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ORIGINAL PAPER

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Soil diatom communities from Ile de la Possession (Crozet, sub-Antarctica)

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Abstract An ecological study of soil diatoms on Ile de la Possession (Crozet Archipelago, sub-Antarctica) was carried out during the austral summer of 1998/1999. Both diatom and chemistry data were collected. A highly diverse diatom flora of 230 taxa, belonging to 39 genera were identified from 104 samples. Several of them are considered to be new. The most abundant genera were *Diadesmis*, *Achnanthes* and *Pinnularia*. Principal Component Analysis (PCA) was used to classify the samples based on their chemical characteristics. Moisture and nutrients were the main factors separating three groups of samples: dry fellfield soils, soils influenced by marine animals and mesic valley soils. Species assemblages correspond well with this division. Forward Selection with Monte Carlo permutations was used to reduce the number of significant variables. The analysis selected moisture, phosphate and sulphate concentrations. Based on the analysis, the same three groups of the PCA were found. Weighted averaging and calibration were used to develop a statistical transfer function to infer the moisture content of soils from the diatom assemblages.

Introduction

The Crozet Archipelago (45°48′–46°26′S, 50°14′–52°15′E) is a group of five small islands located in the southern Indian Ocean (Fig. 1), 2,400 km from the coasts of South Africa and the Antarctic Continent, lying just north of the Antarctic Convergence. The main island is Ile de la Possession with a surface area of 156 km^2. More details regarding climate and vegetation of the island are given in Van de Vijver and Beyens (1999a).

During the past few years, a number of papers have been published on diatoms from Ile de la Possession, describing diatom communities in freshwater habitats and moss vegetation (Van de Vijver and Beyens 1999a, b). Terrestrial diatoms form a major constituent of soils in the subantarctic region (Hahn and Neuhaus 1997) but, unfortunately, they remain poorly studied. Germain (1937) and Larson (1974) published papers on diatoms from a peat core on Kerguelen. However, papers dealing with the actual soil diatom flora are scarce. Bunt (1954) analysed the diatom composition in soils from Australian Macquarie Island while, in 1998, Van de Vijver and Beyens published the first, though preliminary, results from Ile de la Possession. During a second sampling campaign in 1999, a new set of soil samples was collected from other locations than those in 1998. In contrast to the first paper, we now present all necessary environmental data and we relate the occurrence of diatom taxa and their communities to differences in their chemical and physical habitat.

This study aims to enlarge our knowledge of the actual diatom communities that occur in the soils of Ile de la Possession and reveal the principal factors that influence them. We focus in detail on the influence of moisture, since this is a highly variable parameter in subantarctic soils. The results will later be used in a further study involving the subfossil diatom composition in some of the larger valleys of the island, in order to reconstruct the moisture history of the past 2,500 years.

Materials and methods

Sampling

Sixty soil samples were collected on Ile de la Possession (Fig. 1) during the austral summer of 1999/2000. Sampling sites were randomly chosen from the entire island. Soil samples were taken after removal of the vegetation, at a depth of 10 cm, and stored in 50-ml PVC bottles after adding 3% formaldehyde. In order to determine

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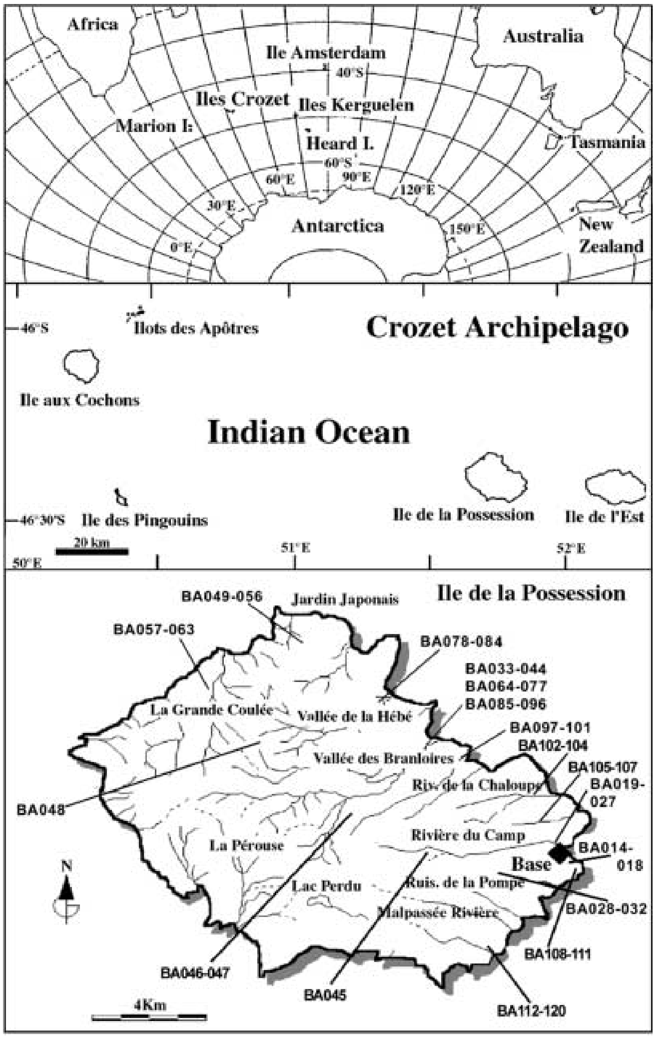

Fig. 1. Sketch map of Antarctica, the Crozet Archipelago and Ile de la Possession showing the location of the different sampling sites (only first and last sample numbers are shown)

the differences in diatom composition due to soil moisture content, a representative range in moisture content was selected. An additional 44 samples were taken (Fig. 1) and analysed for the development of the moisture transfer function. No other physico-chemical data are available for these samples, so they were excluded from all other statistical analyses.

