.87976	27.92220	59.12730	75.41880	64.48600	48.50300	19.47420	2.99321	1.94105	322.9630	1.562	91.0	7.7
Gah–01	Gahai	-7.71253	3.63353	4.26481	6.15929	17.11260	37.13290	80.15460	85.02190	97.84660	85.35610	80.58940	47.28950	8.28117	2.46753	551.6760	NA	162.0	11.4
Sic–07	NA	-7.10914	3.65587	4.23014	4.77408	12.87160	30.31240	81.47020	114.17300	113.11200	85.51150	99.35450	45.12930	6.49687	1.94411	599.3790	NA	107.0	11.1
Sic–08	NA	-7.24033	3.58655	4.10507	4.71466	12.65620	29.95400	80.98510	112.98400	112.59800	85.71110	98.07550	44.60450	6.43874	1.91140	594.7380	NA	140.0	16.7
Sic–12	NA	-6.81161	3.83712	4.39794	4.87854	13.27990	31.06680	82.59820	116.47400	114.06300	85.45100	101.81800	46.23030	6.62149	1.99633	608.8740	NA	109.0	9.6
Sic–13	NA	-6.81412	3.81705	4.48595	4.90104	13.33850	31.10540	82.56710	116.75900	114.22100	85.14870	102.13500	46.29000	6.62600	2.01285	609.5900	NA	115.1	10.0
Sic–15	Kasha lake	-3.70959	5.94657	3.94758	8.25871	15.36380	33.12700	76.07120	129.77500	111.29200	96.07630	115.51400	49.16670	7.56896	4.13099	650.2920	NA	122.4	16.7
Sic–16	NA	-1.90895	7.51555	2.88954	6.25449	11.95360	25.81650	60.44870	118.04400	115.84700	100.28400	102.80800	39.71980	5.82987	3.28970	593.1840	NA	105.5	12.0
Sic–17	NA	-2.81152	6.65554	3.25450	7.01640	12.88420	27.57490	64.38220	122.73000	115.99600	100.95300	106.65900	42.16940	6.30747	3.63583	613.5630	NA	97.0	7.9
Sic–25	NA	-14.77750	-2.52742	3.63752	3.66914	6.52397	12.73380	39.44140	67.15630	84.59950	68.94410	54.32540	22.17900	3.48913	1.79117	368.4900	NA	130.0	11.5
CTP–01	NA	-7.76317	2.77727	1.34590	0.55994	2.08439	3.81872	16.23900	72.98400	125.06500	131.36700	60.00560	10.08540	1.25643	1.21066	426.0220	NA	43.0	11.5
CTP–02	NA	-7.76039	2.77938	1.34531	0.55984	2.08450	3.82023	16.24610	72.98740	125.06900	131.37100	60.00460	10.08390	1.25658	1.21050	426.0390	NA	55.0	12.8
CTP–04	NA	-11.09910	0.18507	1.94303	0.97314	2.89166	5.04165	20.04620	76.04540	108.73700	112.11400	60.77770	14.20870	1.97927	2.08471	406.8430	NA	43.5	12.6
CTP–06	NA	-10.69550	0.94244	1.87781	0.93548	2.72588	4.75953	18.78300	71.65680	103.33100	106.41700	57.22510	13.23260	1.85833	1.97004	384.7720	NA	37.5	12.7
CTP–07	NA	-10.67350	0.96101	1.87394	0.93270	2.72000	4.74994	18.75070	71.62050	103.41700	106.52200	57.20850	13.20300	1.85313	1.96401	384.8150	0.200	81.0	13.3
CTP–08	NA	-11.63770	0.51751	2.04903	1.06693	2.92660	5.07675	19.56540	69.88330	93.35130	95.07140	55.02890	14.11460	2.05856	2.22547	362.4180	NA	6.4	6.3
CTP–10	NA	-10.57340	1.51852	1.86297	0.93532	2.62760	4.58600	17.84110	67.22450	95.85670	98.32620	53.44050	12.57650	1.80054	1.93218	359.0100	NA	51.4	11.4
CTP–11	NA	-10.57200	1.52060	1.86274	0.93518	2.62710	4.58516	17.83760	67.21400	95.84690	98.31620	53.43230	12.57370	1.80015	1.93179	358.9630	NA	50.0	13.3