Laboratory methods

A complete physico-chemical analysis was performed using a Palintest interface field spectrophotometer. Details of the analytical methods are fully described in MacQuaker (1976). The soil material was treated for chemical analysis following the method of the Dutch Normalisation Institute. First, soil material was dried, weighed and suspended in distilled water. Later, water was filtered (using a Whatman 3 filter) and the chemical analyses were performed on the filtered water. pH and conductivity were measured using a WTW Multiline P4 on the filtered water. Soil moisture was measured using the Eijkelkamp TRIME-FM. This device creates an electromagnetic field between two probes and measures moisture by the Time Domain Reflectometry method (Topp 1980). Probes with a length of 11 and 15 cm were used. The value given by the TRIME is total volume percentage. Table 1 lists all samples together with their physico-chemical characteristics.

Diatom slides were prepared following the method of Van der Werff (1955). A small sample was treated with 37% H_2O_2 and saturated $KMnO_4$ in order to remove all organic material. To speed up the reaction, samples were heated on a hot plate for a short period. Cleaned diatom valves were mounted in Naphrax. In each sample, a total of 500 diatom valves were identified and enumerated on random transects at ×1,000 under oil immersion objectives, using an Olympus BX50 microscope equipped with Nomarski optics. It sometimes proved difficult to obtain large counts with this material. Even after scanning entire slides at ×1,000, some samples yielded less than 300 valves. Considering the extreme environments involved, these numbers seemed acceptable (Beyens 1989). Light micrographs were taken to identify difficult taxa.

Identifications of so-called "Antarctic" species were based on Bourrelly and Manguin (1954), Le Cohu and Maillard (1983, 1986), Schmidt et al. (1990) and Oppenheim (1994). Nomenclature follows Krammer and Lange-Bertalot (1986–1991) and Lange-Bertalot (1993), except for the species transferred to *Luticola* and *Diadesmis* by Round et al. (1990). For *Achnanthes*, taxonomy was based on Lange-Bertalot and Krammer (1989), and for *Pinnularia* on Krammer (2000).

Samples and slides are stored at the University of Antwerp (RUCA), Department of Biology, Unit of Polar Ecology, Limnology and Paleobiology.

Data analysis

All environmental variables, except for pH, were log-transformed since they had skewed distributions. After this transformation, no skewed distributions were shown. The data set was first screened to remove rare taxa. If a diatom taxon was not present in at least three samples with a relative abundance of 1%, it was considered a "rare" taxon and removed from further statistical analysis.

The statistical techniques used in this study are described in full detail in Jongman et al. (1987). Ordination analysis was performed using the computer program CANOCO (ter Braak 1987) version 4.0 (ter Braak and Smilauer 1998). We used Principal Component Analysis (PCA) to determine the major directions of variation in the chemical variables in this data set. The PCA was based on a standardized correlation matrix of the transformed chemical data. In order to perform a cluster analysis, all soil chemistry data were ln-transformed. A hierarchic-agglomerative clustering, based on minimum variance strategy with the Squared Euclidian Distance as dissimilarity measure, was used to classify the samples (Kovach Computing Services 1993). Due to a gradient length of 2,3, a unimodal method was appropriate. Therefore, a Canonical Correspondence Analysis (CCA) was used to detect patterns of variation in the species data which can be explained by environmental variables (Jongman et al. 1987). Since not all of the 8 environmental variables influence the diatom distributions independently, we used CCA with forward selection and unrestricted Monte Carlo permutation test (999 permutations, $P \leq 0.05$).

Weighted averaging regression and calibration (Line and Birks 1990) using the program WACALIB (version 3.0) were used to determine the optima and tolerances of the most common species for soil moisture. The optima were calculated for moisture content of the soil by using simple weighted averaging with inverse deshrinking. Bootstrap estimates were used afterwards to obtain valid r^2 correlation values for the transfer function. Species data were weighted by abundance. A minimum occurrence in three samples was needed for taxa to be included in the analysis.

Results

Species composition

A total of 230 taxa (including species, varieties and forms) representing 39 genera were recorded. Only 82 of

Table 1. Physico-chemical results of samples from Ile de la Possession

Sample	pH	Conductivity (μs cm^{-1})	PO_4 (mg/l)	NH_4 (mg/l)	Cl (mg/l)	SO_4 (mg/l)	Hardness (mg/l $CaCO_3$)	Soil moisture (%)
BA14	5.5	198	0.56	1.1	0	28	15	28.63
BA15	5.4	795	2.1	1.8	0	0	0	25.57
BA16	6.1	172	0.78	0.79	3.9	3	0	31.17
BA17	6.4	864	7.8	11.6	0	0	0	40.47
BA18	5.8	279	0.86	5.4	0	5	10	44.37
BA19	5.3	296	0	3.75	21.6	0	0	89.47
BA20	5.1	346	0.35	5.2	4.6	1	5	87.57
BA21	5.8	58	0.3	0.73	3.6	0	0	33.37
BA22	5.5	211	0.12	4.5	10.8	0	10	69.43
BA23	5	164	1.46	8.1	5	0	0	40.33
BA24	5.1	322	2.3	4.4	0	0	0	81.83
BA25	5.2	137	5.7	5.1	0	0	0	43.17
BA26	6.6	453	2.7	0.56	2.7	12	15	16.90
BA28	6.7	41	0.09	0.25	27	104	0	19.60
BA29	6.7	41	0.09	0.2	6.6	54	0	19.23
BA30	6.3	208	0.36	1.85	15	0	0	47.80
BA31	6.1	72	0.1	1.25	9.1	10	0	35.43
BA32	5.7	792	3.5	0.2	23	0	15	30.97
BA33	6.1	245	2.9	2.6	17	0	0	69.13
BA34	6.1	750	5.9	1.84	18	0	35	100.00
BA35	6.1	1.22	0.48	1.86	13	29	0	81.70
BA36	4	848	10	0.64	100	0	20	25.33
BA37	6.4	141	3.15	0	13	0	0	46.97
BA38	7	40	0.54	0.3	12.5	0	0	10.73
BA39	6.2	51	3.5	0.42	29.5	0	0	23.07
BA40	6.4	96	0.65	3.85	6.5	0	0	81.27
BA41	7	1196	0.46	1.05	40	44	5	18.13
BA42	6.4	295	2.05	2.75	13.5	0	0	32.97
BA43	6.1	260	0.87	2.75	20	0	0	30.17
BA44	6.7	51	0.08	0.4	7.6	0	0	9.20
BA45	6.1	225	0.27	2.25	20.5	14	5	36.97
BA47	6.7	50	0.48	0.31	22.5	9	10	5.00
BA48	7.1	46	0.15	0.32	23	9	0	0.00
BA49	5.3	960	4.3	1.1	19.5	13	5	36.73
BA50	4.8	2000	6.75	0.83	680	0	30	41.87
BA51	5.8	977	6.2	1.16	16.5	6	65	45.43
BA52	6.9	8.2	4.12	1.96	15	1	75	31.17
BA53	6.5	775	6.32	11.6	33	16	80	56.13
BA54	5.8	648	4.05	2.04	340	8	20	49.87
BA55	6.2	711	16	10.08	37	0	70	59.53
BA56	7.8	960	2.45	1.16	7.9	96	20	0.00
BA57	5	757	1.2	4.6	295	9	0	33.87
BA60	6.6	100	0.08	0.31	52	0	0	47.63
BA62	5.9	168	1.25	4.32	22.5	0	10	55.03
BA64	6.1	73	0.92	0.86	15	8	5	48.87
BA66	5.8	365	1.8	1.1	14	0	0	100.00
BA69	5.2	1173	6.2	0.82	21.5	0	5	100.00
BA71	5.2	392	1.36	3.08	17	0	0	100.00
BA73	6.2	341	2.56	2.9	40	0	20	59.63
BA80	6.4	242	3.24	2.4	19.5	0	0	54.30
BA83	7.2	141	0.64	1.64	17	0	0	50.57
BA85	5.9	640	3.2	1.26	2.35	0	0	50.30
BA87	6.6	123	0	0.29	21.5	27	35	79.97
BA089	5.4	305	0.88	2.32	32	0	0	65.87
BA091	5.3	72	0.04	0.083	14.5	0	0	81.03
BA94	4.3	1139	7.4	0.38	34	8	30	18.57
BA99	7.2	368	5.2	5.92	23	14	5	6.97
BA101	5.2	310	5.2	7.04	40	0	0	46.20
BA102	5.9	440	0.52	4	18.5	0	0	99.33
BA106	5.8	612	6.2	0.34	36	0	25	65.50

these have relative frequencies $>1\%$ in at least 3 samples, and have been retained for numerical analysis.

The highest number of taxa (i.e. 84 including 7 marine taxa) was recorded in sample BA041, a relatively dry sample taken near the coastline of Baie Americaine. The fewest taxa indentified were seven (samples BA036, BA043). The mean number of taxa is 33, which is quite high for soil samples.

Table 2. Relative importance of the main diatom genera (% abundance of all counted valves)

Diadesmis	28.8
Pinnularia	18.7
Achnanthes s.l.	12.9
Fragilaria s.l.	11.4
Navicula s.l.	11.2
Nitzschia	0.4
Others	16.6

Among the most important taxa, many are considered to have a typical Antarctic distribution, including *Achnanthes confusa* Manguin, *A. aueri* Krasske and *Fragilaria maillardii* Le Cohu. The counts were dominated by individuals of the genus *Diadesmis* (Table 2). Almost 29% of all counted valves belonged to this genus. *Diadesmis* is very widespread on Ile de la Possession, with quite a lot of new taxa that still need to be described. The descriptions of the new taxa (i.e. *Diadesmis comperei*, *D. crozetikerguelensis*, *D. ingeae*, *D. vidalii*, *D. latestriata*, *D. korruganensis*, *D. langebertalotii*) are to be published elsewhere (R. Le Cohu and B. Van de Vijver, unpublished work, and B. Van de Vijver, P. Ledeganck, L. Beyens, unpublished work). The overall dominance of *Diadesmis* is typical for soils. *Diadesmis* was followed by *Pinnularia* (19%), *Achnanthes* (12%), *Fragilaria* and *Navicula* (both 11%).