CTP–14	NA	-8.67550	3.34681	1.53179	0.70202	2.08841	3.69985	14.69650	62.09680	99.59860	103.33900	50.27080	9.78862	1.33775	1.40876	350.5590	3.100	39.0	13.3
CTP–16	NA	-7.28505	4.28849	1.28355	0.51822	1.74856	3.15175	13.03440	61.89920	109.03300	114.30900	51.05490	8.15985	1.02302	1.02893	366.2440	0.400	27.0	14.1
CTP–19	Datsa Co	-3.87938	7.88222	0.81236	0.47061	0.84139	1.83088	7.83115	48.77140	104.17600	110.93600	41.52560	3.18187	0.25720	0.20018	320.8350	19.100	18.8	14.6
CTP–20	NA	-6.33837	5.73417	1.12588	0.41914	1.40558	2.57408	10.60490	54.56560	101.91800	107.01600	45.30550	6.21421	0.75955	0.76296	332.6720	NA	35.4	17.2
CTP–21	NA	-8.16188	3.33485	1.43501	0.62247	2.01278	3.58884	14.66290	65.24330	109.13800	113.99300	53.37050	9.56115	1.24348	1.27174	376.1430	0.600	32.8	14.1
CTP–23	NA	-12.06420	0.37647	2.12726	1.12810	3.01034	5.20730	19.83680	68.62130	87.97050	88.99420	53.63400	14.46050	2.14607	2.34063	349.4770	NA	NA	6.2
CTP–25	NA	-12.16040	0.30414	2.14434	1.14059	3.03485	5.24706	19.96340	68.69880	87.43750	88.36580	53.63540	14.58070	2.16829	2.36698	348.7840	NA	NA	8.0
LBC–01	NA	-1.63177	7.14158	1.04499	1.77041	7.26682	18.86600	40.41830	95.07050	131.05700	132.75200	72.79400	16.47360	2.37498	0.71813	520.6060	NA	135.0	12.2
LBC–02	NA	-1.72328	7.07323	1.05200	1.76067	7.21786	18.71710	40.22140	94.88390	130.86300	132.57600	72.66590	16.44010	2.37081	0.73218	519.5000	NA	110.0	10.8
LBC–03	NA	-1.69681	7.09230	1.05128	1.76597	7.24052	18.78140	40.30740	94.97030	130.90200	132.60100	72.72580	16.46730	2.37438	0.72881	519.9160	NA	110.0	10.6
LBC–07	NA	0.51887	8.04945	2.29498	4.86078	17.07460	42.63370	74.68580	135.54800	122.17400	114.98100	100.43400	36.47570	5.33536	1.17857	657.6770	NA	NA	3.1
LBC–08	NA	0.56892	8.08957	2.28633	4.84251	17.09200	42.78000	74.78180	135.38300	121.92800	114.68600	100.37600	36.40900	5.30248	1.16839	657.0350	NA	NA	NA
LBC–09	NA	-0.31410	6.94834	5.76285	9.86197	20.16390	42.54350	67.51590	103.35800	127.43000	121.25800	78.51560	42.82190	6.71666	3.74540	629.6940	NA	NA	11.9
Qai–03	Quinghai	-8.31392	4.76687	3.43130	3.71569	5.10849	10.47190	24.03880	34.94390	45.60050	43.97490	27.15440	11.73580	3.23639	2.21940	215.6320	12.200	88.0	13.1
Qai–06	Keluke Hu	-10.78120	2.34443	3.86549	3.97972	4.07549	4.86726	14.36750	26.97010	27.41570	22.48160	11.72850	4.53673	2.23231	1.90721	128.4280	0.400	330.0	15.0
Qai–07	Xiaochai Damuhu	-11.97840	1.75750	2.26383	2.00430	2.01467	1.94242	10.48110	19.30260	19.63800	15.99320	7.83090	1.94800	1.11492	0.83075	85.3646	NA	101.0	13.3
Qai–08	Da Sugan Hu	-11.25740	3.43655	0.79830	0.59017	0.57893	0.78816	2.88706	7.35104	8.60897	6.60101	1.55104	0.34764	0.36941	0.27416	30.7459	26.200	89.0	12.1

Tab. A.17.: Taxa's counted abundances. Broken head capsules were summed up and the total number was rounded up to integer. Abbreviations see on pages VI–VIII and details for taxa on page 119.

sample code	Abla?mon	Ablainde	Acriind1	Acri?lon	Acri?luc	Acriinde	faChiro1	faChiro2	sfChiron	trChiron	ChEiinde	ChEimen1	ChEim1m1	ChEim1m2	ChEim1m3	ChEimen2	ChEim2m1	ChEim2m2	ChEim2m3	ChEimen3	ChEim3m1	ChEim3m2	ChEim3m3	Clat?man	Concinde	Corn?asc	Corn?arc	Corn?scu	Corninde	CoThinde	Cric?bic	CrOrinde	Cricsano	Cricshil	Cricgsyl	Cricgsy1	Cricgsy2	Cric?tib	Cryc?fud	Crycinde	sfDiame1	sfDiame2	sfDiame3	sfDiame4	Dicrinde	Euki?cla	Euki?grc	Eukiinde	EuTvinde	Glyp?pae	Glypinde
Cha-01	0	0	0	15	0	0	0	0	0	0	1	1	0	1	0	1	1	2	0	1	2	1	0	0	0	0	0	1	0	1	0	2	0	1	0	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mad-01	0	2	0	5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YeR-08	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	2	0	0	0	5	0	2	0	0	0	2	1	0	0	1	1	0	1	0	0
YeR-10	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
YeR-11	0	0	0	42	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YeR-13	0	0	0	4	0	0	0	0	0	1	1	1	0	0	0	4	0	0	0	6	0	0	0	0	0	0	0	1	1	0	0	0	0	3	0	4	2	0	1	0	0	0	0	0	0	0	0	0	0	0	1
YeR-15	0	0	0	57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YeR-17	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	59	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YeR-20	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YeR-26	0	0	0	19	0	0	0	0	0	0	1	0	0	1	0	3	1	8	0	1	0	1	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YeR-27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YeR-28	0	1	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
YeR-34	0	0	0	16	0	0	0	0	0	1	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
YeR-43	0	0	0	10	0	1	0	0	0	0	2	6	5	3	0	5	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
YeR-44	0	0	0	8	0	0	0	0	0	0	0	2	1	0	0	3	1	0	0	2	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YeR-47	2	0	0	12	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
YeR-48	0	0	0	20	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YeR-49	1	1	0	3	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Gah-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Sic-07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	2	1	0	0
Sic-08	0	0	0	26	0	0	0	0	0	0	1	10	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sic-12	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	1	0	2	0	0	3	0	2	1	0	0
Sic-13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sic-15	6	0	0	0	0	0	0	0	0	0	0	3	21	16	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sic-16	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	2	0	0	0
Sic-17	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sic-25	0	0	0	3	0	0	0	0	0	0	2	9	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTP-01	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	3	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTP-02	0	0	0	10	0	0	0	0	0	0	1	2	2	0	0	1	0	1	0	0	0	1	2	0	0	6	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTP-04	0	0	0	9	0	0	0	0	0	0	0	6	2	1	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTP-06	0	0	0	2	0	0	0	0	0	0	0	2	3	3	9	1	0	1	1	2	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	4	0
CTP-07	0	0	0	27	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTP-08	0	0	0	32	0	1	0	0	0	0	0	1	2	0	0	2	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTP-10	0	0	0	1	0	2	0	0	0	1	0	3	7	0	2	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTP-11	0	0	0	10	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTP-14	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTP-16	0	0	0	0	0	0	0	13	0	1	0	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTP-19	0	0	51	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTP-20	0	0	0	0	0	0	0	0	1	1	0	4	1	0	1	0	0	0	0	0	0	0	0	0	0	1	12	2	1	3	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	8	4
CTP-21	0	1	0	5	0	0	0	0	0	0	0	6	1	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTP-23	0	0	0	16	0	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CTP-25	0	0	0	7	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LBC-01	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LBC-02	0	0	0	0	0	0	0	2	1	0	3	5	5	3	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LBC-03	0	0	0	0	0	0	0	1	0	0	2	5	1	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LBC-07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
LBC-08	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	6	0	0
LBC-09	0	0	0	0	0	0	0	0	1	4	0	7	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Qai-03	0	0	0	0	0	0	0	0	0	8	4	0	0	0	0	5	0	1	0	10	1	0	0	0	0	0	0	0	0	0	0	1	0	0	2	16	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Qai-06	0	0	0	0	0	0	0	0	1	0	4	8	2	12	1	2	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	1	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Qai-07	0	0	24	0	2	0	7	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Qai-08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

sample code	Hete?mar	Limninde	Metr?eur	Micr?ari	Micr?ins	Micr?jun	Micr?rad	Micrinde	Nano?rec	Nanoinde	sfOrthoc	Orth?fri	Orth?obu	Parl?con	Parlinde	Part?aus	Part?dis	Part?pen	Partinde	Patd?nus	Poly?nub	Polyinde	Proc?cho	Procinde	Psec?bas	Psec?obv	Psec?sop	Psec?sol	Psecinde	Psed?per	Psesind2	Psesinde	Saetinde	Serg?lov	Serginde	Sticinde	Sticind1	sfTanypo	trTanyt1	trTanyta	TaCoinde	Tany?gra	Tany?lap	Tanyinde	Thil?vit	Tvetinde