A small portion of all counted valves belonged to marine genera such as *Fragilariopsis*, *Grammatophora*, *Pseudogomphonema* and *Thalassionema*. This is easily explained by the immediate vicinity of the ocean. Due to heavy winds, the influence of seaspray on the nearby soils is quite obvious.

Soil chemistry

To summarize the major patterns of variation within the chemistry data, a PCA (Fig. 2a) and cluster analysis (Fig. 2b) were performed. The results are shown as a PCA-correlation biplot and a dendrogram. Long arrows represent the environmental variables that explain most variation and are therefore more important within the data. The angles between their vectors reflect the varying degree of colinearity between them. Small angles between biplot arrows indicate generally high positive correlations. The cluster analysis was used to determine the different groups within the PCA analysis.

The first two PCA axes account for 60.4% of the variation within these data with eigenvalues of $\lambda 1 = 0.342$ and $\lambda 2 = 0.261$. The eigenvalues for subsequent axes are much lower ($\lambda 3 = 0.155$ and $\lambda 4 = 0.100$) and these are not dealt with any further. Axis 1 probably reflects a salinity and/or nutrient gradient, as these two groups of variables (Hardness and Cl vs PO_4 and COND) are closely linked. The second axis is clearly a moisture gradient. The results of the cluster analysis confirm the PCA results. Three different groups are found. The first group contains only samples taken from soils that were subject to some sort of animal influence (penguin rookeries, elephant seal beaches, wandering albatross nesting areas). These areas are clearly characterized by high inputs of nutrients and salinity. On the other side of the first axis, group 3 is positioned grouping samples from so-called fellfield

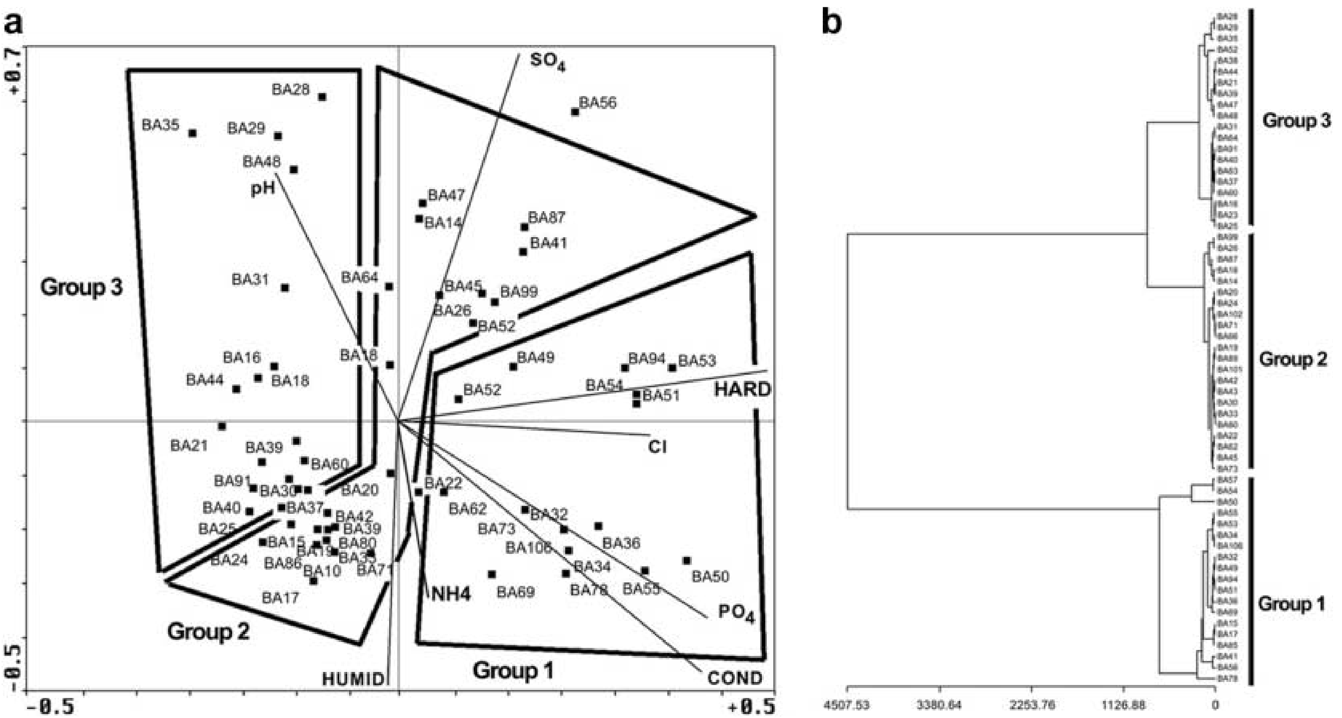

Fig. 2. Principal Components Analysis (PCA) correlation biplot of samples of PCA axis 1 and PCA axis 2; sites are arranged according to their chemistry data, and cluster dendrogram showing all sites based on chemistry data. The different groups that can be identified are shown on the *right*

areas, characterized by poor nutrient conditions and high pH values. Almost no vegetation cover (only *Poa annua* L., *Deschampsia antarctica* Desv. and *Poa cookii* Hook are capable of surviving here) was observed on these grounds. These samples are usually situated at a higher elevation (>200 m), on the top of steep hills that border the larger valleys on the island. Finally, the last group (i.e. group 2) is composed of fairly acid soils with a normal, well-developed vegetation of mosses, grasses and ferns. Samples in this group are not confined to a typical habitat and are usually found in the (larger) valleys of the island.

Diatom analysis

A preliminary CCA ordination was performed using all eight variables. The first two axes collectively explain 10.0% of the variance in the diatom data [$\lambda 1 = 0.376$ (5.6%), $\lambda 2 = 0.289$ (4.4%)]. This low percentage is not surprising. It is typical for noisy data sets containing many zero values (Stevenson et al. 1991). The species-environment correlation was 0.86 for CCA axis 1 and 0.81 for CCA axis 2, which translates to a total of 46.2% of the diatom-environment relationship being explained. This high value demonstrates a strong relationship between the diatoms and the measured environmental parameters. Monte Carlo unrestricted permutation tests performed on the first two axes showed that both were statistically significant ($P < 0.005$).

The original set of eight parameters was then reduced using forward selection and further unrestricted permutations. Humidity, PO_4 and SO_4 were selected. A CCA of the 60 samples in the data set constrained to these 3 selected environmental variables (Figs. 3, 4) explains 55.6% of the total variance in the diatom-environment relationship. No other individual variables explained significant additional proportions of variance within the diatom assemblage data.

In a CCA diagram, arrow length indicates the importance of the variable and its orientation reflects the correlation with the axes. Axis 1 is strongly related to moisture (inter-set correlation = 0.78), separating all samples with high moisture degrees (>90%) on the low right side from the very dry samples on the left side. These dry samples were mostly collected on the fellfields and on other barely vegetated areas. Xerophilic taxa and genera such as *Diadesmis* (DCOM, DCRO, DVID), *Luticola mutica* Kützing (LMUT) and *Pinnularia borealis* var. *scalaris* (Ehrenberg) Rabenhorst (PBSC) dominate the dry samples while the more humid samples are characterized by taxa such as *Eunotia paludosa* Grunow (EPAL). The latter samples were taken at lower altitudes, mostly in the larger valleys where the extreme humidity of the soil facilitates peat-formation, resulting in low pH values (<5.5) and low nutrient conditions.

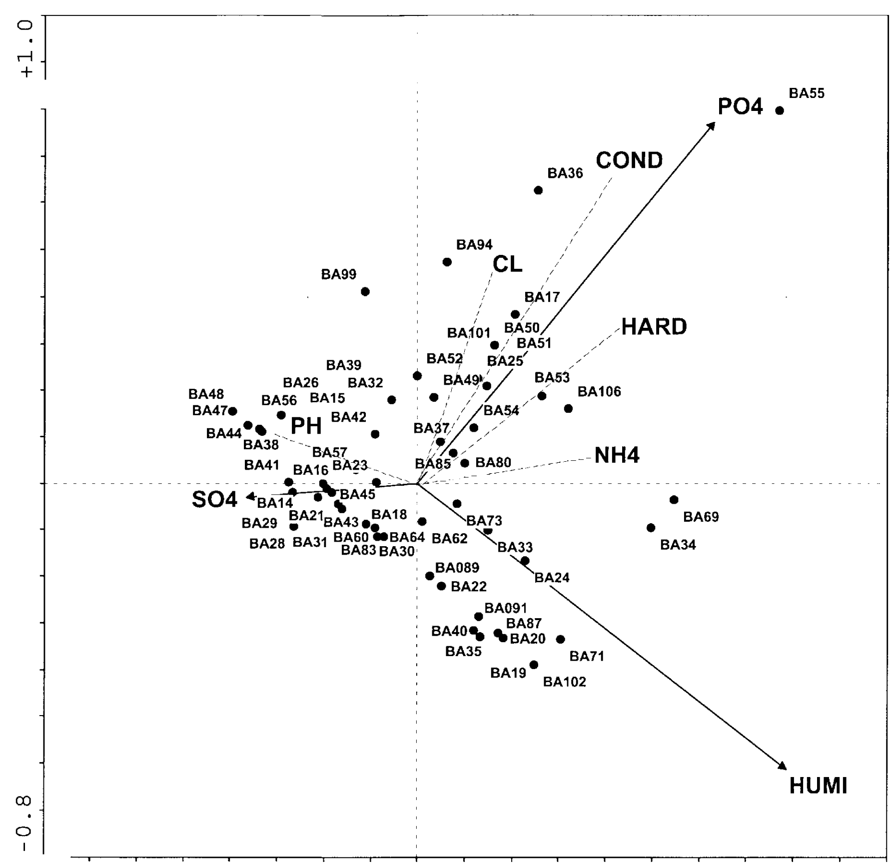

Fig. 3. Canonical Correspondance Analysis (CCA) ordination diagram showing the relationship between sites and environmental variables (not all sites are labelled). *Solid arrows* indicate environmental variables as detected by forward selection. *Dashed arrows* show all other variables. CCA axes 1 and 2 are shown