Cha-01	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	7	0	0	0	0
Mad-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	0	0	0	1	0	21	0	0	0	6	0	0	0	0	0	0	0	0	3	0	2	1	6	0	0	0	0
YeR-08	0	1	2	0	0	0	0	2	0	0	5	4	6	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	4	0	0	0	1	0	1
YeR-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	27	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0
YeR-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
YeR-13	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	8	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	19	0	7	0	0	0	0
YeR-15	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
YeR-17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YeR-20	1	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	1	0	0	0	0	0	0	9	0	0	0	2	0	0	0	0	0	0	0	0	0	0	12	1	8	0	0	0	0
YeR-26	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	12	0	0	0	0
YeR-27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YeR-28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	7	0	0	0	1	0	13	0	0	0	1	0	0	0	0	0	0	0	0	0	0	22	2	4	0	0	0	0
YeR-34	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	1	0	0	2	0	0	3	0	0	4	3	0	1	0	0	0	0	0	0	1	0	18	0	0	11	1	0	0
YeR-43	0	0	24	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	8	0	0	1	0	0	0
YeR-44	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	7	0	28	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0
YeR-47	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	2	0	0	0	0	0	0	0	0	6	0	9	0	9	0	1	0	0
YeR-48	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	3	0	0	0	0	0	5	1	1	0	1	0	0	0	0	0	0	0	0	1	0	8	0	6	0	0	0	0
YeR-49	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	7	21	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	1	0	13	2	7	0	0	0	0
Gah-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	8	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	1	0	0
Sic-07	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	27	1	0	3	0	0	4	0	0	0	0	1	1
Sic-08	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	5	0	20	0	1	0	0	0	0	0	0	8	1	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0
Sic-12	1	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	14	6	0	0	0	0	13	0	0	2	0	0	1
Sic-13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	2	0	0	0	0	6	0	0	1	0	0	0
Sic-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sic-16	1	1	0	0	0	0	0	0	0	0	3	0	3	3	2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	11	0	0	0	0	1	0
Sic-17	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7	1	3	0	12	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	0	0	20	1	0	0
Sic-25	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	14	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0
CTP-01	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	5	2	7	5	2	0	0
CTP-02	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	16	3	0	0	0
CTP-04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	10	0	2	2	0	0	0
CTP-06	0	0	0	0	0	0	0	0	3	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	3	0	0	0	0	0	0	0	0	8	2	2	0	1	0	0
CTP-07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	0	0	0	0	1	2	0	0	0	0	0	1	1	0	0	0	0	0	0	0	7	1	7	0	0	0	0
CTP-08	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	18	0	0	1	2	0	0
CTP-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	18	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	6	0	0	1	0	0	0
CTP-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	1	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	24	1	6	0	3	0	0
CTP-14	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3	0	2	0	0	0	0	0	0	0	0	0	0	2	2	38	1	0	0	0
CTP-16	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	2	2	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	1	7	0	0	0	0
CTP-19	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
CTP-20	0	0	0	0	0	0	0	0	4	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
CTP-21	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	2	0	0	0	0	1	0	1	5	0	0	0	0	0	0	0	0	0	0	7	0	18	1	3	0	0	0	0
CTP-23	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	13	0	0	6	1	0	0
CTP-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	10	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	0	21	0	1	6	1	0	0
LBC-01	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	36	0	0	3	0	0	0
LBC-02	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	2	0	0	0	0	0	0	0	0	0	0	6	0	0	2	0	0	0
LBC-03	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	3	0	0	0	1	0	0	0	0	35	1	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0
LBC-07	1	0	0	2	4	4	7	11	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	6	0	0	15	0	0	0
LBC-08	12	0	2	2	0	0	0	2	0	0	6	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	1	0	0	0	0	0	0	0	0	1	4	7	0	0	2	0	0	1
LBC-09	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	3	1	2	0	0	0	0	0	0	0	0	0	0	42	0	0	0	0	0	0
Qai-03	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	1	1	4	0	0	0	4	0	0	1	6	0	0	0	0	2	0	3	0	0	0	0	0	0
Qai-06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	12	0	1	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
Qai-07	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	3	0	0	3	1	0	0
Qai-08	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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