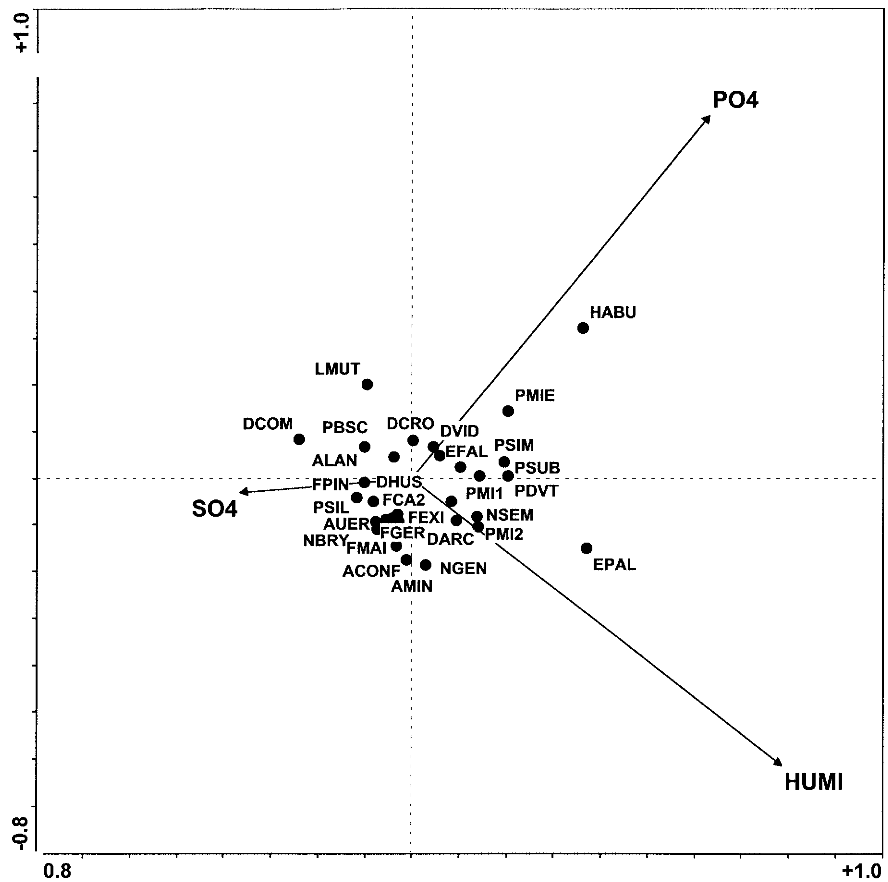

Fig. 4. Canonical Correspondence Analysis ordination diagram showing the principal taxa and their relationship with the environmental variables (*ACON Achnanthes confusa*, *ALAN A. lanceolata*, *AMIN A. minutissima*, *AUER A. aueri*, *DARC Diadesmis arcuata*, *DCOM D. comperei*, *DCRO D. crozetikerguelensis*, *DVID D. ingeae*, *DHUS Diatomella hustedtii*, *EFAL Eunotia fallax*, *EPAL E. paludosa*, *FCA2 Fragilaria capucina*, *FEXI F. exigua*, *FGER F. germainii*, *FMAI F. maillardii*, *FPIN F. pinnata*, *HABU Hantzschia abundans*, *LMUT Luticola mutica*, *NBRY Navicula bryophila*, *NGEN N. geniculata*, *NSEM N. seminulum*, *PBSC Pinnularia borealis* var. *scalaris*, *PDVT P. divergentissima*, *PMI1 P. microstauron* morp. 1, *PMI2 P. microstauron* morp. 2, *PMIE P. microstauron* var. *elongata*, *PSIL P. silvatica*, *PSIM P. similiformis*, *PSUB P. subcapitata*)

Axis 2 is related to the phosphate concentration of the samples (inter-set correlation = 0.76), grouping samples with high phosphate levels on the top right while samples with very low phosphate concentrations are situated on the left side. Most phosphate-enriched samples come from areas where the animal influence was clearly visible. Sample BA36, for instance, was taken behind the cabin at Baie Americaine where elephant seals lie all year round (personal observation), while sample BA50 was collected near a macaroni-penguin rookery. These samples were dominated by *Pinnularia microstauron* var. *elongata* Manguin (PMIE) and *Hantzschia abundans* Lange-Bertalot (HABU), while in the phosphate-poor samples, high frequencies of *Navicula bryophila* Petersen (NBRY) and *A. aueri* (AUER) were recorded.

Development of a diatom-based moisture transfer function

This survey showed clearly that humidity was the principal factor influencing the soil diatom communities. Van de Vijver and Beyens (1999a) revealed a similar relationship between the moisture values of moss vegetation and diatoms assemblages on the island.

The moisture content can therefore be inferred from the soil diatom communities using weighted-averaging regression and calibration. When the calibration is performed, it is clear that a linear relationship between inferred and observed *F*-values is revealed (Fig. 5, $r^2 = 0.68$, $n = 104$). This signifies that the diatom-predicted values for soil moisture compare well with the actual measurements. Weighted averages (also referred to as "optima") for the principal diatom taxa with respect to moisture are shown in Fig. 6. These weighted average values improve and extend our knowledge of the ecology

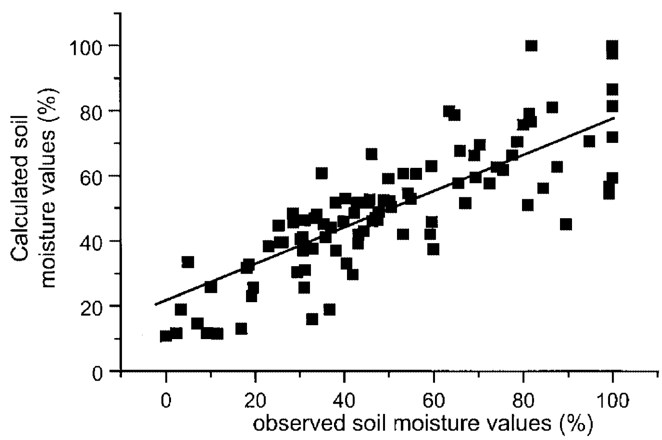

Fig. 5. Plot of observed versus inferred moisture content. Linear regression equation is $y = 0.6399{*}x + 18.017$, where x and y are the observed and the calculated moisture values, respectively. The *dark squares* represent the different samples

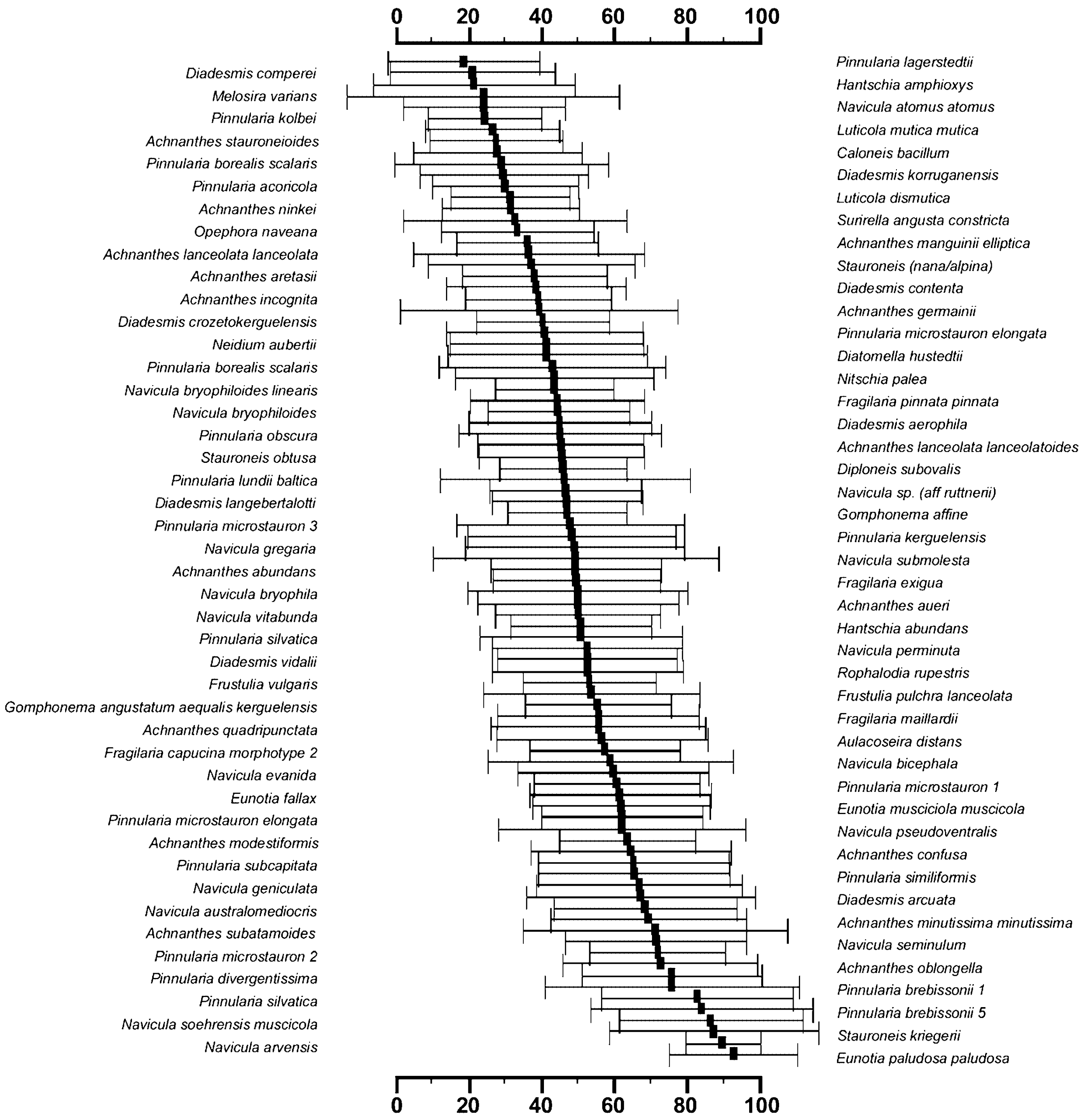

Fig. 6. WA optima and tolerances for soil moisture illustrated in ascending order for the principal diatom taxa used to develop the model

of terrestrial subantarctic taxa. The data can be used afterwards for paleo-ecological interpreations of peat cores.

Discussion

The soils on Ile de la Possession form an ideal habitat for many diatom taxa, resulting in high species numbers, including a large number of typical subantarctic taxa. In 1998, a preliminary study was published on the soil diatom flora of Ile de la Possession (Van de Vijver and Beyens 1998), indicating a high taxonomical diversity. The diatom composition as observed in the soils is quite different from the composition in the freshwater [domination of *Fragilaria* (Van de Vijver and Beyens 1999b)] and moss [clear domination of *Achnanthes* s.l. (Van de Vijver and Beyens 1999a)] habitats.

The genus *Diadesmis* is quite well represented in the soils, both in number of taxa and in number of individuals. The high number of new *Diadesmis* taxa that have to be described from these samples is not surprising. *Diadesmis* is a very recently re-erected but poorly studied genus, typical for dry and semi-wet soils (Moser et al. 1998). The presence of the same taxa on Kerguelen (R. Le Cohu, personal comment) indicates the close floristic relationship that exists between these islands in the southern Indian Ocean, reinforcing the idea of a distinct diatom-floristic region in the southern hemisphere.

Both chemistry data and diatom distributions indicate that moisture and phosphate are the major factors grouping and separating soils on Ile de la Possession. Based on the PCA and CCA results, the soils can roughly be divided into three different groups: a first group containing all samples influenced by the presence of animals; a second group of soils primarily found in the larger valleys; and finally a third group of dry (mostly fellfield) soils. Moisture separates the first two groups from the third while phosphate is responsible for the differentiation of groups 1 and 2. The diatom flora reflects these divisions and produces an excellent response to the measured chemistry data.

The three groups are briefly discussed below.

Soils influenced by animals

Ile de la Possession contains high numbers of marine mammals (elephant seals and fur seals) and birds (including penguins, albatrosses and petrels). These animals occupy the coastline around the island often forming huge colonies. The Pointe Basse area in the northwestern part of the island has high animal numbers. Van de Vijver and Beyens (1999b) have already reported the presence of a typical diatom community in pools and lakes that are influenced by elephant seals and penguins, with *F. pinnata* Ehrenberg, *Pinnularia kolbei* Manguin and *A. delicatula* (Kützing) Grunow being the most typical species. It is clear that the soils that surround these pools are also highly influenced by the animals, which is reflected in both high nutrient (PO_4 and NH_4) and high salinity (mostly Cl) conditions. The effects are visible on the vegetation which is characterized by *Poa annua* and *Cotula plumosa* Hook. The soils are dominated by *Diadesmis crozetikerguelensis* (manuscript name), *Pinnularia microstauron* var. *elongata* and *L. mutica*.

Fellfield soils

The higher slopes and plateaux on the island are sparsely vegetated and consist mostly of rocky and/or stony substrates. Water runs easily through these soils, leaving them quite dry between periods of rainfall. The nutrient conditions are very poor (NH_4 < 0.25, PO_4 < 0.1 mg/l) while the pH is considerably higher than in other soils on the island (pH > 6.7). This is reflected in the diatom species composition of these areas. Taxa that are capable of surviving in those extreme environments are: *Diadesmis ingeae* (manuscript name), *Pinnularia borealis* var. *scalaris*, *Orthoseira roeseana* (Rabenhorst) O'Meara, *A. germainii* Manguin, *A. stauroneioides* Manguin and *Frustulia cirisii* (manuscript name). The community has already been described by Van de Vijver and Beyens (1998) when it was named the *Diadesmis contenta*-assemblage. A similar community was also found in extreme dry mosses on the island (Van de Vijver and Beyens 1999a). However, at that time, the taxonomical status of *Diadesmis contenta* was unclear. After reexamining some samples, most of the valves are more likely to belong to *Diadesmis ingeae*.

Valley soils

Fellfield soils and soils influenced by marine animals do not reflect the average soil diatom composition that can be observed on Ile de la Possession. They both produce some kind of natural stress (drought or increased nutrients) that affects the diatom flora. In the valleys, the diatom flora is not influenced by decreasing water content or too much nutrient and salinity input. These soils are dominated by *E. paludosa*, *A. aueri* and *F. maillardii*. The *E. paludosa* community was previously reported from acid soils in the larger valleys (Vallée des Branloires, Vallée de la Hébé) where the pH values are quite low (< 5.5). Frenot (1986) measured extremely low pH values, due to the peat-formation. In the smaller valleys, only slightly lower pH values were recorded, resulting in the presence of a more circum-neutral, aerophilous diatom flora, dominated by several *Achnanthes* taxa and *F. maillardii*.

Conclusions

A highly diverse soil diatom flora was found in all soil samples, dominated by *Diadesmis* (with several new species), *Achnanthes* and *Pinnularia*. The community analysis revealed the presence of three groups of samples: samples from dry fellfield soils, samples taken from soils influenced by animals, and samples from mesic valley soils. The main parameter that is responsible for this division seems to be moisture. A transfer function for moisture was calculated.

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